

대한척추신경외과학회

창립 30주년

제31차 정기학술대회

2017년 9월 15일 / 금 ~ 16일 / 토
연세대학교 백양누리 지하1층



*Beyond the Miracle,
Challenge to the Future*

주최  대한척추신경외과학회
The Korean Spinal Neurosurgery Society

주관  대한신경외과학연구재단
THE KOREAN NEUROSURGICAL SOCIETY

 대한신경외과학회
THE KOREAN NEUROSURGICAL SOCIETY



창립 30주년을 맞은
대한척추신경외과학회

‘지난 30년의 영광과 기적을 넘어
다음 30년을 향한 새로운 도약’

*Beyond the Miracle,
Challenge to the Future*

INVITATION



존경하는 회원 여러분,

창립 30주년을 맞은 대한척추신경외과학회. 우리나라 척추 건강을 위하여 국민들에게 한걸음 다가가는, 열린 자세의 Made in 척추신경외과의 새로운 도약이 펼쳐지는 2017 대한척추신경외과학회 제31차 정기학술대회를 개최 하게 된 것을 전 회원들과 함께 깊이 감사 드립니다.

그 어느 해보다 변화가 많은 격동과 생동감 넘치는 가을, 31회를 맞이한 대한척추신경외과학회가 활기찬 막을 올립니다.

지난 30년의 길고 긴 시간 동안 지속적으로 변화하는 척추 의료 시장의 요구에 대해 생각하고 적응해나가면서 독자적인 포지션을 얻었고, 국내외 척추 분야에서 그 누구도 대체할 수 없는 절대적인 영향력을 행사하는 학술대회 이기에 매년 대한척추신경외과학회의 위상이 더욱 높아졌습니다. 이러한 의미에서 이번 학회는 국내외 척추학회 회장님들을 모시고 지나간 30년을 돌아보며 다가오는 30년을 계획하는 학회로서, 중장기 발전 전략을 토의하며 급변하는 척추의료시장에서 국민들의 척추 건강을 지키기 위한 우리의 Vision 과 Mission을 공유하는 중요한 자리가 될 것입니다. 머물지 않는 지속적인 변화는 우리 학회의 숙명이며 끊임없이 발전하는 것은 당연한 일입니다. 이러한 정신으로 우리 대한척추신경외과학회는 절대로 멈추지 않을 것입니다.

특히 과거의 유산과 새로운 혁신 사이에서 주변의 의료 환경에 조화로운 균형을 찾는 것이 학회와 회원 여러분들께 남겨진 키워드 일 것입니다. 이번 31차 정기 학술대회를 통하여 우리 모두 열심히 노력하고 서로 소통하고 비전을 공유, 실천 함으로써 새로운 30년을 위한 위대한 첫 발자국을 시작할 수 있기를 기대합니다.

2017. 9

대한척추신경외과학회 회장 조용은

Program At a Glance

2017. 9. 15 (Fri.)

	아트홀	그랜드볼룸	Poster
08:00			
09:00			
10:00	10:00-12:00 Pre Congress NECA Symposium 척추 진료의 사회경제적 함의		
11:00			
12:00			
13:00	13:10-14:10 Symposium I: Hot Issue in Spine Care I [척추변형 연구회] Comprehensive Approach of Spinal Deformity Surgery Through Sagittal Spinal Balance	13:10-14:10 Symposium I: Hot Issue in Spine Care I [기초연구회] The Current Basic Research in the Korea Spinal Neurosurgery Society	
14:00	14:10-15:10 Symposium I: Hot Issue in Spine Care I [경추 연구회] Noteworthy Topics in Korean Cervical Spine Research Society in 2016	14:10-15:10 Symposium I: Hot Issue in Spine Care I [척추종양 연구회] Recent Management of Extradural Tumor	
15:00			15:10-15:30 Poster View
16:00	15:30-16:30 Symposium II: Hot Issue in Spine Care II [최소침습 척추학회] MISS Suggestion for Pure Lumbar Foraminal Stenosis Management	15:30-16:30 Symposium II: Hot Issue in Spine Care II [골다공증 연구회] Considerations in the Medical Treatment of Osteoporosis	
17:00	17:00-18:30 대한척추신경외과학회 30주년 기념행사		
18:00			
19:00			

2017. 9. 16 (Sat.)

	아트홀	그랜드볼룸 A	그랜드볼룸 B	Poster
08:00	08:00-09:00 Free Paper I : Basic Research In Spine Disorders	08:00-09:00 Free paper I : Minimal Invasive Surgery	08:00-09:00 Free Paper I : Degenerative Cervical Spine	
09:00	09:00-09:20 Award Presentation Session			
	09:20-10:00 Guest Lecture I			
10:00				
	10:30-11:30 Best Paper Competition			
11:00				
	11:30-12:10 Guest Lecture II			
12:00		12:10-13:00 Luncheon Seminar I	12:10-13:00 Luncheon Seminar II	
13:00	13:00-13:50 Plenary Session 대한척추신경외과 중장기 발전 전략 수립을 위한 포럼			
	13:50-15:10 Symposium III: Innovation in Neurospine Care			
14:00				
15:00				15:10-15:30 Poster View
	15:30-16:30 Update on Spinal Cord Injury Management [Emerging Technology]	15:30-16:30 Biospine [Emerging Technology]	15:30-16:30 Predictive Analytics in Spine Surgery Outcomes [Emerging Technology]	
16:00				
	16:30-17:30 Free Paper II : Aging Spine / Osteoporosis	16:30-17:30 Free Paper II : Cord Tumor / Trauma Spine	16:30-17:30 Free Paper II : Infection / Deformity / 기타	
17:00				
18:00				
19:00				

Program

2017. 9. 15 (Fri.)

아트홀

10:00-12:00	Pre Congress NECA Symposium Socioeconomic Implications of Spine Care	좌장 : 서울대 정천기
12:30-13:00	등록	
13:00-13:05	개회	학술이사 윤승환
13:05-13:10	개회사	회장 조용은
Symposium I: Hot Issue in Spine Care I		
척추변형 연구회	Comprehensive Approach of Spinal Deformity Surgery Through Sagittal Spinal Balance	좌장 : 한림대 문승명, 가톨릭대 이진식
13:10-14:10	1. Radiographic Assessment Using Novel Imaging Modality 2. Cervical Alignment and its Clinical Relevance 3. Current Strategies for the Restoration of Adequate Lumbar Lordosis 4. Complications and Risk Stratification in Deformity Surgery	충남대 최승원 / 20 서울대 현승재 / 21 연세대 김경현 / 22 연세대 하 윤 / 23
경추연구회	Noteworthy Topics in Korean Cervical Spine Research Society in 2016	좌장 : 성균관대 신현철, 고려대 박윤관
14:10-15:10	1. Cost-Effectiveness Analysis of Single Level Anterior Cervical Discectomy and Fusion and Cervical Disc Replacement 2. Surgical Timing Affects Survival in Patients with Cervical Metastasis 3. The Change of Cervical Spine Curvature After Laminoplasty in Patients Who were Diagnosed with Cervical Spondylotic Myelopathy Without OplI; Minimum 2 – Year Follow-Up 4. Postoperative Changes in Deep Cervical Extensor Muscle Volume: Comparison Between Unilateral Conventional Open Door and Contralateral Deep Extensor Muscle Preserving Approach for Laminoplasty at Same Patients	한림대 오재근 / 28 성균관대 박종혁 / 30 국군수도병원 문정현 / 32 경상대 이영석 / 36
15:10-15:30	Coffee Break & Poster View	
Symposium II: Hot Issue in Spine Care II		
최소침습 척추학회	MIS Suggestion for Pure Lumbar Foraminal Stenosis Management	좌장 : 세란병원 박성춘, 조선대 이승명
15:30-16:30	1. Minimized Solution by Percutaneous Endoscopic Lumbar Foraminotomy 2. New Trial of MISS: Percutaneous Biportal Endoscopic Approach for Lumbar Foraminal Stenosis 3. Not enough.. a More Thorough Ecompression Only by MED Paraspinal Approach 4. Not Stable. Proven Longevity for Efficacy by MIS-TLIF	수원나누리병원 김현성 / 39 수원월스기념병원 허동화 / 41 가톨릭대 김진성 / 43 연세대 박정윤 / 45
17:00-18:30	대한척추신경외과학회 30주년 기념행사	진행 : 총무이사 이상구
18:30-19:00	Transfer to 그랜드볼룸	
19:00-	Gala Dinner 그랜드볼룸	

Program

2017. 9. 15 (Fri.)

그랜드볼룸

10:00-12:00 **아트홀**
Pre Congress NECA Symposium

12:30-13:00 **등록**

13:00-13:10 **아트홀**
개회
개회사

Symposium I: Hot Issue in Spine Care I

기초연구회

The Current Basic Research in the Korea Spinal Neurosurgery Society

좌장 : 계명대 **김인수**, 연세대 **김금년**

- 13:10-14:10
1. Improvement for Regional Bone Formation and Osteointegration Between Orthopedic Device and Osteoporotic Bone in Animal Study 순천향대 **정제훈** / 52
 2. Combining Stem Cells and TUDCA for Spinal Fusion as an Alternative to Bone Morphogenetic Proteins 차의과대 **한인보** / 53
 3. Crispr Application on Spine Research Field. – Human Primary Ligamentum Flavum Cell Gene Editing 고려대 **허준석** / 55
 4. The Effect of Ursodeoxycholic Acid in Spinal Cord Injury: in Vitro and in Vivo Study 차의과대 **손세일** / 57

척추종양 연구회

Recent Management of Extradural Tumor

좌장 : 한양대 **백광흠**, 이화여대 **조도상**

- 14:10-15:10
1. Osteosarcoma & Ewing Sarcoma 성균관대 **이선호** / 62
 2. Chordoma 원자력의학원 **장응규** / 64
 3. Giant Cell Tumor 연세대 **이성** / 66
 4. Multiple Myeloma 인제대 **이창현** / 68
- 15:10-15:30 Coffee Break & Poster View

Symposium II: Hot Issue in Spine Care II

골다공증 연구회

Considerations in the Medical Treatment of Osteoporosis

좌장 : 전남대 **이정길**, 순천향대 **도재원**

- 15:30-16:30
1. 골다공증 치료시 알아야 할 보험 인정 기준: 검사 및 약제 선택 동국대 **정주호** / 72
 2. 골다공증 치료 약제 선택 시 알아야 할 주의 사항과 금기 경북대 **조대철** / 81
 3. 골다공증 치료 반응의 모니터링 경희대 **김승범** / 88
 4. 골다공증 치료 가이드 라인 (골대사학회 및 골다공증 학회 권고안) 인제대 **진용준** / 93

16:30-17:00 Transfer to **아트홀**

17:00-18:30 **대한척추신경외과학회 30주년 기념행사** **아트홀** 진행 : 총무이사 **이상구**

19:00- Gala Dinner

아트홀

08:00-09:00	Free Paper I	
	Basic Research In Spine Disorders	좌장 : 인제대 정용태, 국민건강보험공단 일산병원 장호열
FP I-1	척추변형 및 다분절 척추 재수술에서 아우트리거 로드기술을 이용한 수술적 치료	경희대 윤상덕 / 97
FP I-2	염증반응 이후 경막세포의 유착기전 연구 : integrin $\alpha 2\beta 1$ 을 통한 collagen 결합능 상승과 matrix metalloproteinase의 역할	고려대 문홍주 / 98
FP I-3	Strategy for personalized medicine based on ALS patient-derived stem cells using CRISPR/Cas9-mediated genome editing	연세대 윤여민 /100
FP I-4	NIHS DB를 이용한 경추 후종인대골화증 환자의 발생률, 사망률 및 다른질환과의 연관성 연구	연세대 김진호 /101
FP I-5	파킨슨병의 비운동증상과 척추 수술 후 섬망과의 관계	연세대 김진호 /102
FP I-6	황색인대 골화증을 가진 환자에서 흉수병증의 정도에 영향을 주는 영상적 파라미터	울산대 이병주 /103
FP I-7	근육섬유세포와 황색 인대 비후 활동성	고려대 허준석 /104
FP I-8	비타민 D와 척추체주변근육과의 연관성 : 인체 자료와 실험쥐모형에서의 분석	경북대 방우석 /105
FP I-9	수술을 요하는 요추 추간판탈출증 환자의 신체계측 분석	서울부민병원 이동엽 /107
FP I-10	Sprague-Dawley rats 에서 경추 2번 신경 절단후 냉각이질통:실험실 조사	경북대 조대철 /108
FP I-11	30대 이상의 정상 한국인에서의 시상면 균형에 관한 연구	차의과대 손세일 /109
FP I-12	퇴행성 척추 질환 환자에게 Fitbit을 이용한 수술후 신체 활동 측정을 통한 예후 분석	연세대 강지인 /110
09:00-09:20	Award Presentation Session	좌장 : 중앙대 김영백, 의료중재원 박형천
	[우수논문학술상]	
	The Effect of Cell Penetrating Peptide Combine with Runx2 On Mesenchymal Stem Cells	서울대 양승헌, 박성배 /113
09:20-10:00	Guest Lecture I	좌장 : 부산대 송근성, 경희대 김성민
	1. Surgery of Spinal Ependymoma	Asia Spine President, Osaka City University, Japan Kenji Ohata /118
	2. Anterior Surgery in Thoracolumbar Spine	President, Korean Society of Spine Surgery, Aju University, Korea Chang-Hoon Jeon /119
10:00-10:30	<i>Coffee Break & Poster View</i>	
10:30-11:30	Best Paper Competition	좌장 : 서울대 정천기, 경북대 성주경
BPC-1	시상면 불균형을 보이는 요추부 후만증에 대한 교정 수술 후 발생하는 PJF와 PJK의 유발 인자 및 방사선학적 결과	경희대 임유석 /123
BPC-2	경추척추변형분류의 교정 제안: 다분절 후방경추유합술 이후 장기간 추적 자료를 이용한 분석	서울대 현승재 /125
BPC-3	파킨슨 병과 골다공증성 척추 골절 : 한국인 대상 코호트 연구	계명대 이창규 /126
BPC-4	2016년 WHO 분류기준에 따른 4등급 악성 척수 수질내 교모세포종에서, 유전자변형이 생존분석과 예후에 미치는 영향	연세대 이 성 /127
BPC-5	퇴행성 척추 질환의 치료를 위한 Oblique lateral lumbar interbody fusion (OLIF) 시행 후 요추 4-5 번 추간판 부위의 요근 (Psoas muscle)의 용적 변화 양상 : 수술 중 발생한 요근의 손상에 따른 근위축의 양상 및 임상적 결과에 따른 요근의 변화 양상	가톨릭대 조현진 /129
BPC-6	새로운 비구속 타입의 인공 디스크를 사용한 경추 하이브리드 유합술의 인접 분절 퇴행과 운동성 보존에 대한 영향	가톨릭대 허정우 /131
BPC-7	중증도 성인 시상면 변형과의 관련 인자 분석	인하대 류달성 /133

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BPC-8	후방 접근법 척추체 제거 및 전후방 유합술을 위한 허리신경총의 해부학적 고찰; cage 진입을 위한 공간 측정	울산대 김문규 /134
11:30-12:10	Guest Lecture II 좌장 : 가톨릭대 조경석, 성균관대 어 환	
	1. Diffusion Tensor Imaging and Cervical Myelopathy	President, Disorders of the Spine and Peripheral Nerves, ANS / CNS Medical College of Wisconsin, USA Marjorie Wang /140
	2. The Definition Change of ir/Reducible AAD and Following Treatment Strategy	President, China Neurosurgical Society, China Feng Zeng Jian /143
12:10-13:00	Luncheon Seminar 그랜드볼룸 A, B	
13:00-13:50	Plenary Session	
	대한척추신경외과 증장기 발전 전략 수립을 위한 포럼 좌장 : 연세대 조용은, 가천대 이상구	
	1. 대한척추신경외과의 현황과 과제	연세대 구성욱 /148
	2. 대한척추신경외과의 대국민 홍보 전략	가톨릭대 조정기 /150
13:50-15:10	Symposium III: Innovation in Neurospine Care 좌장 : 연세대 김근수, 울산대 노성우	
	1. Restoration and Enhancement of Physiological Musculoskeletal Function in the Degenerative Spine	President, Neurospinal Society of Japan, Japan Kim Phyo /154
	2. 신경외과 수술용 로봇 개발	전남대 마이크로로봇 연구소장 및 교수 박종오 /157
	3. 척수손상으로 인한 마비 장애인의 보행 보조로봇	서강대 기계공학 교수 공경철 /159
	4. 환자 맞춤 치료를 위한 대용량 데이터와 머신러닝 활용사례	연세대 심장내과 장혁재 /161
15:10-15:30	Coffee Break & Poster View	
Emerging Technology	Update on Spinal Cord Injury Management 좌장 : 중앙보훈병원 박관호, 전북대 은종필	
15:30-16:30	1. Clinical Guideline in Managing Peri-operative Spinal Cord Injury	강릉아산병원 박진훈 /166
	2. "No longer use of Steroid" in Spinal Cord Injury	조선대 김석원 /168
	3. Investigational New Drugs for Spinal Cord Injury	인제대 신준재 /173
	4. Recent Update of Pathophysiology of Degenerative Cervical Myelopathy	고려대 이장보 /178
16:30-17:30	Free Paper II	
	Osteoporosis / Aging / Tumor 좌장 : 수원월스기념병원 박춘근, 순천향대 장재철	
FP II-1	요부의 퇴행성 질환을 가진 여성의 요부 신전 근육의 크기와 등척성 근력의 특징	성균관대 서용곤 /181
FP II-2	The effect of biocomposite screws on bone regeneration in a rat osteoporosis model	순천향대 정제훈 /182
FP II-3	근감소증 변수 및 척추근퇴행과 시상균형매개변수와의 관계	중앙대 고명진 /183
FP II-4	요추체간 유합술에서 골 충전재로서의 탈회골기질 (DBM) : DBM 과 자가골의 동시 이식술을 통한 전향적 비교 연구	고려대 김범준 /184
FP II-5	퇴행성 요추부 측만증의 전방접근법을 통한 수술적 치료	경희대 조대진 /185
FP II-6	신경공 경우 추체간 유합술후 케이지 이동 및 후방탈출의 위험인자: 골다공증이 위험도를 높이는가?	경북대 박만규 /186

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FP II-7	척추외과가 의료용 캐드(CAD) 프로그램을 직접 활용하여 시행한 척추종양 제거수술의 수술 전 가상시뮬레이션	부산대 이정환 /188
FP II-8	척추종양 수술에서 MEP와 D-WAVE의 신경감시 비교	연세대 강지인 /189
FP II-9	Microsurgery vs Endovascular ; which is adequate for initial treatment of spinal dural AVF?	울산대 허 연 /190
FP II-10	골다공증이 케이지 단독 전방유합술후 임상적 영상학적 결과에 미치는 영향	전남대 박재영 /192
FP II-11	한국 노인의 척추 시상면 불균형과 관련된 관련된 직업: 농부	전남대 문봉주 /193
FP II-12	경수 신경병증 수술 이후 중등도 이상의 요통의 변화	서울대 정종명 /194

17:40- 총 회
폐 회

그랜드볼룸 A

08:00-09:00

Free Paper I

Minimal Invasive Surgery

좌장 : 서울대 **장태안**, 한림대 **조용준**

FP I-1	Can the biportal endoscopic surgery achieve enough canal decompression for degenerative lumbar stenosis? Prospective case control study	월스기념병원 홍헌진 /197
FP I-2	요추 1번-5번 측방경유요추체간유합술 (DLIF)과 사측방경유요추체간 유합술 (OLIF)의 영상의학적 결과에 관한 케이지 (cage)의 의의	중앙대 고명진 /199
FP I-3	제5요추-제1천추간 추체간유합술법에 따른 결과 비교 : 추간공경유 요천추유합술과 사측방경유 요천추유합술	중앙대 문하용 /201
FP I-4	경피적 내시경 요추 추간판제거수술 후 재발은 과소평가되었을지도 모른다: 독립적인 관찰자에 의한 분석	서울부민병원 이동엽 /203
FP I-5	요추부 척추강, 외측 함요 협착증에 있어 기존의 전통적인 감압술에 비해 미세 침습적 감압술의 장점은 무엇인가? - 3가지 다른 요추부 감압술의 비교분석 (미세 현미경, 원통형 견인기, 내시경적) : 예비보고	강남베드로병원 이철우 /204
FP I-6	요추 추간판탈출증에서 경피적 내시경 추간공확장술의 유용성	안양월스기념병원 최경철 /206
FP I-7	요추 내시경 수술에서 디스크 제거량과 수술 후 영상의학적 결과 분석	서울대 황성환 /207
FP I-8	The reverse knot X-shape suture in annular repair during microscopic lumbar discectomy; technical note and clinical outcomes	고려대 김주한 /209
FP I-9	양방향 내시경과 단일 내시경에서 요추 수술후 근육손상 효소의 비교	부산힘내라병원 이 남 /211
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FP I-11	퇴행성 요추관 협착증에서 국소마취하진정 상태에서 극돌기간 감압술 후 2년 이상 임상 결과 분석	인제대 진용준 /214
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09:00-12:10

이트홀

Award Presentation Session
Guest Lecture I
Best Paper Competition
Guest Lecture II

12:10-13:00

Luncheon Seminar I

좌장 : 중앙대 **박승원**, 가톨릭대 **류경식**

1. Clinical Evidence of O-arm Navigated Pedicle Screw Placement Accuracy & Precision

Tsukazaki Hospital **Nobuyuki Shimokawa** /220

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	– O-arm & Navigation Korea Reimbursement Update	
	2. Bone Strength Treatment: Once Weekly Teriparatide	서울대 김치현 /222
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	Emerging Technology	좌장 : 차의과대 한인보, 울산대 전상용
	Biospine	
	1. Introduction to the First Biospine-AP 2018 Meeting and ISSLS	고려대 김주한 /225
15:30-16:30	2. Discovering a New Treatment for SCI from the Interpretation of Preclinical Studies	강원대 김충효 /227
	3. Development of Spinal Fusion System Using Biodegradable Polymer	연세대 신동아 /230
	4. Mechanism and Materials of Spine Implant	Global Biomedical Systems; CEO 안경기 /232
16:30-17:30	Free Paper II	
	Trauma / Cervical Spine / Deformity	좌장 : 인제대 손문준, 이화의대 조용재
FP II-1	불안정 흉요추 방출성 골절에서 "측면 추경절제술"을 이용한 감압 및 원주형 재건술 : 수술기법 및 18명의 수술환자에 대한 고찰	고려대 문홍주 /235
FP II-2	흉추 및 흉요추 접합 부위에서 발생한 외상 및 퇴행성 질환의 후방 흉추체간 케이지 유합술 임상 결과	울산대 남한가위 /237
FP II-3	제1-2경추간 불안정에 대한 제1경추외측과 및 제2경추경 나사못을 이용한 환추-축추고정술 후 하부경추부 시상부 배열의 변화	대구가톨릭대 김대현 /239
FP II-4	외상성 척추골절에서 후방 유합 수술결과의 비교 : 고식적 척추경 나사못 고정술 vs 극돌기간 압박 고정술	부산힘내라병원 이 남 /241
FP II-5	경추1번 나사못과 이중막대를 이용한 경추1번 방출성 골절의 운동성 보존 치료	창원경상대 박영섭 /242
FP II-6	어떤 경추 수술 방법이 C5 palsy를 유발하는가? : 경추 수술 방법에 따른 C5 palsy 발생률 차이	연세대 이광수 /243
FP II-7	다분절 전방 경추 유합술 시행 후 경추의 시상 정렬에 따른 환자 예후와의 관계	서울대 전세일 /245
FP II-8	2년 이상의 추적관찰을 통한 단일 및 다부위 케이지 단독 전방 경추 융합술의 결과	전남대 이정길 /246
FP II-9	경추 전방접근 후에 발생하는 경추 추간판 침강에 관여하는 위험인자 분석	가톨릭대 이정재 /247
FP II-10	경추 후관절골절의 치료	이화의대 조용재 /248
FP II-11	Prodisc-C를 사용한 경추인공디스크치환술: 단일 기관에서 10년이상 추적 관찰한 임상적 및 영상학적 전향적 연구 결과	가톨릭대 허정우 /250
FP II-12	Arthroplasty for cervical spondylotic myelopathy with 30 months follow-up data	연세대 이종주 /252
17:30-17:40	Transfer to 아트홀	
17:40-	아트홀 총 회 폐 회	

그랜드볼룸 B

08:00-09:00

Free Paper I

Degenerative Cervical Spine

좌장 : 가톨릭관동대 **진병호**, 가천대 **김우경**

- | | | |
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| FP I-1 | Risk factor analysis for OPLL progression in multilevel cervical OPLL patients by 3-dimensional volumetric measurement | 연세대 이종주 /255 |
| FP I-2 | 언덕 모양의 후종인대골화를 치료에 경추 전방 유합술이 언제 적절한가? | 연세대 노성현 /256 |
| FP I-3 | 치상돌기 분리증 환자군과 비 치상돌기 분리증 환자군의 경추 1-2간 후방 고정술 후 후두부 통증, 가동 범위 및 임상적 결과에 대한 비교 | 연세대 강지인 /258 |
| FP I-4 | 경추 수술시 척추 동맥 개방성 평가를 위한 ICG 조영술의 유용성 | 가톨릭대 이종범 /260 |
| FP I-5 | 새로운 경추 척추 시상면 영상학적 인자로서의 K-line 기울기 | 한림대 오재근 /262 |
| FP I-6 | 후종인대 골화증을 동반한 경추성 척수증의 후방 하이브리드 수술법: 후향적 연구 | 인하대 신제임스키 /263 |
| FP I-7 | 낮은 T1 경사면과 Stand-alone cage를 이용한 ACDF에서 subsidence의 관련성 | 부산대 이수현 /264 |
| FP I-8 | K-line 양성의 경추부 후종인대 골화증에서 후궁성형술 및 후궁성형-유합술의 결과 비교 | 가톨릭대 김일섭 /265 |
| FP I-9 | laminoplasty 이후 관상면에서의 척추 전만의 예측 인자 분석 | 부산대 이준석 /267 |
| FP I-10 | 경추 1-2번간 후방고정술에 대한 생역학적 비교연구 : 유한요소 해석 | 연세대 천동현 /269 |
| FP I-11 | 경추 척수증 환자의 수술 결정에서 운동성 MRI 의 유용성 | 가톨릭대 이종범 /270 |
| FP I-12 | 상부 경추 고정술 시행후 하부 경추 배열 변화의 위험성 분석 | 가톨릭대 이종범 /271 |

09:00-12:10

아트홀

Award Presentation Session
Guest Lecture I
Best Paper Competition
Guest Lecture II

12:10-13:00

Luncheon Seminar II

좌장 : 고려대 **김세훈**, 인하대 **윤승환**

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| 1. Current Multicenter Clinical Trials of E-Coli derived rhBMP-2 for Spine Fusion | 연세대 진동규 /275 |
| 2. Realizations of 3D printed Product in Spine Surgery- Merits and Concerns | 순천향대 임수빈 /276 |

13:00-15:10

아트홀

Plenary Session
Symposium III: Innovation in Neurospine Care

15:10-15:30

Coffee Break & Poster View

Emerging Technology

Predictive Analytics in Spine Surgery Outcomes

좌장 : 가톨릭대 **김대현**, 영남대 **김상우**

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|---|---|----------------------|
| 1. Introduction of Modified 'Frailty Index' from National Surgical Quality Improvement Program (NSQIP) Surgical Risk Calculator | 순천향대 박형기 /280 | |
| 15:30-16:30 | 2. FRAILITY as a Crucial Predictor of Outcomes for Spine Surgery Candidates | 단국대 김영진 /282 |
| | 3. Patient-Reported Pain vs Actual QOL & Function | 경희대 이준호 /284 |
| | 4. PROMIS vs Conventional Parameters (ODI, NDI, SF-36..) | 가톨릭대 홍재택 /286 |

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16:30-17:30	Free Paper II	
	Deformity	좌장 : 원광대 박종태, 건국대 최우진
FP II-1	한국인 시상면 불균형에서의 건강 관련 삶의 질	참포도나무병원 김병우 /293
FP II-2	성인 척추 변형 수술에서 Pedicel subtraction osteotomy와 Posterior column osteotomy중에서 어떤 것을 선택해야하는지 결정할 때에 수술중 방사선 사진의 유용성	서울대 한상현 /295
FP II-3	K-와이어와 도관나사를 이용한 프리핸드 S2AI 나사 삽입법	성균관대 최호용 /297
FP II-4	단부위 요추 후방 고정술후 발생하는 인접마디 변성과 척추골반각 변수와의 상관 관계에 대한 연구 Seobandi General Hospital-Jember University Faculty of Medicine, Jember, Indonesia	Krisno Adji Novan /298
FP II-5	성인척추변형수술에 금속봉(rod)강도와 인접 상위부후만증 발생의 상관 관계에 대한 연구: 코발트크롬과 타이타늄 금속봉의 비교연구	서울대 현승재 /299
FP II-6	골반 후경에 따른 천장골 나사못(S2AI)의 삽입각도의 변화 분석 :컴퓨터 단층 촬영을 이용한 해부학적 연구	연세대 최선아 /301
FP II-7	어떤 접근 방법이 인접 마디 변성의 발생을 낮추는데 유리할까? : 제 4,5 요추간 전방전위증에 대한 3가지 다른 요추 유합술에 대한 비교 분석	강남베드로병원 이철우 /302
FP II-8	척추변형수술에서 수술중 혈액회수기 사용의 임상적 효용성	성균관대 최호용 /304
FP II-9	수술중 수술 테이블 변형을 통한 퇴행성 요추 질환의 다분절 요추 유합술에서 요추 전만의 회복 효과	울산대 남한가위 /305
FP II-10	심한 시상면 불균형을 보이는 요추 편평등 변형 환자에서 이상적인 상위 기구 고정 척추 분절	경희대 최만규 /307
FP II-11	Modified Iliac Screw Fixation: 방법 및 임상 적용	차의과대 손세일 /309
FP II-12	심한 척추 변형에서 후방 도달 척추 절제술의 임상결과 및 영상학적 결과	서울대 이병훈 /310
17:30-17:40	Transfer to 아트홀	
17:40-	아트홀	
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Program

Poster

- | | | |
|-----|---|---|
| P1 | 만성디스크성 연관통에 대한 동척신경 추간공 경막외 레이저 삭마술 | 수원나누리병원 주윤석 /313 |
| P2 | 외과의의 경험에 따른 척추경제거술의 수술 및 영상의학적 결과 | 삼성창원병원 최호용 /314 |
| P3 | 급성 경추부 통증을 주소로 내원한 환자: 급성 경장근 석회성 건염과 경추부 날개인대의 석회화를 동시에 가진 47세 여자 환자 | 서울부민병원 김기훈 /315 |
| P4 | 수술 후 발생한 신경근 탈출을 동반한 pseudomeningocele: 3례 증례보고 | 보강병원 김성호 /316 |
| P5 | 퇴행성 요추 질환에 대한 L5-S1 PLIF 후 수술에 영향을 주는 요인들 | 보강병원 김성호 /318 |
| P6 | 손상된 요추 신경근 주변의 외상성 경막 누출 부위를 인공경막을 이용하여 감싸는 방법으로 치료한 증례 보고 | 국군수도병원 윤상훈 /320 |
| P7 | 희귀한 천골, 두개골 및 늑골을 침범한 다발성 골결핵: 증례보고 | 국군수도병원 윤상훈 /321 |
| P8 | 수술 중 C-arm 사용 시 의료진의 방사선 피폭량 | 중앙대학교병원 박세훈 /322 |
| P9 | 헤파린 기반의 하이드로겔과 지방유래 줄기세포를 사용한 좌골신경손상의 신경재생 | 연세대학교 이혜란 /323 |
| P10 | 저분자화합물 조합을 이용한 악성 신경교모종세포의 양성 신경교세포 전환 | 연세대학교 의과대학 신경외과교실 김용보 /324 |
| P11 | 유도신경줄기세포에서 일시적인 Ngn2 발현에 의한 척수손상모델에서 신경분화와 신경돌기 성장 향상 | 연세대학교 의과대학 신경외과교실 오진수 /325 |
| P12 | 신경 손상 모델에서 유도 신경 줄기세포를 기반으로 한 유전자 치료와 발프로산의 병합 치료 효과 | 연세대학교 의과대학 의과학과 신경외과학교실 백다예 /326 |
| P13 | 악성 척수 종양에서 마지막 수단으로서의 척수절제술 | 세브란스병원 신경외과 최선아 /327 |
| P14 | 경추1/2번 추궁 아탈구 | 이화의대 목동병원 신경외과 조용재 /328 |
| P15 | 타입 2 척추 시상면불균형에 대한 수술경험 | 이화의대 목동병원 신경외과 조용재 /329 |
| P16 | 경추 후궁절제술 이후 신전시 발생하는 경척수병증 진단시 dynamic MRI 의 유용성 | 영남대학교의료원 신경외과 추윤희 /330 |
| P17 | 전방접근에 의한 경추간판 제거술 및 유합술 시행 후에 황색 인대 좌굴에 기인해 재발생한 경척수병증 | 영남대학교의료원 신경외과 박수동 /331 |

2017. **9.15**(Fri.)



Pre Congress NECA Symposium

척추 진료의 사회경제적 함의

좌장 : 서울대 정천기

2017. **9.15** (Fri.)



척추변형 연구회

Symposium I: Hot Issue in Spine Care I

Comprehensive Approach of Spinal Deformity Surgery Through Sagittal Spinal Balance

좌장 : 한림대 문승명, 가톨릭대 이진석

1. Radiographic Assessment Using Novel Imaging Modality

충남대 최 승 원

2. Cervical Alignment and its Clinical Relevance

서울대 현 승 재

3. Current Strategies for the Restoration of Adequate Lumbar Lordosis

연세대 김 경 현

4. Complications and Risk Stratification in Deformity Surgery

연세대 하 윤

최 승 원

충남대학교병원



최근 주요 약력

- 충남대학교 의과대학, 대학원 졸업 및 박사 취득
- UC San Francisco 정형외과 연수
- 현, 충남대학교 의과대학 부교수
- 현, 충남대학교병원 신경외과 과장

Radiographic Assessment Using Novel Imaging Modality

최 승 원

충남대학교병원 신경외과

최근 수십 년간 척추변형질환의 진단, 평가, 치료방법은 매우 빠르게 발전하고 있으며, 질환의 개념 정립은 현재 진행형이다.

새로운 영상의학적 평가기법이 개발되고 있으며, 진단도구의 개발로 더욱 정밀한 측정이 가능해졌다. 3차원 입체영상촬영이 발전하고 있으며, 영상의학적 검사결과의 분석 도구도 정밀해지고 있다. 이러한 진단 및 평가 도구의 발달은 척추변형질환의 새로운 치료 전략 및 수술후합병증을 줄일 수 있는 전략을 정립하는 데 기초가 되고 있다. 또한 경추에 적용되는 새로운 영상의학적 평가 도구는 경추변형질환의 새로운 개념을 발전시키고 있으며, 흉요추 및 척추 전체의 변형과 밀접한 상호인과관계가 있음을 증명해 주고 있다. 소아 척추변형질환에 대한 진단 및 치료의 발전은 특히 괄목할 만하다. 기존의 영상의학적 평가가 2-D 영상에 기초를 두고 있으나, 두경부부터 하지까지 포함하는 3차원 기립 영상이 가능해지면서 영상의학적 측정이 더욱 정밀해지고 있다.

본 발표는 척추변형질환의 영상진단, 치료, 결과 및 예후와 관련된 최신 논문을 리뷰하여 척추 시상 변형과 관련된 새로운 영상 진단 도구의 개관을 제공하며, 이와 연관된 척추변형질환 개념의 진화를 설명하고자 한다.

Cervical Alignment and its Clinical Relevance

현 승 재

서울대



Current Strategies for the Restoration of Adequate Lumbar Lordosis

김 경 현

연세대



Complications and Risk Stratification in Deformity Surgery

하 문
연세대

MEMO

2017. 9. 15 (Fri.)



경추연구회

Symposium I: Hot Issue in Spine Care I

Noteworthy Topics in Korean Cervical Spine Research Society in 2016

좌장 : 성균관대 신현철, 고려대 박윤관

1. Cost-Effectiveness Analysis of Single Level Anterior Cervical Discectomy and Fusion and Cervical Disc Replacement 한림대 오재근
2. Surgical Timing Affects Survival in Patients with Cervical Metastasis 성균관대 박종혁
3. The Change of Cervical Spine Curvature After Laminoplasty in Patients Who were Diagnosed with Cervical Spondylotic Myelopathy Without OpII; Minimum 2 – Year Follow-Up 국군수도병원 문정현
4. Postoperative Changes in Deep Cervical Extensor Muscle Volume: Comparison Between Unilateral Conventional Open Door and Contralateral Deep Extensor Muscle Preserving Approach for Laminoplasty at Same Patients 경상대 이영석

오재근

한림대학교 성심병원



최근 주요 약력

- 2017.03-현재 한림대학교 성심병원 신경외과 부교수
- 2012.03-2017.02 한림대학교 성심병원 신경외과 조교수
- 2010.05-2012.02 연세대학교 신경외과 연구강사
- 2007.03-2010.04 항공우주의료원 공군 군의관
- 2003.03-2007.02 연세대학교 신경외과 전공의
- 2002.03-2003.02 연세대학교 신경외과 인턴

최근 주요 경력

- 2016.07-2017.06 Columbia University, New York Presbyterian Hospital, The Spine Hospital 방문 교수

Cost-effectiveness analysis of single level anterior cervical discectomy and fusion and cervical disc replacement

오 재 근

한림대

Objective : This study is a retrospective study for the cost – benefit analysis of single level anterior cervical discectomy and fusion and cervical disc replacement, which are the main surgical methods for patients with degenerative cervical disc disease.

Methods : To evaluate the probability and cost of the Markov model, we analyzed 156 patients who underwent single level anterior cervical discectomy and fusion and cervical disc replacement from January 1, 2008 to December 31, 2009, diagnosed as degenerative cervical disc disorder. In this study, cost – benefit analysis was performed using quality adjusted life year (QALY) as the outcome index for patients undergoing surgery, and Markov model was used as a model for analysis. Medical costs in the cost-benefit analysis included direct medical costs and indirect medical costs were excluded. The data were analyzed using TreeAge Pro 2015™ .

Results : Patients who underwent single level anterior cervical discectomy and fusion had a total cost of 2,501,807 won for 5 years and obtained a utility of 3.72QALY. Patients who underwent cervical disc replacement received 4.18QALY for a total of 3,685,949 won for five years. The cumulative cost-effectiveness ratio of cervical spine replacement surgery was 2,549,511 Won / QALY, which was lower than the general payment standard of 30,000,000 Won / QALY.

Conclusions : Both anterior cervical discectomy and fusion and cervical disc replacement are cost-effective alternatives to patients with degenerative cervical disc disease. Cervical disc replacement may be an effective alternative to obtain more benefits.

Key words : cost analysis, cost effectiveness analysis, cost benefit analysis, anterior cervical discectomy and fusion, cervical disc replacement

박종혁

삼성서울병원 성균관대학교 의과대학



최근 주요 경력

- 경희대학교 의학전문대학원 졸업
- 가톨릭 대학교 인천성모병원 인턴, 레지던트 수료
- 삼성서울병원 신경외과 척추분과 임상강사

Surgical timing affects survival in patients with cervical metastasis

Jong-Hyeok Park, M.D., Sun-Ho Lee, M.D., Ph.D.,
Eun-Sang Kim, M.D., Ph.D., Whan Eoh, M.D., Ph.D.

Department of Neurosurgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea

Objective : The purposes of this study are to question whether preoperative radiotherapy affects the clinical outcomes after surgical treatment or surgical timing may be associated with overall survival after cervical metastasis. We investigate affecting factors and overall survival after cervical metastasis between initial Radiotherapy prior to surgical treatment (Group 1) and radiotherapy following initial surgical treatment (Group 2) at the diagnosis of cervical metastasis.

Methods : A retrospective analysis of medical records was performed on 36 cervical metastatic patients from February 2007 to December 2015. Overall survival (OS) after cervical metastasis, OS after surgery, clinical outcomes were analyzed between Group 1 and Group 2. Affecting factors of overall survival after cervical metastasis included; primary tumor type, initial treatment modality, Tomita score, Eastern Cooperative Oncology Group scale, Karnofsky performance scale (KPS), Nurick grade, Frankel classification, preoperative symptom and Spinal stability neoplastic score.

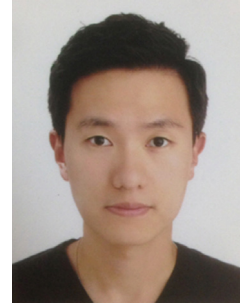
Results : Both groups showed improvement of postoperative VAS. But, only group 2 showed significant improvement of JOA score. It was 1.3 ± 1.9 in Group 2 ($p=0.03$). OS after cervical metastasis was 7.0 months (95% Confidence Interval (CI), 4.8–9.3) in Group 1 and 15.8 months (95% CI, 8.8–24.0) in Group 2. OS after surgery was 4.5 months (95% CI, 3.4–5.5) and 15.3 months (95% CI, 7.1–23.4) in each Group ($p<0.05$). Among group 2, patients with pain only showed about three times longer OS after cervical metastasis than patients with motor weakness ($p<0.05$). Factors related to overall survival after cervical metastasis were primary tumor type, initial treatment modality and preoperative symptoms ($p<0.05$).

Conclusion : Surgical treatment before radiotherapy showed better clinical outcomes than radiotherapy prior to surgical treatment. It is concluded that OS after cervical metastasis was long in initial surgical treatment group. OS after cervical metastasis also was dependent to presence or absence of preoperative motor weakness. In summary, surgery for metastatic cervical spine before neurologic deficit and radiotherapy may be a good decision in case of cervical metastasis. Future studies will be required to ascertain these results.

Key Words : cervical metastasis, surgery, radiotherapy, prognosis, survival outcomes.

문정현

The Armed Forces Capital Hospital

**Education Carrier**

- 2001.03–2003.02 Chonnam National University College of Natural Science
Premedical School, Gwang ju , Korea
- 2003.03–2007.02 Chonnam National University, College of Medicine, Gwang ju, Korea M.D.
- 2010.03–2016.07 Seoul National University, Master of science from Graduate school, Seoul, Korea

Medical Trainingship

- 2007.03–2008.02 Internship, Seoul National University Hospital, Seoul, Korea
- 2008.03–2012.02 Residentsip, Department of Neurosurgery
Seoul National University Hospital, Seoul, Korea
- 2015.05–2017.02 Clinical fellow, Department of Neurosurgery
Seoul National University Hospital, Seoul, Korea

Medical license and Board Certification

- 2007.02 License of Medical Doctor
- 2012.02 Board Certification of Neurosurgery

Military Service

- 2012.04–2015.04 Army surgeon, the 20 army division (Gyeonggi-do)



The change of cervical spine curvature after laminoplasty in patient who presented cervical spondylotic myelopathy; Minimum 2-year follow up

Jung Hyeon Moon

Department of Neurosurgery, Korea Armed Forces Capital Hospital, Bundang, Korea

Introduction

Laminoplasty is the gold standard treatment for cervical spine stenosis. Even though laminoplasty has known to cause relatively less kyphotic change of cervical spine than laminectomy after operation, there have also been several papers that reported laminoplasty would aggravate malalignment of cervical spine curvature following operation.

The Spine Journal 6 (2006) 274S-281S

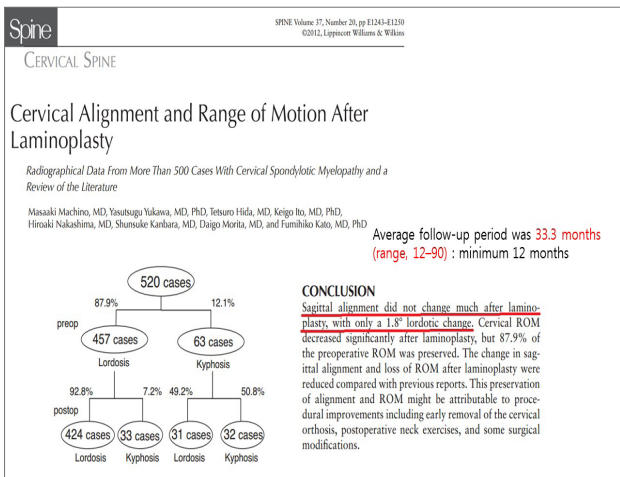
Cervical laminoplasty

Michael P. Steinmetz, MD, Daniel K. Resnick, MD*

Department of Neurosurgery, University of Wisconsin School of Medicine, 40834 Clinical Science Center, 600 Highland Ave., Madison, WI 53792, USA

Cervical alignment

In general, no specific laminoplasty technique has been able to prevent the development of some degree of kyphosis after surgery. Moreover, no laminoplasty technique is effective for the restoration of lordosis in an already kyphotic spine. The range of worsening spinal alignment, not necessarily kyphosis, has been reported to range from 22% to 53% [11,15-17,24,42,43,47]. This loss of lordosis is not improved with the addition of a posterolateral fusion [28,48]. Other authors have reported much better preservation of lordosis with the use of modern instrumentation techniques [46]. The incidence of development of kyphosis



Sagittal Alignment of the Cervical Spine After the Laminoplasty

Kyung-Soo Suk, MD, Ki-Tack Kim, MD, Jung-Hee Lee, MD, Sang-Hun Lee, MD, Yang-Jin Lim, MD, and Jin-Soo Kim, MD

Preoperative Factors Affecting Postoperative Kyphosis. As mentioned above, preoperative factors affecting postoperative kyphosis are preoperative diagnosis of myelopathy cases associated with cervical spondylosis, a preoperative lordosis angle of <10° in the neutral position, and a preoperative kyphotic angle during flexion that is greater than a lordotic angle during extension.



Long-term outcome of laminectomy for cervical ossification of the posterior longitudinal ligament

Clinical article

SOO EON LEE, M.D., CHUN KEE CHUNG, M.D., Ph.D., TAE-AHN JAHNG, M.D., Ph.D., AND HYUN-JIB KIM, M.D., Ph.D.

Department of Neurosurgery, Seoul National University College of Medicine, Seoul, Korea

TABLE 2. Change in cervical curvature

Postop OPLL Type	Preop OPLL Type			Total
	Kyphosis	Straight	Lordosis	
segmental				
kyphosis	0	0	1	1
straight	0	0	0	0
lordosis	0	1	5	6
continuous				
kyphosis	0	0	0	0
straight	0	3	1	4
lordosis	0	1	6	7
mixed				
kyphosis	0	0	2	2
straight	0	0	3	3
lordosis	0	0	11	11
total	0	5	29	34

ity^{1,5,21,28,29} Although a biomechanical study of OPLL was not available, we suggest that the OPLL itself supplements the anterior support of the vertebral body in the cervical load. Moreover, in the present series of laminectomies, our surgical strategy of preserving the facet joint also contributed to the maintenance of the curvature.

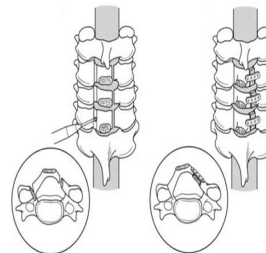
Purpose

- We tried to present the criteria of preoperative cervical angle to be tolerable for laminoplasty through analysis of change of cervical curvature during follow-up period in cervical spondylotic myelopathy without OPLL or with segmental OPLL

Patients and methods

We reviewed retrospectively 49 patients who were diagnosed with cervical spondylotic myelopathy without OPLL or with segmental OPLL from 2004 to 2014. All patients followed up at a minimum 2 years.

Surgical technique



Hardware-augmented laminoplasty. A-D: The techniques are similar to the Hirabayashi-type laminoplasty. In the final step, as described by Shaffrey, et al., titanium miniplates are placed to secure the elevated laminae and hold the bone graft in place.

J Spinal Disord Tech • Volume 26, Number 3, May 2013

Symmetrically Medial Bony Gutters for Open-door Laminoplasty

Soo E. Lee, MD, Chun K. Chung, MD, Chi H. Kim, MD, and Tae-Ahn Jahng, MD

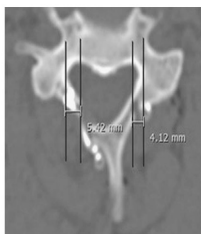


FIGURE 2. The distance of the bony gutter on a computed tomography scan. The location of a bony gutter was defined as a distance between the most lateral point of the spinal canal and the most medial position of the gutter. If the gutter line was medial to the canal line, the distance was expressed as a positive number.

RESULTS

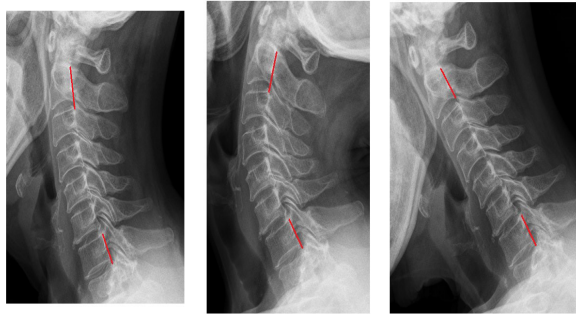
The average distance of the bony gutter was 3.40 ± 1.6 mm in all patients. The average distance of the right bony gutter was 3.43 ± 1.84 mm and that of left bony gutter was 3.35 ± 1.46 mm. The average distance of the right bony gutter at C5 was 3.70 ± 1.39 mm [95% confidence interval (CI), 3.27, 4.12] and that of the left bony gutter at C5 was 3.36 ± 1.48 mm (95% CI, 2.97, 3.75).

<Radiological assessment>

The preoperative image studies (MRI, CT, and dynamic x-ray) of the cervical spine were done in all patients.

Based on preoperative CT, we excluded patients who had continuous or mixed type OPLL and traumatic injury Hx.

Both neutral and dynamic studies with flexion and extension in lateral view were subsequently performed at 3 months, 6 months, 12 months, 2 years, 3 years, 4 years postoperatively.



The neural cervical curvature and flexion - extension ROM of cervical spine on the lateral radiograph using a tangent method

Lordotic angle : negative
Kyphotic angle : positive

<Outcomes assesment>

Clinical outcomes were assessed with JOA score, including the neck disability index score (NDI) and with visual analog scales (VAS) for neck and arm pain.

Results

Table 1. Patients characteristics

Number of patients (n)	49
Male : female (n)	33 : 16
Mean age at surgery (years of age)	61.84 ± 9.91
Mean follow-up length (months)	38.7 ± 10.4
Hypo-lordosis* : normal lordosis (n)	19* : 30
OPLL + : OPLL - (n)	24 : 25
Hinge Fx. + : hinge Fx. - (n)	6 : 43
MR signal change + : MR signal chage - (n)	37 : 11

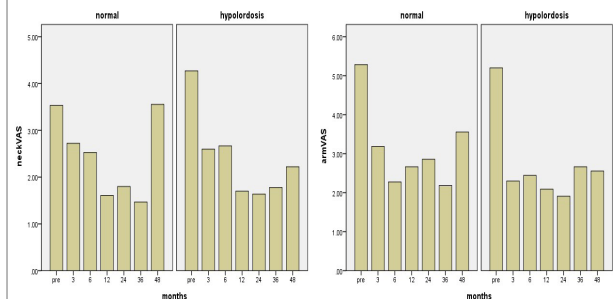
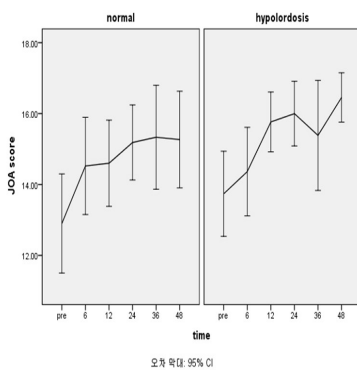
*Hypo-lordosis > -10
Normal lordosis ≤ -10

Table 2. Comparison between hypo-lordosis group and normal lordosis group

	Hypo-lordosis	Normal lordosis	P - value
Age (months)	60.9 ± 9.87	62.4 ± 10	0.62
OPLL*	0.52 ± 0.51	0.46 ± 0.5	0.69
MR signal change**	0.79 ± 0.41	0.83 ± 0.59	0.78
Hinge Fx.***	0.15 ± 0.37	0.1 ± 0.3	0.55
Mean follow-up (months)	40.4 ± 9.96	37.6 ± 10.7	0.36

* With OPLL = 1; without OPLL = 0
** With MR signal change = 1; without MR signal change = 0
*** With hinge Fx = 1; without hinge Fx = 0

<Clinical result>



척추외형 교정 효과 측정*

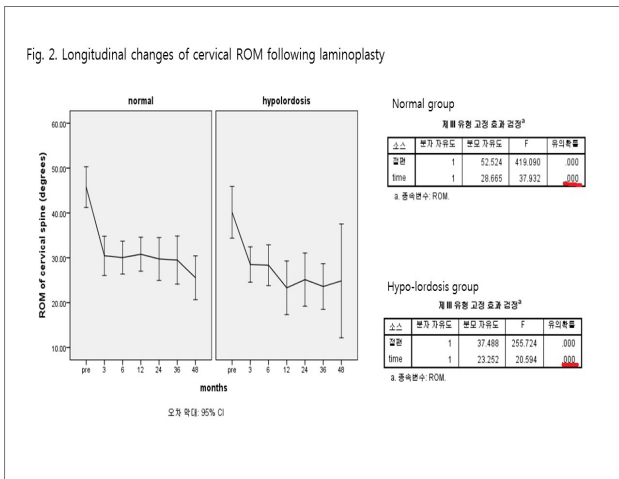
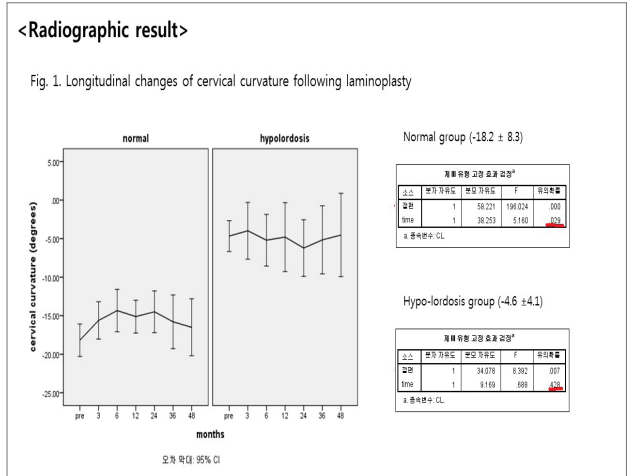
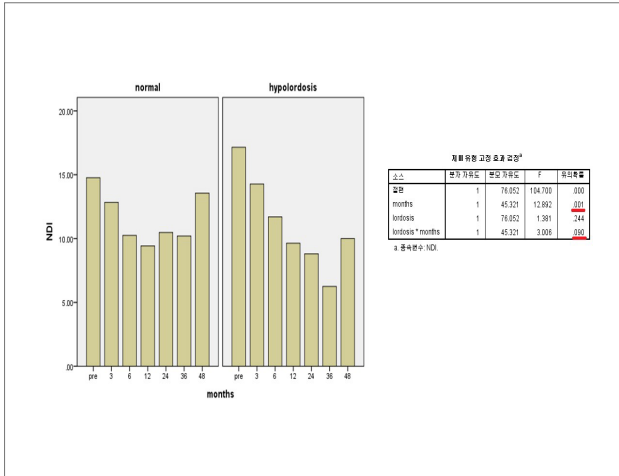
조각	척추외형교정	척추외형교정	F	유의성
교정	1	83.547	59.416	.000
months	1	58.872	7.040	.010
lordosis	1	83.547	829	.385
lordosis * months	1	58.872	850	.360

* 통계분석: ANOVA

척추외형 교정 효과 측정*

조각	척추외형교정	척추외형교정	F	유의성
교정	1	80.451	68.696	.000
months	1	55.333	6.988	.011
lordosis	1	80.451	.004	.947
lordosis * months	1	55.333	.024	.877

* 통계분석: ANOVA



Limitation of study

First, our study was a retrospective analysis.

Second, intra and interobserver measurement was not performed.

Third, why the cervical curvature in normal group after laminoplasty decreased was not known, even though that in hypo-lordotic group did not decrease.

Fourth, only 2 patients presented preoperative kyphotic angle in cervical curvature.

Finally, a larger number of cases and an additional, longer follow-up period are necessary.

Conclusion

In present study, we suggested that laminoplasty might be tolerable operation for cervical spine stenosis even though patients have hypo-lordotic angle in preoperative cervical curvature.

J Neurosurg (Spine 3) 98:210-218, 2003

Cervical laminoplasty: a critical review

JOHN K. RATLIFF, M.D., AND PAUL R. COOPER, M.D.

Department of Neurosurgery, Rush-Presbyterian-St. Luke's Medical Center and Chicago Institute of Neurosurgery and Neuroresearch, Chicago, Illinois; and Department of Neurosurgery, New York University School of Medicine, New York, New York

Reported incidence of spinal straightening and kyphosis after laminoplasty⁹

Technique (reference no.)	Worsening Alignment (%)	New Kyphosis (%)
Hattori ^{41,53}	22	4
Hirabayashi ^{13,15,35,38,39,43,50,51,57,78,88}	53	4
Kurokawa ^{43,52,63,64,66,72,75,85}	25	2
Laminoplasty w/ fusion ^{16,59}	46	15
hardware augmentations ^{13,61,62}	0†	0‡

* Percentage reflects a mean of reported series.
 † Not reported.
 ‡ No kyphosis reported.



Symposium I: Hot Issue in Spine Care | [경추연구회]

Postoperative Changes in Deep Cervical Extensor Muscle Volume: Comparison Between Unilateral Conventional Open Door and Contralateral Deep Extensor Muscle Preserving Approach for Laminoplasty at Same Patients

이 영 석

경상대



최소침습 척추학회

Symposium II: Hot Issue in Spine Care II

MISS Suggestion for Pure Lumbar Foraminal Stenosis Management

좌장 : 세란병원 **박성춘**, 조선대 **이승명**

1. Minimized Solution by Percutaneous Endoscopic Lumbar Foraminotomy

수원나누리병원 **김현성**

2. New Trial of MISS: Percutaneous Biportal Endoscopic Approach for Lumbar Foraminal Stenosis

수원월스기념병원 **허동화**

3. Not enough.. a More Thorough Ecompression Only by MED Paraspinal Approach

가톨릭대 **김진성**

4. Not Stable. Proven Longevity for Efficacy by MIS-TLIF

연세대 **박정윤**



Minimized Solution by Percutaneous Endoscopic Lumbar Foraminotomy

김 현 성
수원나누리병원



허 동 화

월스기념병원



최근 주요 약력

- 월스기념병원 척추센터 근무
- 분당차병원 신경외과 조교수
- 한림대 춘천성심병원 신경외과 조교수
- 강남세브란스 척추신경외과 임상강사

최근 주요 경력

- 연세대학원, 석사 및 박사학위 취득
- 연세대학교 원주의과대학 졸업
- 방송통신대학교 사회과학대학 미디어 영상학과 졸업



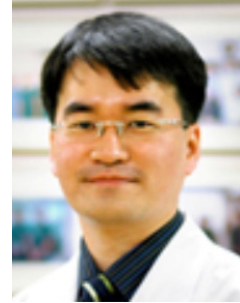
New Trial of MISS: Percutaneous Biportal Endoscopic Approach for Lumbar Foraminal Stenosis

허 동 화

수원월스기념병원

김진성

가톨릭대 서울성모병원 신경외과
Xian Jiatong 의과대학 (시안, 중국), 정형외과



주요 학력

- 가톨릭의대 졸업(1997)
- 가톨릭의대 신경외과학 석사, 박사(2013)

주요 경력

- 우리들병원 척추외과 과장 2008.3~2012.2
- 가톨릭대 서울성모병원 신경외과 부교수 2012.3~2017.3
- 가톨릭대 서울성모병원 신경외과 교수 2017.4~현재
- Academic Editor for the journal Medicine® (<http://journals.lww.com/md-journal>)

학회 활동

- ISO/TC150 (국제표준화기구/외과용이식재) 전문위원
- 산업 통상자원부, 의료기기 R&BD 실무위원 (2015년~)
- 산업 통상자원부, 척추치료기기 명품화 연구회 – 총무이사, 2014–2016
- 대한최소침습척추학회 (KOMISS)
- 총무이사, 연구이사 (전)
- 국제교류이사 (현)
- 세계최소침습척추수술학회 WCMSST 2016 – 학술위원장
- 아시아최소침습척추수술학회 ACMISST 2017 – 학술위원장
- AOSpine – Korean faculty, Member of T4F
- 정회원– NASS, CNS, Society of Minimal Invasive Spine Surgery (SMISS), ISASS, etc

특허

- 특허 등록 3건, 기술이전 3건
- Published SCI(E) papers
Main authors more than 58 papers
More than 13 Chapters in textbooks



Not enough.. a More Thorough Ecompression Only by MED Paraspinal Approach

김진성

가톨릭대

박 정 윤

연세대학교 강남세브란스병원 신경외과



최근 주요 약력

- 1992-1998 전북대학교 의과대학
- 2000-2003 전북대학교병원 신경외과 전공의
- 2006-2007 연세대학교 강남세브란스병원 척추신경외과 전임의
- 2006-2010 연세대학교 의과대학 신경외과 박사
- 2007-2011 국민건강보험공단 일산병원 신경외과 임상조교수

최근 주요 경력

- 2011-현재 연세대학교 강남세브란스병원 신경외과 조교수
- 대한최소침습척추학회 상임이사
- 대한척추골다공증연구회 운영위원
- 대한척추신경외과학회 총무간사
- 2015-2016 메사추세츠공과대학, Medical engineering and science 교환교수



MISS Suggestion for Pure Lumbar Foraminal Stenosis Management : Not Stable decompression. Proven longevity for efficacy by MIS TLIF!

박 정 윤

연세대학교 강남세브란스병원 신경외과

Lumbar foraminal stenosis는 노인인구에서 하지 방사통을 일으키는 가장 중요한 퇴행성 척추 질환 중 하나이다. 임상에서 비교적 흔하게 경험할 수 있는 질환이나, 최적의 수술적 방법에 대하여는 아직 여러가지 이견이 있으며, 수술자마다 본인의 경험 및 적응증에 따라 다양한 수술방법이 적용된다. 대표적 수술방법으로 Wiltse approach를 통한 Foraminal decompression이며 고식적 절개법, 관상확장기를 이용한 감압수술이 주로 이루어지며, 최근에는 내시경을 이용한 감압수술이 시행되고 있는데, 단일공 내시경 (Uniportal endoscopy) 뿐만 아니라 biportal endoscopy을 이용한 감압수술이 시도되고 있다.

그러나 많은 경우에 lumbar foraminal stenosis는 disc space narrowing과 instability를 포함한 spondylolisthesis가 동반하며 foraminal decompression과 함께, disc space restoration 및 instability 해결을 위한 유합수술이 필요할 수 있다. 또한 foraminal stenosis와 함께 central stenosis도 같이 동반되는 경우가 많으며, 일반적인 foraminal decompression만 시행한 경우 상당히 많은 환자에서 disc space narrowing등이 진행되어 foraminal stenosis가 재발하여 2차 수술이 필요한 경우가 있다.

Foraminal stenosis와 다른 다양한 문제들이 복합적으로 발생한 lumbar foraminal stenosis의 경우 facet joint의 direct removal을 포함한 Transforaminal interbody fusion (TLIF)가 대안이 될 수 있으며, Minimally invasive transforaminal interbody fusion (MIS TLIF)이 1st choice가 될 수 있다. MIS TLIF은 disc space restoration이 가능하여 foraminal stenosis의 재발을 막을 수 있으며, 유합수술의 중요한 합병증 하나인 Adjacent segment degeneration의 발생률도 다른 유합수술에 비하여 비교적 적게 발생하여, MIS TLIF with unilateral pedicle screw fixation에 대한 안정성이 증명되면서, minimal incision (2.5cm)으로 MIS TLIF이 가능해져서 단순 decompression 대신 보다 장기적인 안정성을 가지는 lumbar foraminal stenosis의 효과적 수술법의 하나로 이용될 수 있다.

MEMO

2017. **9.15** (Fri.)



대한척추신경외과학회 30주년 기념행사

진행 : 총무이사 이상구



기초연구회

Symposium I: Hot Issue in Spine Care I

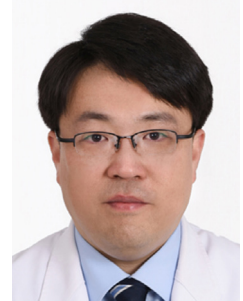
The Current Basic Research in the Korea Spinal Neurosurgery Society

좌장 : 계명대 김인수, 연세대 김금년

1. Improvement for Regional Bone Formation and Osteointegration Between Orthopedic Device and Osteoporotic Bone in Animal Study
순천향대 정제훈
2. Combining Stem Cells and TUDCA for Spinal Fusion as an Alternative to Bone Morphogenetic Proteins
차의과대 한인보
3. Crispr Application on Spine Research Field. – Human Primary Ligamentum Flavum Cell Gene Editing
고려대 허준석
4. The Effect of Ursodeoxycholic Acid in Spinal Cord Injury: in Vitro and in Vivo Study
차의과대 손세일

정 제 훈

순천향대학교 부천병원 신경외과



최근 주요 약력

- 2004.05–2006.02 경희대학교 신경외과 전임의
- 2006.04–2007.02 서울아산병원 신경외과 전임의
- 2007.03–2013.02 한림대 한강성심병원 신경외과 부교수
- 2013.02–현재 순천향대학교 부천병원 신경외과 부교수

최근 주요 경력

- 2008.06–2008.09 washington university school of medicine 척추센터 연수
- 2016.08–2016.09 UCSF Orthopedic spine center 연수
- 2016.09–2017.08 Stanford University Neurosurgery department 연수

Improvement for Regional Bone Formation and Osteointegration between Orthopedic Device and Osteoporotic Bone in Animal Study

Je Hoon Jeong M.D., Ph.D..

Department of Neurosurgery, Soonchunhyang University Bucheon Hospital

Postmenopausal osteoporosis is a disease characterized by low bone mass and depleted bony microarchitecture because of increasing bone turnover induced by estrogen deficiency. Implant insertion is very important in the surgical treatment of bone fracture for patients with osteoporosis. The reduction in bone mass lessens the capacity of bone to support an orthopedic implant. Consequences can include screw loosening or pull out, and delayed deformity of adjacent structures.

Various attempts to reinforce the integration of implants with bone and screws have been reported. Originally, orthopedic implant devices are made from metals and polymers. Biodegradable orthopedic devices have received considerable attention because of their considerable advantages including better quality of postoperative imaging, ease of approach for revision surgery, biocompatibility, enhancement of bone formation, and the lack of need for removal operations. The ideal biodegradable orthopedic material provides appropriated biomechanical stability and degrades with time while simultaneously being replaced by functional autogenous bone tissue.

The aim of this study was to evaluate effect of biodegradable screws containing bone morphogenetic protein-2 (BMP-2) and the local effectiveness of biodegradable biocomposite screws in ovariectomy (OVX) induced osteoporotic rats.



Combining Stem Cells and TUDCA for Spinal Fusion as an Alternative to Bone Morphogenetic Proteins

한인보

차의과대

허준석

고대안암병원



최근 주요 약력

- 고려대학교 의과대학 학사 및 동대학원 석/박사 졸업
- 고려대학교 의료원 인턴 및 신경외과 레지던트 수료
- 고려대학교 안암/구로 병원 신경외과 임상강사 수료
- 전. 기초과학연구원 (IBS) 유전체교정연구단 연구위원
- 현. 고려대학교 안암병원 신경외과 임상조교수

최근 주요 경력

- 대한 신경외과학회, 척추신경외과학회 종신회원
- 대한척추신경외과학회 기초, 경주, 척추종양, 골다공증 연구회 정회원
- 대한신경통증학회 교육수련이사, 대한소아신경외과학회 총무간사
- ISSLS 정회원



CRISPR Application on Spine Research Field – Human Primary Ligamentum Flavum Cell Gene Editing –

허준석

고려대

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) are the hallmark of a bacterial defense system that forms the basis for CRISPR–Cas9 genome editing technology. This has recently been shown to work in a variety of eukaryotic cells (animals and plants), and has received tremendous attention as a breakthrough in the scientific community. Subsequently, researches using them have been exploding in industry and medicine. However, these innovative technologies have not yet been applied in spine research.

Conditions for correct gene editing are very tricky. First, the guide RNA should be well designed and CRISPR system must be well transfected into the cell, it must function properly in the nucleus without off–target effect, and the cell must also maintain viability. The details of application to commonly used cell lines are well known, but the method of application to primary cells derived from the spine such as the ligament flavum has not been studied.

Herein I present the fundamental mechanism of CRISPR system, show how to deliver CRISPR into the cell and analyse the indel (insertion & deletion) efficacy in general, and finally disclose the details how to apply on spine field.



손 세 일

차의과학대학교 분당차병원



최근 주요 약력

- 2016.03-현재 차의과학대학교 분당차병원 신경외과 조교수
- 2014.02-2016.02 서울대병원 신경외과 진료 조교수
- 2011.03-2014.02 서울대병원 신경외과 전임의
- 2007.03-2011.02 서울대병원 신경외과 전공의

최근 주요 경력

- 현재 한국 생체재료학회 학술위원
- 현재 대한척추신경외과학회 교과서 편찬위원회 위원
- 현재 대한척추신경외과학회 홍보위원
- 2015 대한척추신경외과학회 총무위원회 위원



The effect of Ursodeoxycholic Acid in Spinal Cord Injury: in vitro and in vivo study

Wan-Kyu Ko, Inbo Han, Seil Sohn

Department of Neurosurgery, CHA University, CHA Bundang Medical Center, Seongnam-si, Gyeonggi-do, Republic of Korea

Purpose : Spinal cord injury (SCI) results in acute inflammatory responses, which can lead to a number of pathological impairments. Although methylprednisolone is well known for the anti-inflammatory drug, it has numerous side effects. The aim of this study was to investigate the anti-inflammatory effects by Ursodeoxycholic acid (UDCA) in SCI rats.

Methods : The moderate mechanical compression SCI was performed in adult Sprague Dawley (SD) rats. The post-injury locomotor functions were assessed using Basso, Beattie and Bresnahan (BBB) locomotor scale methods and the tissue volume of injured region was analyzed using hematoxylin and eosin staining. The pro-inflammatory factors were evaluated by immunohistochemistry and quantitative real time polymerase chain reaction (qRT-PCR). The phosphorylation of extracellular signal-regulated kinase (ERK), c-Jun N-terminal kinase (JNK), and p38 in mitogen-activated protein kinase (MAPK) signaling pathways were measured by western blot assays.

Results : UDCA improve the BBB scores and promotes the recovery of the lesion of spinal cord. UDCA inhibits the immunoreactivity of glial fibrillary acidic protein (GFAP) and tumor necrosis factor- α (TNF- α) that induce pro-inflammatory factors. UDCA also decreased the pro-inflammatory cytokines such as TNF- α , interleukin 1- β (IL-1 β), interleukin 6 (IL-6) and increased the anti-inflammatory cytokine interleukin (IL-10) in mRNA levels. UDCA suppressed the phosphorylation of ERK, JNK, and p38 signals, which lead to inflammatory signal pathways.

Conclusion : UDCA reduces the inflammatory responses as well as promotes the tissue recovery in SCI rats. These results suggest that UDCA can serve as a useful anti-inflammatory drug.

MEMO

2017. **9.15** (Fri.)



척추증양연구회

Symposium I: Hot Issue in Spine Care I

Recent Management of Extradural Tumor

좌장 : 한양대 백광흠, 이화의대 조도상

1. Osteosarcoma & Ewing Sarcoma

성균관대 이선호

2. Chordoma

원자력의학원 장응규

3. Giant Cell Tumor

연세대 이 성

4. Multiple Myeloma

인제대 이창현

이 선 호

성균관대학교



최근 주요 약력

- 1997 경북대학교 의과대학 졸업
- 2005 경북대학교 의과대학 신경외과 전문의

최근 주요 경력

- 2007-2008 경북대병원 신경외과 임상조교수
- 2008-2009 성균관대 삼성서울병원 신경외과 임상조교수
- 2010-2013 성균관대 삼성서울병원 신경외과 조교수
- 2014-현재 성균관대 삼성서울병원 신경외과 부교수
- 2014-2015 MD Anderson Cancer Center, visiting professor



Osteosarcoma, Chondrosarcoma & Ewing sarcoma

Sun-Ho Lee

Department of Neurosurgery, Sungkyunkwan University, Samsung Medical Center, Seoul, Korea

With advancements in spinal imaging and reconstruction/stabilization techniques, surgical treatment of primary spine tumors has improved. Proper diagnosis and careful preoperative multidisciplinary planning are paramount when dealing with patients harboring these lesions. Histopathologic diagnosis is critical to understanding the natural history, aggressiveness, and likelihood of the tumor to respond to chemotherapy, radiation, or other adjuvant treatments. A patient-specific treatment strategy should be based on histology and spinal column location aiming to preserve as much neurologic function as possible, ensure spinal stability, and improve oncologic prognosis. Surgical planning requires knowledge of the tumor grade; its relationship with surrounding osseous, vascular, and neural structures; and the presence or absence of systemic metastasis. And a multidisciplinary treatment team can create a definitive approach aiming for maximal oncologic control while preserving functional status and spinal stability.

We attempts to define a strategy to stage, plan, and treat primary malignant spine tumors based on histology and location in this session.

장 응 규

한국원자력의학원 신경외과



최근 주요 약력

- 한국원자력의학원 신경외과 주임과장
- 한국원자력의학원 Cyberknife 방사선 수술센터장
- 대한척추종양연구회 회장 (2016-현재)
- 대한방사선수술학회 부회장 (2017-2018)

최근 주요 경력

- Visiting scholar, Department of Radiation Oncology, University of California at Los Angeles (prof. William McBride)(2012, 1-2012, 2)
- Postdoctoral research fellow in department of Neurosurgery, Stanford University Medical Center (2004-2006)

Long term follow up result in spinal chordoma 41 cases

Ung-Kyu Chang, M.D. Ph.D

Department of Neurosurgery, Korea Institute of Radiological and Medical Sciences

Introduction : Spinal chordoma is a rare primary malignant bone tumor that originates from primitive notochord remnant of the axial skeleton, with the sacrum being the common location (50%) followed by the skull base (35%) and the mobile spine (15%). Despite being low grade malignancy with a slow growth rate and less tendency to metastasize than other bone and soft tissue malignant tumors, surgical excision with safe margin is usually not feasible due to their critical anatomical location and large size at presentation. This led to high rates, up to 60%, of local recurrence and distant metastasis, with an ultimate poor outcome. Most studies showed complete wide resection to provide lower risk of recurrence, longer continuous local control and an extended disease-free period compared to subtotal resection. However, non-significant correlation between the extent of resection and recurrence rate has been reported. Some studies reported aggressive surgical resection followed by radiotherapy to offer the best chance of long-term control. Recently, the new radiotherapy modalities, high-dose irradiation and stereotactic radiosurgery, has proved to be effective as an adjunctive treatment or treatment for recurrences, following aggressive surgical resection.

The aim of this study was to evaluate overall and progression-free survivals depending on the extent of removal. Moreover, we tried to compare the efficacy of two distinctive adjuncts, external photon beam radiation therapy (EBRT) and stereotactic radiosurgery (SRS), in terms of local tumor control following incomplete tumor resection.

Materials and Methods : We retrospectively reviewed medical and radiological records of 41 cases of spinal chordoma since 2000. There were 25 men and 16 women. The mean postoperative follow-up duration was 89.5 months (range, 6–195 months). They were 31 cases of sacral lesions and 10 cases of mobile spine (cervical and lumbar). Mean age was 54.7 (sacral lesions) and 45.3 (upper cervical lesions). Treatment modality was biopsy plus radiation therapy (RT) (8 cases, including 4 cases of radiosurgery), subtotal removal plus RT (5 cases, including 1 case of radiosurgery), marginal resection with or without RT (6 cases) and wide resection only (22 cases).



Results and Discussion : Overall mean survival time was 121.2 months. Disease progressions was seen 30 cases (73%) and mean progression free period showed 40.2 months. Thirteen cases out of 22 cases who received wide resection showed local recurrence (59%) after initial treatment, progression free time was 44.2 months. All of patients who underwent marginal resection or subtotal resection plus RT showed recurrence. Progression free times each of them was 36 and 14.9 months respectively. Biopsy plus RT group showed regrowth in 6 of 8 cases at a mean of 40.4 months (75%). Eleven cases showed no evidence of disease with mean follow up of 54.3 months.

With regard to the type of radiotherapy, external photon beam radiation therapy (EBRT) was done in 16 tumors and radiosurgery in 20 tumors. On follow-up, tumor progression occurred in all lesions treated with external photon beam radiation therapy (EBRT) but only 38% of lesions treated with stereotactic radiosurgery (SRS) ($P=0.003$). Extraspinal metastasis was seen in nine cases (lung, liver, fibula, femur, shoulder, buttock and anterior neck).

In the literature, chordoma displays racial and age-related disparities in incidence. Age <59 , primary tumor size <8 cm, microscopic tumor necrosis, Ki-67 $>5\%$, and surgical resection are known to be independent predictors of survival in patients with chordoma. Surgical resection significantly improves survival in patients with chordoma despite high rates of local recurrence. Local recurrence is associated with significantly with an increased risk of metastasis and tumor-related death.

As for radiation therapy, a high local control rate can achieved for postoperative adjuvant radiation treatment of primary tumor cases, but local control rate is decreased in recurrent cases. High dose radiation more than 70Gy is required for chordoma control.

Conclusions : Most cases of chordoma show local recurrence and resistant to cure. Radical surgery with appropriated surgical margin and adjuvant radiation therapy should be considered to tumor control.

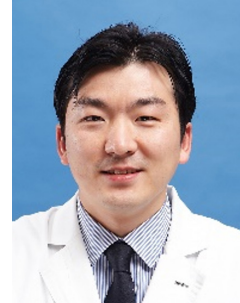


Giant Cell Tumor

이 성
연세대

이 창 현

인제의대 일산백병원 신경외과



경력 및 학력

- 현, 인제의대 일산백병원 신경외과 조교수
- 분당서울대병원 진료교수 역임
- 분당서울대병원 전임의 수료
- 서울대학교병원 수련의, 전공의 수료
- 서울의대 의학박사(수료)
- 서울의대 의학석사
- 중앙의대 졸업
- 2014년 대한신경외과학회 추계 학술대회 최우수 포스터상
- 2014년 대한척추신경외과학회 나누리 학술상 수상
- 2013년 대한신경외과학회 봉생김원묵 학술상 수상
- 2011년 대한척추신경외과학회 우수논문상 수상

학회 활동

- 대한신경외과학회 정회원
- 대한척추신경외과학회 정회원
- Global Spine Journal 학술논문 편집위원
- International Journal of Orthopedics 학술논문 편집위원
- The Nerve 학술논문 편집위원
- Journal of Minimally Invasive Spine Surgery & Technique 학술논문 편집위원
- 대한신경외과학회 학술지 심사위원
- 대한척추신경외과학회 학술지 심사위원
- 대한신경손상학회 학술지 심사위원

저서

- Practical points in spine surgery 2012 Bummun education, Part1, General approach to the patients with spinal disorder, Part 4, Astrocytoma and miscellaneous intramedullary tumors.
- Practical Neurosurgery for medical education 의학교육용 신경외과 실제, 2014 Bummun education.

Multiple Myeloma

이 창 현

인제대

Multiple myeloma (MM) is the second most common hematologic malignancy. The diagnosis of MM requires $\geq 10\%$ clonal plasma cells in the bone marrow or biopsy-proven plasmacytoma, plus evidence of end-organ damage (hypercalcemia, renal failure, anemia, and lytic bone lesions). The definition of MM has recently been expanded to include a $\geq 60\%$ clonal plasma cell burden in the bone marrow, serum involved/uninvolved light chain ratio of ≥ 100 , or more than one focal lesion on magnetic resonance imaging ≥ 5 mm in the absence of endorgan damage. MM is an incurable malignancy previously associated with poor survival rates.

However, over the past two decades, the introduction of novel treatment options has resulted in a dramatic improvement in response rates and overall survival (OS). Due to the introduction of several new effective therapeutic agents, multiple myeloma is one of the most active and changing fields in clinical oncology.

The current initial therapy paradigm of induction with combination agents, autologous transplantation, and long-term maintenance can be further improved upon in all of its components. Current trials aim to improve induction and maintenance components with the addition of monoclonal antibodies or newer generation proteasome inhibitors, while transplant conditioning is also an object for further improvement. It is clear that the multi-clonal heterogeneity of MM requires multi-targeted approaches in order to effect a lasting remission or cure. Conservative and palliative treatments are mainstay for these lesions. However, timely surgical interventions should be considered for the cases of pathologic fractures with progressive neurologic compromise.



골다공증연구회

Symposium II: Hot Issue in Spine Care II

Considerations in the Medical Treatment of Osteoporosis

좌장 : 전남대 이정길, 순천향대 도재원

1. 골다공증 치료시 알아야 할 보험 인정 기준: 검사 및 약제 선택 동국대 정주호
2. 골다공증 치료 약제 선택 시 알아야 할 주의 사항과 금기 경북대 조대철
3. 골다공증 치료 반응의 모니터링 경희대 김승범
4. 골다공증 치료 가이드 라인 (골대사학회 및 골다공증 학회 권고안) 인제대 진용준

정 주 호

동국대학교 경주병원 신경외과



학력 및 수련

- 1997 동국대학교 의과대학 졸업
- 2002 가천대학교 대학원 석사
- 2005 가천대학교 대학원 박사
- 1998 가천대학교 길병원 인턴 수료
- 2002 가천대학교 길병원 신경외과 레지던트 수료
- 2002-2003 가천대학교 길병원 척추신경치료연구소 전임의
- 2012.09-2014.03 메이요 클리닉 (Rochester, MN USA) 연수

경력

- 동국대학교 경주병원 신경외과 전임강사, 조교수
- 고신대학교 복음병원 신경외과 조교수
- 현. 동국대학교 경주병원 신경외과 부교수

학회 활동

- 대한신경외과학회 정회원
- 대한척추신경외과학회 종신회원
- 대한말초신경학회 종신회원
- 대한신경손상학회 종신회원
- 대한외상학회 평생회원
- 대한척수손상학회 정회원

골다공증 진단 및 치료 요양급여 인정기준

정 주 호

동국대

I. 골밀도검사의 인정기준 <고시 제2007-92호(2007.11.1.)>

다334 골밀도검사의 인정기준은 다음과 같이 함.

가. 적응증

- (1) 65세 이상의 여성과 70세 이상의 남성
- (2) 고위험 요소가 1개 이상 있는 65세 미만의 폐경 후 여성
- (3) 비정상적으로 1년 이상 무월경을 보이는 폐경 전 여성
- (4) 비외상성(fragility) 골절
- (5) 골다공증을 유발할 수 있는 질환이 있거나 약물을 복용중인 경우
- (6) 기타 골다공증 검사가 반드시 필요한 경우

※ 고위험요소

1. 저체중 ($BMI < 18.5 \text{ kg/m}^2$)
2. 비외상성 골절의 과거력이 있거나 가족력이 있는 경우
3. 외과적인 수술로 인한 폐경 또는 40세 이전의 자연 폐경

나. 산정횟수

(1) 진단 시

1회 인정하되, 말단골 골밀도검사 결과 추가검사의 필요성이 있는 경우 1회에 한하여 중심골(central bone)(요추, Ward's triangle 을 제외한 대퇴골)에서 추가검사 인정함.

(2) 추적검사



- (가) 추적검사의 실시 간격은 1년 이상으로 하되, 검사 결과 정상골밀도로 확인된 경우는 2년으로 함.
- (나) 치료효과 판정을 위한 추적검사는 중심골(요추, 대퇴골)에서 실시한 경우에 한하여 인정함.
- (다) 위 (가), (나)의 규정에도 불구하고 glucocorticoid 를 3개월 이상 복용하거나, 부갑상선기능항진증으로 약물치료를 받는 경우는 종전 골밀도검사 결과에 따라 아래와 같이 할 수 있으며, 이 경우 중심골(요추, 대퇴골)에서 시행함.

- 아 래 -

정상골밀도(T-score ≥ -1)인 경우: 첫 1년에 1회 측정, 그 이후부터는 2년에 1회
 T-score ≤ -2.5 인 경우: 첫 1년은 6개월에 1회씩, 그 이후부터는 1년에 1회

※ DEXA 기종으로 L-Spine의 AP와 Lat.에 골밀도 검사 동시 실시 시 수가 산정
 〈고시 제2007-92호(2007.11.1.)〉

요추부위에 양방사선골밀도검사(DEXA) 시 좀 더 정확한 골밀도를 측정하기 위해 L-Spine AP와 Lat. 을 동시에 실시하더라도, DEXA 골밀도검사 1부위만 인정

※ 자각증상은 없으나 진찰과정에서 골다공증이 의심되어 진료담당의사가 실시한 골밀도검사 〈고시 제2000-73호(2000.12.30.)〉

1. 국민건강보험법령에 의한 요양급여는 가입자 및 피부양자의 질병, 부상, 출산 등에 대하여 실시하고 있으며, 자각증상이 없는 상태에서 정기 또는 부정기적으로 신체 및 기능의 이상 유무를 사전에 알기 위하여 본인의 원에 의하여 자발적으로 실시하는 종합건강검진은 국민건강보험요양급여의기준에관한규칙 [별표2] 비급여대상. 3-가에 의거 비급여대상으로 규정하고 있음.
2. 그러나, 최근 갱년기 여성에게 골조직내 무기질 손실에 의한 골다공증 정도를 알기 위하여 골밀도 검사를 하는 경우에는 설사 본인의 희망에 의하여 골밀도 검사를 실시하더라도 검사 실시 전에 전문의사의 상담을 거치게 되므로 진찰과정에서 골다공증의 의심이 있다고 진료담당의사가 판단하여 지시한 검사를 행한 경우에는 검사결과 수치의 이상 유무에 관계없이 급여하며 검사결과가 정상이어서 상병명을 기재할 수 없을 때에는 추정 질병명 또는 증상을 기재하여 청구함.

II. 생화학적 골표지자 검사의 인정기준 〈고시 제2008-31호(2008.5.1.)〉

골다공증에 실시한 생화학적 골표지자 검사는 아래와 같은 경우에 골흡수 표지자 검사와 골형성 표지자 검사를 각 1종씩 인정함.

- 아 래 -

가. 골다공증 약물치료 시작 전 1회

나. 골다공증 약물치료 3~6개월 후 약제 효과 판정을 위해 실시 시 1회

※ 골흡수 표지자

- 나-393(디옥시피리디놀린),

- 나-393-1 (N-telopeptide of Collagen Type 1 (NTX))

- 나-393-2 (C-telopeptide of Collagen Type 1 (CTX))

※ 골형성 표지자

- 나-363(오스테오칼신),

- 나-398(골특이성알카리성포스파타제)

III. 비타민 D검사 <고시 제2016-204호(2016.11.1.)>

너153 기타 비타민 검사 중 비타민 D (D2, D3 및 total D) 검사의 급여기준은 다음과 같이 함. - 비타민 D 검사의 적응증 확대 및 산정방법 추가

- 다 음 -

가. 적응증

- 1) 비타민 D 흡수장애를 유발할 수 있는 위장질환 및 흡수장애 질환
- 2) 항경련제(Phenytoin 이나 Phenobarbital 등) 또는 결핵약제 투여 받는 환자
- 3) 간부전, 간경변증
- 4) 만성 신장병
- 5) 악성종양
- 6) 구루병
- 7) 이차성 골다공증의 원인 감별이 필요한 경우
- 8) 골다공증 진단 후 약물치료 시작 전 1회, 비타민 D 투여 3~6개월 후 약제 효과 판정을 위해 실시 시 1회 인정함을 원칙으로 하되, 이 후 추적검사는 연 2회까지 인정
- 9) 체표면적 40% 이상 화상

나. 기타

- 1) 비타민 D (D2, D3 및 total D) 검사는 1종만 인정
- 2) 선별 검사로 HPLC법(너153주1)은 인정하지 아니함



IV. 골다공증 치료제 <고시 제2017-109호(2017.7.1.)>

1. 허가사항 범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함. 특정조건 없이 단순히 골다공증 예방목적으로 투여하는 경우에는 비급여함.

- 아 래 -

가. 칼슘 및 Estrogen제제 등의 약제

골밀도검사서 T-score가 -1 이하인 경우 (T-score \leq -1.0)

- 나. Elcatonin제제, Raloxifene제제, Bazedoxifene제제, 활성형 Vit D3제제 및 Bisphosphonate제제 등의 약제 (검사지 등 첨부)

1) 투여대상

- 가) 중심골[Central bone; 요추, 대퇴(Ward's triangle 제외)] : 이중 에너지 방사선 흡수계측(Dual-Energy X-ray Absorptiometry: DEXA)을 이용하여 골밀도 측정 시 T-score가 -2.5 이하인 경우(T-score \leq -2.5)
- 나) 정량적 전산화 단층 골밀도 검사(QCT) : 80mg/cm³ 이하인 경우 - single slice QCT로 요추의 trabecular BMD 를 측정할 경우
- 다) 상기 가), 나)항 이외: 골밀도 측정시 T-score가 -3.0 이하인 경우(T-score \leq -3.0) - 중심골이 아닌 부위 (손목, 발목, 발뒤꿈치)에서 pDEXA, QUS로 측정하는 경우
- 라) 방사선 촬영 등에서 골다공증성 골절이 확인된 경우 - 단순 X-ray는 골다공증성 골절 확인 진단법으로만 사용할 수 있음.

2) 투여기간

- 가) 투여대상 다)에 해당하는 경우에는 6개월 이내
- 나) 투여대상 가), 나)에 해당하는 경우에는 1년 이내, 라)에 해당하는 경우에는 3년 이내로 하며, 추적검사서 T-score가 -2.5 이하(QCT 80mg/cm³ 이하)로 약제투여가 계속 필요한 경우는 급여토록 함.

2. 골다공증 치료제에는 호르몬요법(Estrogen, Estrogenderivatives 등)과 비호르몬요법(Bisphosphonate, Elcatonin, 활성형 Vit.D3, Raloxifene 및 Bazedoxifene제제 등)이 있으며, 호르몬요법과 비호르몬요법을 병용투여하거나 비호르몬요법 간 병용투여는 인정하지 아니함. 다만 아래의 경우는 인정 가능함.

- 아 래 -

가. 칼슘제제와 호르몬대체요법의 병용

나. 칼슘제제와 그 외 비호르몬요법의 병용

다. Bisphosphonate와 Vit. D 복합경구제(성분: Alendronate + Cholecalciferol 등)를 투여한 경우

- 라. Bisphosphonate 단일제와 활성형 Vit. D3 단일제 병용
- 마. SERM과 Vit.D 복합경구제(성분:Raloxifene + Cholecalciferiol)를 투여한 경우
 - 라본디캡슐 신규등재 관련

※ SERM : Seletive Estrogen Receptor Modulator(선택적 에스트로젠 수용체 조절제)

3. Calcitriol 경구제(품명: 본키연질캡슐 등) <고시 제2013-127호(2013.9.1.)>

- (1) 각 약제의 허가사항 범위 내에서 투여 시 영양급여 함을 원칙으로 함.
- (2) 허가사항 중 투석을 시행하지 않는 만성신부전증 환자에게 투여하는 경우에는 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함.

- 아 래 -

혈중 Calcitriol이 감소되어 이차성 부갑상선기능항진증을 유발할 때로서,

가. 사구체여과율(GFR)이 $40\text{ml}/\text{min}/1.73\text{m}^2$ 이하이면서, 부갑상선 기능항진증의 소견이 있는 경우(혈청 부갑상선호르몬(Intact PTH)이 $200\text{ pg}/\text{ml}$ 이상)

나. 사구체여과율(GFR)이 $25\text{ml}/\text{min}/1.73\text{m}^2$ 이하인 경우

- (3) 허가사항 중 골다공증의 경우에는 골다공증 치료제 일반원칙에 의하여 영양급여를 인정함.

4. Disodium etidronate 경구제(품명 : 다이놀정 등) <고시 제2013-127호(2013.9.1.)>

허가사항 범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함.

- 아 래-

가. X선 소견에서 뼈의 파제트병(Paget's Disease) 및 이상 부위 골화 (Heterotropic ossification)가 확인된 경우

나. 골다공증에 투여 시에는 골다공증 치료제 일반원칙에 따라 인정

5. Sodium alendronate 시럽제(품명: 마시본액) <고시 제2014-242호(2015-01-01)>

허가사항 및 [일반원칙] 골다공증치료제 “세부사항” 범위 내에서 영양급여를 인정함.

※ [일반원칙] 내용액제(시럽 및 현탁액 등) “세부사항” 적용을 제외함.

6. Pamidronate 제제 <고시 제2013-127호(2013.9.1.)>

- (1) 허가사항 중 골다공증에 투여 시에는 골다공증치료제 일반원칙에 의하여 영양급여를 인정함.
- (2) 허가사항 범위(효능·효과 등)를 초과하여 골형성부전증 소아에게 아래와 같은 기준으로 투여한 경우에도 영양급여를 인정함.



- 아 래 -

정형외과 또는 소아과 전문의에 의해서 골형성부전증으로 진단된 여자 만15세, 남자 만17세 이하의 소아로서,

가. 3회이상 방사선학적으로 입증된 장관골의 골절이 있는 경우

나. 2마디 이상의 척추압박골절이 있는 경우

다. 2세 이하 소아로 다발성골절이 있는 경우

7. Zoledronic acid 5mg/100ml 주사제(품명: 산도스졸레드론산주사액 5밀리그램/100밀리터) <고시 제2016-263호(2017-01-01)>

허가사항 범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함.

- 아 래 -

가. 기존 유사 효능효과 주사제(파미드로네이트 등)에 불응성이거나 부작용으로 투여가 불가능한 골파제트병

나. 골다공증에 투여 시 골다공증치료제 일반원칙을 따르며, 다음과 같은 대상에게 투여 시 인정함.

- 다 음 -

1) 투여대상

가) 중심골(Central bone; 요추, 대퇴(Ward's triangle 제외)) : 이중 에너지 방사선 흡수계측(Dual-Energy X-ray Absorptiometry: DEXA)을 이용하여 골밀도 측정시 T-score가 -2.5 이하인 경우

나) 정량적 전산화 단층 골밀도검사(QCT) : 80mg/cm³ 이하인 경우

다) 65세 이상의 폐경 후 골다공증 환자 중 대퇴골 골절 1개 이상 또는 척추골절 2개 이상인 환자

2) 투여횟수: 1회/년

가) 투여대상 가), 나)에 해당하는 경우 1회 인정하며, 추적검사상에서 T-score가 -2.5 이하(QCT 80mg/cm³ 이하)이거나 골다공증성 골절이 발생하여 약제투여가 계속 필요한 경우 추가 2회까지 인정함.

나) 투여대상 다)의 경우 3회까지 인정함.

골다공증 환자에게 최소 3년간 투약할 것을 권고하고 있는 점, [일반원칙]골다공증치료제' 급여기준에서 DEXA 기준 T-score ≤ -2.5 또는 QCT ≤ 80mg/cm³인 경우 1년 이내 및 골다공증성 골절을 동반된 경우 3년 이내 인정하며, "추적검사상에서 T-score가 -2.5 이하(QCT 80mg/cm³ 이하)로 약제투여가 계속 필요한 경우" 추가 투여를 인정하고 있는 점 등을 고려하여 투여 횟수를 변경함.

8. Teriparatide 주사제(품명: 포스테오주) <고시 제2017-17호(2017.2.1.)>

허가사항 범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함.

- 아 래 -

가. 투여대상

기존 골흡수억제제(alendronate, risedronate, etidronate 등) 중 한 가지 이상에 효과가 없거나(효과가 없는 경우란 1년 이상 충분한 투여에도 불구하고 새로운 골절이 발생한 경우를 의미함) 사용할 수 없는 환자로 다음의 조건을 모두 만족하는 경우

- 다 음 -

- 1) 65세 이상
- 2) 중심골[Central bone: 요추, 대퇴(Ward's triangle 제외)]에서 이중 에너지 방사선 흡수계측(Dual-Energy X-ray Absorptiometry: DEXA)으로 측정된 골밀도 검사결과 T-score -2.5 SD 이하
- 3) 골다공증성 골절이 2개 이상 발생(과거에 발생한 골절에 대해서는 골다공증성 골절에 대한 자료를 첨부하여야 함.)

나. 투여기간

최대 24개월. 한 환자의 일생에서 24개월 과정을 반복해서는 안 됨.

다. Teriparatide acetate 주사제(품명: 테리본피하주사)와 교체투여는 급여로 인정하지 아니함.

‘약제급여목록 및 급여상한금액표’에 테리본피하주사가 등재됨에 따라 두 약제의 교체투여에 대한 안전성 및 유효성이 확립되어 있지 않은 점 고려하여 급여로 인정하지 아니함.

9. Teriparatide acetate 주사제(품명: 테리본피하주사) <고시 제2017-17호(2017.2.1.)>

허가사항 범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정하며, 동 인정기준 이외에는 약값 전액을 환자가 부담토록 함.

- 아 래 -

가. 투여대상

기존 골흡수억제제(alendronate, risedronate, etidronate 등) 중 한 가지 이상에 효과가 없거나(효과가 없는 경우란 1년 이상 충분한 투여에도 불구하고 새로운 골절이 발생한 경우를 의미함), 사용할 수 없는 환자로 다음의 조건을 모두 만족하는 경우

- 다 음 -

- 1) 65세 이상의 폐경 후 여성
- 2) 중심골[Central bone: 요추, 대퇴(Ward's triangle 제외)]에서 이중 에너지 방사선 흡수계측(Dual-Energy X-ray Absorptiometry: DEXA)으로 측정된 골밀도 검사결과 T-score -2.5 SD 이하



3) 골다공증성 골절이 2개 이상 발생(과거에 발생한 골절에 대해서는 골다공증성 골절에 대한 자료를 첨부하여야 함.)

나. 투여기간

최대 72주. 한 환자의 일생에서 72주 과정을 반복해서는 안 됨.

다. Teriparatide 주사제(품명: 포스테오주)와 교체투여는 급여로 인정하지 아니함.

진행성 골다공증에 2차 약제로 급여 인정함. 단, 기등재된 포스테오주와의 교체투여에 대한 안전성 및 유효성이 확립되어 있지 않은 점 고려하여 급여로 인정하지 아니함.

V. 폐경 후 호르몬요법 인정기준

〈고시 제2013-127호(2013.9.1.)〉

폐경기증후군 및 골다공증에 사용하는 호르몬요법은 허가범위 내에서 아래와 같은 기준으로 투여 시 영양급여를 인정함.

- 아 래 -

가. 적응증

- 1) 폐경기증후군의 증상완화와 골밀도검사에서 같은 성, 젊은 연령의 정상치보다 1표준편차 이상 감소된 경우에 골다공증의 예방 및 치료목적으로 투여 시 영양급여를 인정함.
- 2) 심혈관계 질환의 예방 및 치료에는 인정하지 아니함.

나. 재평가 기간

매 12개월마다 재평가를 실시하여야 함(환자의 전반적인 상태 및 필요성)

다. 적정투여기간

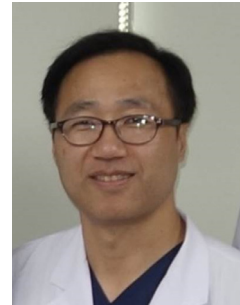
60세까지 투여하며, 60세를 초과하여 호르몬 요법을 지속하는 경우에는 동 치료의 효과를 평가하여 지속투여 여부를 결정하여야 함.

참고문헌

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2. 골다공증의 진단 및 치료 지침; 대한골대사학회 2013, 2015

조 대 철

경북대학교병원 신경외과



최근 주요 약력

- 2016-현재 경북대병원 신경외과 부교수
- 2012-2016 경북대병원 신경외과 조교수
- 2006-2007 경북대병원 신경외과 전임의
- 1998-2001 경북대병원 신경외과 전공의
- 1991-1996 경북대학교 의과대학

최근 주요 경력

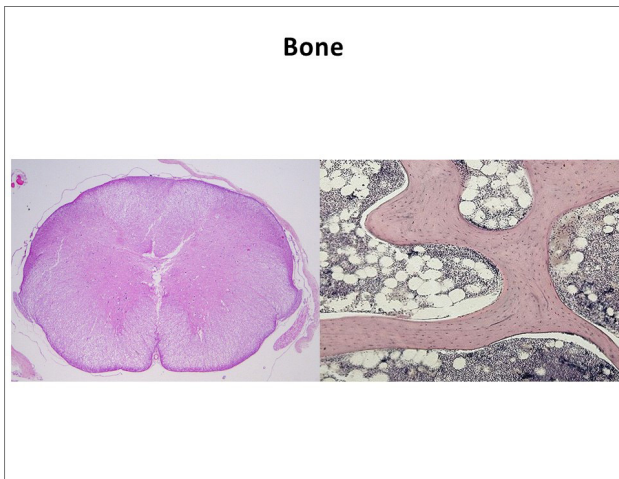
- 대한신경외과학회 정회원
- 대한척추신경외과학회 종신회원
- Cervical Spine Research Society
- Australian and New Zealand Bone and Mineral Society
- Visiting Academic of St. Vincent's Institute of Medical Research, The University of Melbourne, Melbourne, Australia



골다공증 치료 약제 선택시 알아야 할 주의 사항과 금기

조 대 철

경북대학교 병원 신경외과



Chemical Composition of Bone

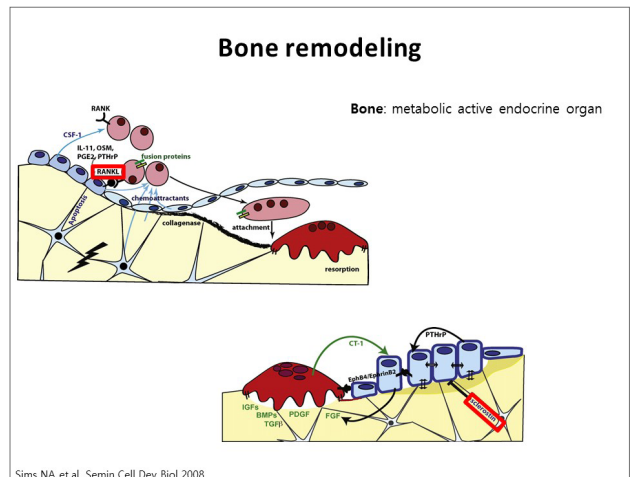
Bone cells : Osteocytes, Osteoblasts, Osteoclasts

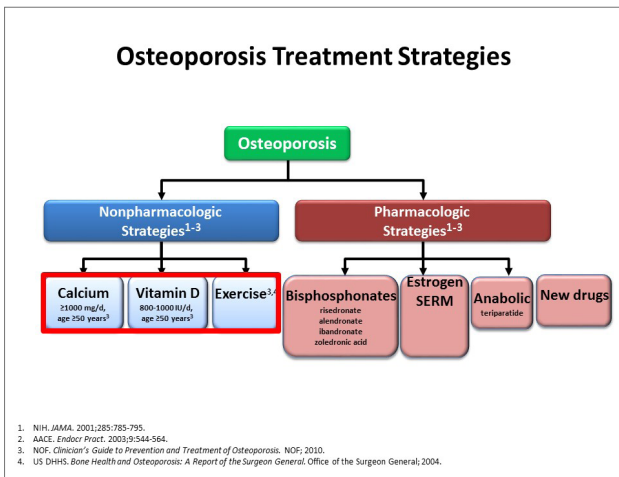
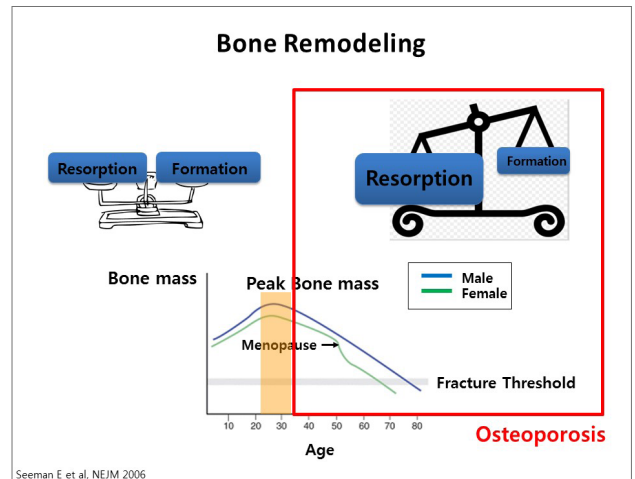
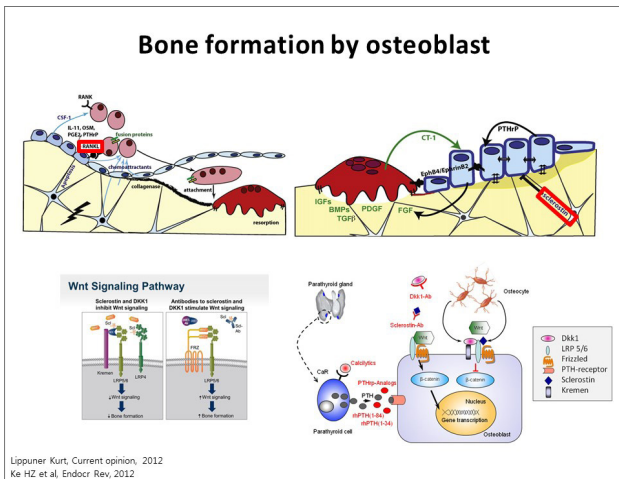
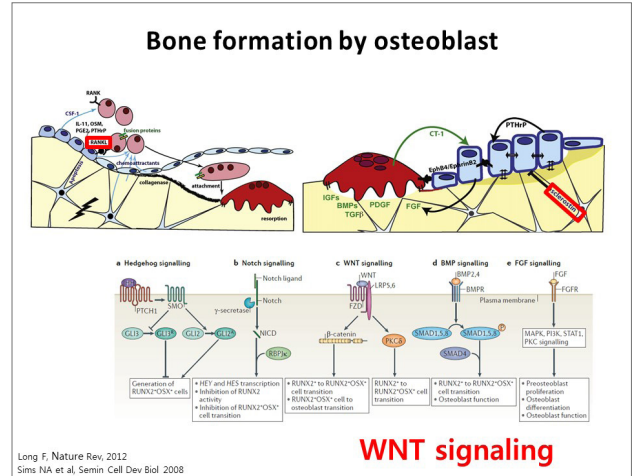
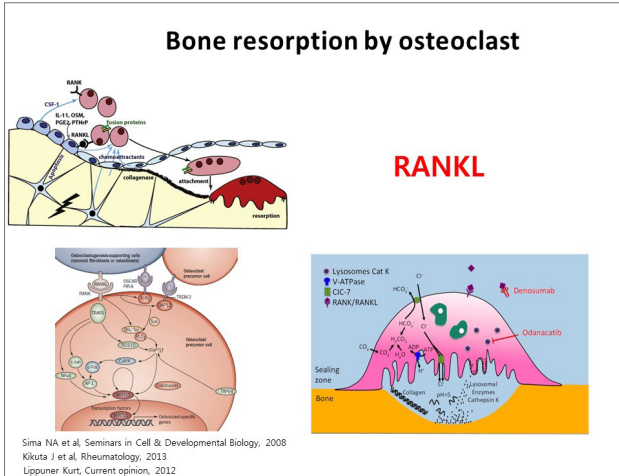
Matrix Organic (35%) flexibility, tensile strength, resists stretching and twisting

- Type I collagen fiber
- Noncollagen protein : proteoglycan, glycosaminoglycan, glycoprotein (osteonectin, osteopontin...), Vit K-dependent protein (osteocalcin...), serum protein (albumin...), bone morphogenic protein

Inorganic (65%) Hardness, strength, resists compression and tension

- Hydroxyapatite (mineral salts)
- Storage for Ca, P, Su, Mg, Cu





Calcium

- 혈중 정상치: 8.8~10.8mg/dL
- 2010년 한국인 영양섭취기준
 - : 50세 이상 성인의 칼슘 권장섭취량 1일 700mg
- 2015년 대한골대사학회 권고안
 - : 50세 이상 남성, 폐경 여성 1일 800~1000mg 섭취 권장

※ 표 8-1. 칼슘 흡수에 영향을 주는 요인

요인	칼슘 흡수 증가 요인	칼슘 흡수 감소 요인
장	장 운동 지연	장 운동 촉진
장	장 운동 지연	장 운동 촉진

※ 표 8-2. 칼슘 함유 식품 및 함량

식품군	식품명	수량	함량 (mg)	식품군	식품명	수량	함량 (mg)
유제품	우유	1리터	294	채소류	당근	100g	18
	요구르트	1리터	156		시금치	100g	53
	치즈	1리터	129		시금치	100g	39
곡류	밀가루	1리터	158	견과류	호두	100g	182
	쌀	1리터	20		아몬드	100g	115
	보리	1리터	56		땅콩	100g	58
육류	쇠고기	100g	107	기타	우유	1리터	294
	돼지고기	100g	145		시금치	100g	53
	닭고기	100g	21		시금치	100g	53



Vitamin D

- 혈청 25(OH)D 농도: Vit. D 영양상태 반영
- Deficiency: < 20ng/mL Inadequacy: < 30ng/mL
- 2010년 한국인 영양섭취기준
 - 성인 1일 필요량 5~10 µg (200~400 IU)
- 2015년 대한골대사학회 권고안
 - 50세 이상 남성, 폐경 여성 1일 **800 IU**

☛ 표 3-3. 비타민 D 함유 식품 및 함유량

음식	함유량(IU)
대구 간유 100ml (비타민 D = 15 ml)	1300
연어 200g	300
고등어 200g	36
참치, 기름, 불고기 200g	270
멸치, 조식 200g	200
채널 태 (노른자) 1개	25
복숭아 100g	20

Vitamin D

Fig. 1. 비타민 D 결핍으로 인한 골다공증, 골감소증, 낙상, 골절의 병리 생리학적 경로

Vitamin D

chosun.com

한국인 평균 혈청 비타민 D 농도 18.4ng/mL

충분 30ng/mL 이상 부족 21~25ng/mL 위험 농도 20~100ng/mL

10대 이상 22.04%가 혈청 비타민 D 농도 20~25ng/mL 이하인 것으로 나타났다 (2010~2015년 1차 국민건강영양조사 자료)

WORLD KOREA

Vitamin D Deficiency

PLIPS et al Journal of Internal Medicine 2006; 260: 245-254

Osteoporosis Treatment Strategies

1. NIH, JAMA, 2001;285:785-795.

2. AACE, Endocr Pract. 2003;9:544-564.

3. NOF, Clinician's Guide to Prevention and Treatment of Osteoporosis, NOF, 2010.

4. US DHHS, Bone Health and Osteoporosis: A Report of the Surgeon General, Office of the Surgeon General, 2004.

Bisphosphonate

ALN on bone surfaces at 24 hrs

1. Baron R et al. Bone 2011;48: 677-692. 2. Kimmel DB. J Dent Res 2007;88: 1022-1033

3. Masarachia P, et al. Bone 1996;19:281-290. 4. Kostenuik PJ, et al. J Bone Miner Res 2009;24:182-195

Problems with Bisphosphonate

단기적 문제점

- 상부 위장관 문제
- 식도이상 반응, 식도암의 위험
- 중증 근육통
- 저칼슘혈증
- 급성기 반응
- 안과적 염증(포도막염)

장기적 문제점

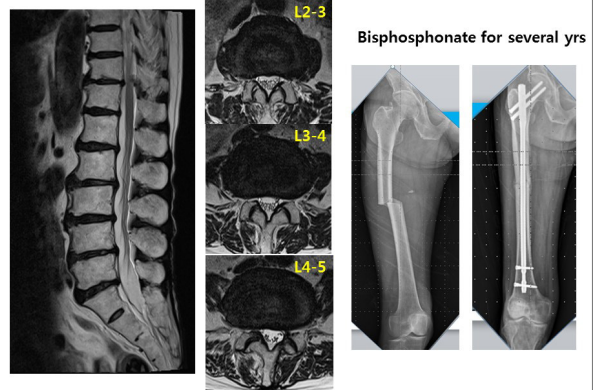
- Bone turnover의 과도한 억제
- 비전형 대퇴골골절
- 턱뼈 골괴사(ONJ)
- 심혈관 사건-심방세동 발생 등

용량/용법: 1) 아침에 음식물, 음료수 또는 다른 약물 섭취 최소한 30분 전에 (흡수 저하 때문) 충분한 양의 물과 함께 복용한다 (식도자극 가능성을 감소시키기 위해)
 2) 복용후 적어도 30분간, 그리고 최초 음식물 섭취전까지 누워서는 안된다
 3) Calcium and Vit D 함께
 4) 중증 신부전 환자 (CrCl 30ml/min) 에서는 권장되지 않는다

Osteonecrosis of Jaw (ONJ) after Long-term BPs

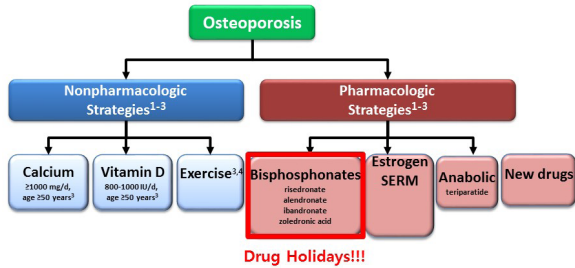


F/64 Rt antero-lateral thigh pain for 3 months



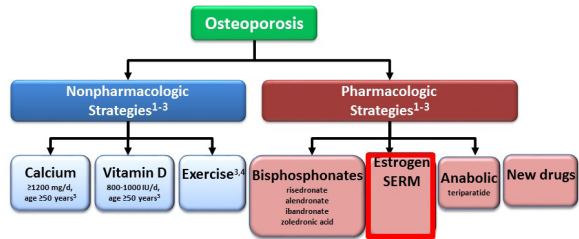
Bisphosphonate for several yrs

Osteoporosis Treatment Strategies



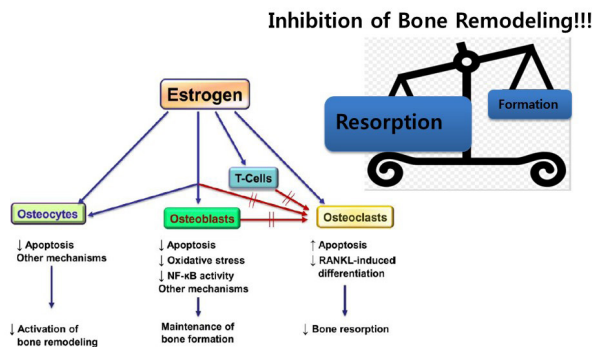
1. NIH, JAMA, 2001;285:785-795.
 2. AAFC, Endocr Pract, 2003;9:544-564.
 3. NOF, Clinician's Guide to Prevention and Treatment of Osteoporosis, NOF, 2010.
 4. US DHHS, Bone Health and Osteoporosis: A Report of the Surgeon General, Office of the Surgeon General, 2004.

Osteoporosis Treatment Strategies



1. NIH, JAMA, 2001;285:785-795.
 2. AAFC, Endocr Pract, 2003;9:544-564.
 3. NOF, Clinician's Guide to Prevention and Treatment of Osteoporosis, NOF, 2010.
 4. US DHHS, Bone Health and Osteoporosis: A Report of the Surgeon General, Office of the Surgeon General, 2004.

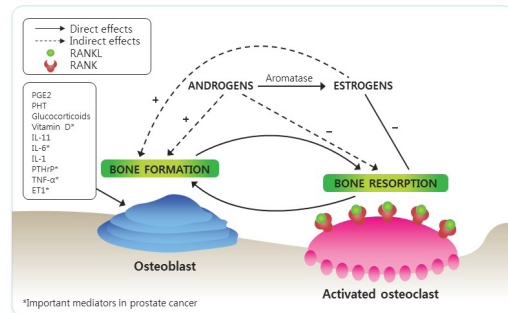
Estrogen Deficiency and Osteoporosis



Tulay Okman-Kilic, Estrogen Deficiency and Osteoporosis, <http://dx.doi.org/10.5772/59407>

Estrogen Increases the Risk of Breast Cancer

호르몬 치료는 골흡수를 억제하고 골형성을 자극하여 골강도를 증가시키지만, 유방암 위험을 증가시키는 단점이 있습니다.

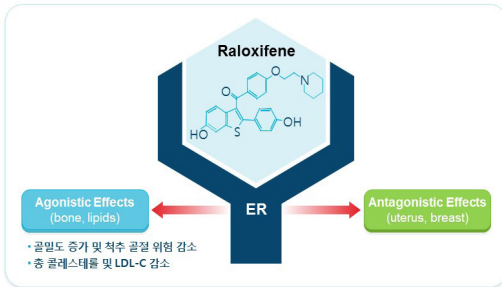


Can Urol Assoc J, 2010;4:129-135.
 Open Orthop J, 2009;3:14-22.

Selective Estrogen Receptor Modulator

선택적 Estrogen 수용체 조절제(SERM)

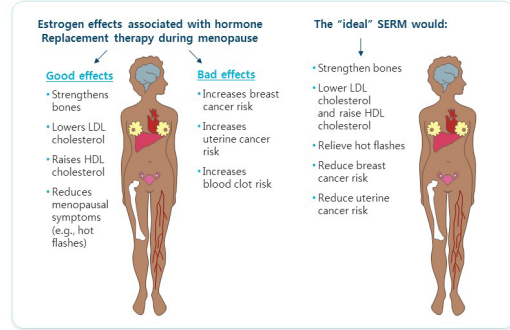
- Estrogen 및 progestin 등의 호르몬 제제가 아닌 비호르몬 제제로 **선택적으로 estrogen 수용체와 결합하여 골격계에 estrogen과 같은 효과를 나타냅니다.**



ER, estrogen receptor

Estrogen versus SERM

- 유방암 위험 증가 등 단점을 보이는 호르몬 치료와는 달리 **SERM 제제는 estrogen의 임상적 이점만을 나타냅니다.**

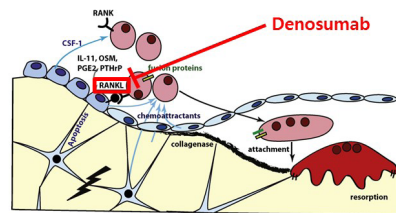


Problems with SERM

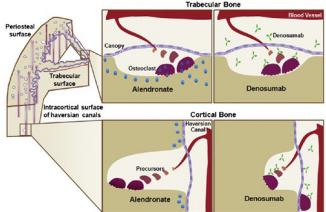
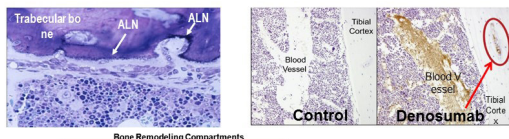
- Hip fracture risk
- Vitamin D

Raloxifene + Vit D

Targets of new osteoporotic drugs



Denosumab



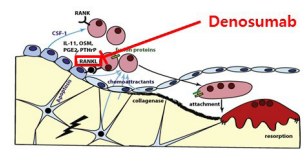
Monoclonal Ab to RANKL
Denosumab circulates in blood and extracellular fluid including bone tissue, can reach both **trabecular** and **cortical** bone^{1,4}

1 Baron R et al. Bone 2011 48: 677-692. 2. Kimmel DG J. J. Bone Miner Res 2007; 22: 1022-1033. 3. Masarachia P, et al. Bone 1996; 19: 281-290. 4. Kottmann PJ, et al. J. Bone Miner Res 2009; 24: 182-195. Zebaze RM et al. Bone. 2014 Feb;59:173-9.

Denosumab vs Bisphosphonate

Table 1. Adverse Events*

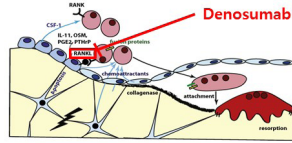
Event	Denosumab (N=3886)	Bispho (N=3876)	P Value
All	3605 (92.8)	3607 (93.1)	0.91
Serious	3004 (77.3)	3172 (81.6)	0.41
Fatal	70 (1.8)	90 (2.3)	0.68
Leading to study discontinuation	93 (2.4)	81 (2.1)	0.39
Leading to discontinuation of a body drug	192 (4.9)	202 (5.2)	0.55
Adverse events occurring in at least 2% of subjects			
Infection	2055 (52.9)	2108 (54.4)	0.17
Cancer	187 (4.8)	190 (4.9)	0.81
Hypocalcemia	0	3 (0.1)	0.08
Osteonecrosis of the jaw	0	0	NA
Serious adverse events			
Cancer	144 (3.7)	135 (3.5)	0.28
Infection	139 (3.5)	133 (3.4)	0.14
Cardiovascular event	186 (4.8)	178 (4.6)	0.14
Stroke	54 (1.4)	54 (1.4)	0.89
Coronary heart disease	47 (1.2)	39 (1.0)	0.41
Peripheral vascular disease	32 (0.8)	30 (0.8)	0.83
Abial fibrillation	29 (0.7)	29 (0.7)	0.98
Adverse events occurring in at least 1% of subjects			
Eczema	118 (3.0)	65 (1.7)	<0.001
Falling	175 (4.5)	219 (5.7)	0.02
Flu-like	84 (2.2)	51 (1.3)	0.008
Serious adverse events occurring in at least 0.5% of subjects			
Cellulitis (including erysipelas)	12 (0.3)	1 (0.0)	0.002
Convulsion	1 (0.0)	11 (0.3)	0.004



Denosumab	Bisphosphonate
esp. Trabecular bone	Trabecular & Cortical bone
Strongly bind for 10 yrs	reversible
Oral; slow absorption (1-2hr); affected by eating	IV; rapid absorption Not affected by eating
Rapid	Usually rapid
By the kidney	Not removed by kidney; complex elimination

Denosumab

- 사용상 금기: 1) 임부
2) 저칼슘 혈증
3) 이 약의 과민반응



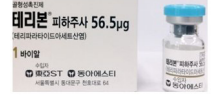
Incidence of atypical femur fracture

- Incidence of atypical femur fractures in **naive** patients*
 - **0.1 per 10,000** person-years (1 per 100,000 person-years)
- Incidence of atypical femur fractures in patients on **BP**† (Post-Marketing)
 - **5.5 per 10,000** person-years (55 per 100,000 person-years)
 - Incidence: rare
- Incidence of atypical femur fractures in patients on **denosumab**
 - (Clinical Trials, Proactive Monitoring [2 cases in clinical trial, 4 post-marketing cases])
 - **0.3 per 10,000** person-years (2.7 per 100,000 person-years)
 - Incidence: very rare

신장애헌자에게 사용할 수 있는 유일한 옵션!!!

1. Donnelly E et al. Curr Opin Support Palliat Care 2012, 6:348-354

Anabolic drugs (PTH)



다음환자에는 투여하지 말것

- ☑ 테리파라타이드 또는 이 약의 부형제 성분에 대하여 과민반응
- ☑ 기존의 고칼슘혈증
- ☑ 골격 악성종양 또는 골전이와 있는 환자
- ☑ 일차적인 골다공증 이외의 대사성 골 질환 (부갑상선 기능항진증 및 뼈의 Paget's disease 포함)
- ☑ Alkaline phosphatase의 충분히 설명되지 않는 상승
- ☑ 임부 및 수유부
- ☑ 이전에 골격에 방사선 치료를 한 경우
- ☑ **중증의 신장기능 손상**

Anabolic drugs (PTH)

Kidney function test

- 1) BUN/Cr
- 2) Creatinine Clearance
- 3) GFR(glomerular filtration rate, 사구체 여과율)

중증신장기능 손상

- CrCl : 30ml/minute 미만
- GFR : 4단계 이하

단계	사구체여과율	상태	관리/치료
1	> 90	정상 신기능	추적 관찰
2	60-89	경도 신기능 저하	추적관찰, 혈압 및 위험요인 조절
3	30-59	중등도 신기능 저하	추적관찰, 혈압 및 위험요인 조절
4	15-29	중증 신기능 저하	신장 전문의 진료, 신대체 요법 준비
5	< 15	말기 신부전	신대체 요법

김승범

경희대학교병원 신경외과



학 력

- 1997 한양대학교 의과대학 졸업
- 2000 한양대학교 의과대학 학사
- 2004 한양대학교 의과대학 박사

경 력

- 1997-2002 한양대학교 서울병원 인턴 및 신경외과 전공의
- 2002 신경외과 전문의 취득
- 2002-2003 연세대학교 의과대학 강남세브란스병원 전임의
- 2003-2005 한양대학교 서울병원 전임의
- 2005-2006 원광대학교 산본병원 교수
- 2006-현재 경희대학교병원 신경외과 교수
- 2013-2014 Dept. of Neurosurgery, University of California, Davis, Medical Center Visiting Professor (Spine)

현 재

- 2016-현재 경희대학교 의과대학 신경외과 교수

학회 활동

- (현) 대한노인신경외과학회 총무이사
- (현) 대한신경외과학회 수련 교육 간사
- (현) 대한척추신경외과학회지 편집위원
- (현) 대한미세침습수술연구회 상임이사
- (현) 대한척추 골다공증 학회 상임이사
- (현) 대한척추종양학회 상임이사
- (현) 대한척추신경외과학회 교과서 편찬 위원회 간사
- (현) 대한척추신경외과학회 이사
- (현) 대한말초신경학회 회원관리이사



골다공증 치료의 모니터링

김 승 범

경희대학교병원 신경외과

골다공증 치료 모니터링

- 임상적 골절
- BMD DEXA
- Bone turnover marker
- Biopsy

골표지자의 임상적 의의의 변화

- 과거:골표지자 측정은 BMD의 변화 속도를 예측
- 현재: 골의 질과 골절 위험의 예측에 더 의의가 있다고 보고 있다.
- BMD와 골표지자는 골의 두가지 측면을 관찰
BMD – 그야말로 bone mass
골표지자 – 골의 대사상태와 quality

Bone markers in Osteoporosis

- 골밀도 검사는 골다공증의 주된 검사 방법이며 측정 정확도가 비약적으로 개선되었다.
- 골밀도 검사는 정적인 반면 골표지자 측정은 보다 동적이다.
- 골대사는 매일 매일 변화하고 골밀도가 같다 하더라도 골대사의 상태는 서로 다르고 그에 따른 pathologic significance도 서로 다르다.
- BMD 측정치를 동적인 지표로 이용하려면 최소한 6개월에서 1년간은 기다렸다가 재측정을 해야 하지만 골표지자는 측정 당시의 골대사 상태를 정확히 반영한다.

Bone markers in Osteoporosis

- A guide to selecting pharmacotherapy.
- 골다공증 치료 약제의 효과를 적절히 평가하기 위해서 진단 당시에 항상 골표지자를 측정하는 것이 좋다.
- 하지만 골대사에 큰 영향을 주지 않는 치료를 선택한 경우는 골표지자를 측정하는 것은 의미가 없다.



Bone turnover markers

- ▶ Formation and resorption markers through blood and urine sample : express the metabolic activity of osteoblasts or osteoclasts respectively.
- ▶ Some markers represent both processes, e.g. osteocalcin (OC).
- ▶ Results should therefore always take into consideration the whole clinical picture and an understanding of the nature and source of each marker is essential for a comprehensive interpretation.

Bone turnover markers

The bone remodelling cycle

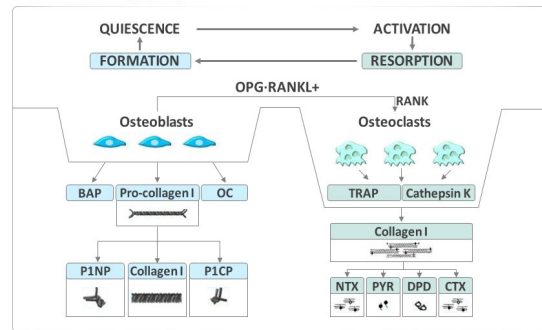
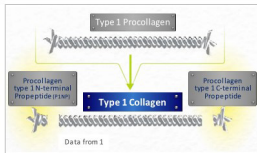


Fig 1. The bone remodelling cycle
1. G. Wheeler, et al. / Transl Med. 2013 Aug 29:11-201

Bone turnover markers

P1NP (amino-terminal propeptide of type 1 collagen)



- ☑ IOP, IFCC, NBHA에서 비교적 변동성이 적은 P1NP를 권고하고 있습니다. BONE FORMATION의 REFERENCE MARKER로서 권고하고 있습니다.^{1,2}
- ☑ P1NP 수치변화를 통해 뼈를 형성하는 ANABOLIC ACTIVITY를 확인할 수 있습니다.¹

P1NP may be particularly clinically useful because this marker is relatively insensitive to the circadian rhythm or the effects of food intake⁴ and has a high signal-to-noise ratio³

International Osteoporosis Foundation
International Federation of Clinical Chemistry
National Bone Health Alliance

1. Kröger H, et al. Osteoporos Int. 2014;25:2159-2171. 2. 대한민국에서부터 골다공증 지침서 2015. 3. Kassthal A, et al. Curr Med Res Opin. 2006;32:61-4. 4. Kröger H, et al. Osteoporos Int. 2014;25:2159-2171

Bone turnover markers

OSTEOCALCIN

“ OSTEOCALCIN 은 비 콜라겐 단백질으로써 골 형성지표 중 하나이다. 그러나 OSTEOCALCIN 은 골 기질 내에 편입되어 있는 단백질이기 때문에 골 흡수 과정 동안에도 혈액으로 분비될 수 있다. 따라서 한시기의 OSTEOCALCIN 혈중농도는 골 형성과 골 흡수의 두 가지 성격을 모두 표시하는 것이기 때문에 골 형성의 특이적 골 표지자라기 보다는 골 교체를 전반적으로 반영한다고 할 수 있다.

1. 대한민국에서부터 골다공증 지침서 2015

Bone resorptive markers

NTX (N-terminal telopeptide of type 1 collagen)

NTX 는

“ NTX 는 골 흡수 과정에서 Cathepsin-K에 의해 type 1 콜라겐으로부터 유리 되는 골 흡수지표로서 폐경후 여성의 골절위험을 예측하는 인자가 될 수 있다. 공복 채혈이 추천되지만 소변을 통한 NTX sample(NTX)역시 비교적 식사에 의한 영향이 적다.¹”

1. G. Wheeler, et al. / Transl Med. 2013 Aug 29:11-201

Bone resorptive markers

Recommended Assessment of BTMs for the Evaluation of OP Therapies

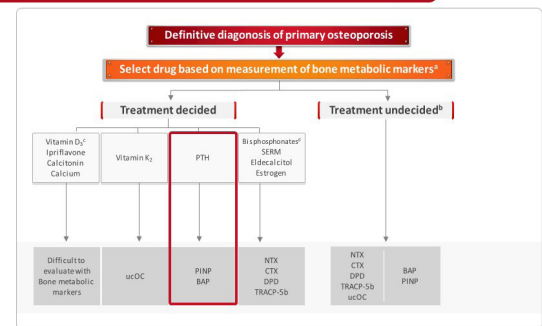
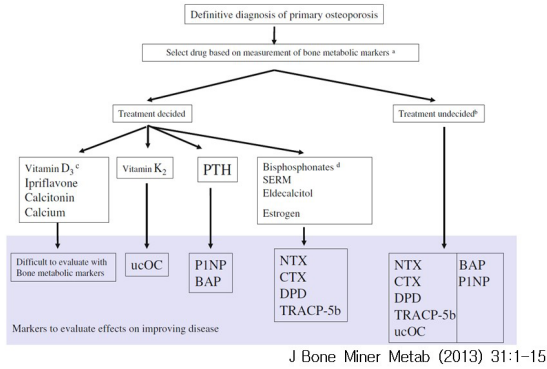


Fig 1. Measurement of bone turnover markers in drug treatment of osteoporosis
1. Nakazono Y, et al. / Bone Miner Metab. 2013;29:1017-15

Measurement of bone turnover markers in drug treatment of osteoporosis



Osteocalcin

- γ-carboxylation of osteocalcin depends highly on vitamin K nutrition
- Vitamin K deficiency produces under-carboxylated osteocalcin (ucOC), which has less ability to bind hydroxyapatite.
- the serum level of ucOC is a sensitive marker for vitamin K deficiency in bone.
- 고령인구는 vit K 요구량이 많고 결핍증이 발생하기 쉽다.

Monitoring of treatment efficacy and compliance to treatment

- Women on hormone replacement therapy (HRT) who had the highest quartile of percentage change from baseline to six months in NTX, BALP and DPD had the greatest change in spine BMD after one year. (Rosen CF et al. J Clin Endocrinol Metab 1997)
- Ensuring adherence to treatment for osteoporosis is a major challenge.
A significant fall in bone markers after starting a treatment indicates that medication is being taken regularly and is absorbed properly.

Evaluation of drug treatment effect

Table 5 Minimum significant changes (MSC) in bone turnover markers approved for osteoporosis

Type of marker	Assay method	Units	MSC (%) ^a (twice the mean day-to-day variation)	Reference (%) ^b
Bone formation markers				
BAP	CLEIA	µg/L	9.0	-
BAP	EIA	U/L	-	23.1 ^c
P1NP	RIA	µg/L	12.1	-
Bone resorption markers				
DPD ^d	EIA	nmol/mmol Cr	23.5	29.6 ^e
sNTX	EIA	Nmol BCE/L	16.3	14.2 ^e
uNTX	EIA	nmol BCE/mmol Cr	27.3	35.0 ^e
sCTX	EIA	ng/mL	23.2	-
uCTX	EIA	µg/mmol Cr	23.5	51.1 ^e
TRACP-5b	EIA	mU/dL	12.4	16.2 ^e
Bone matrix-related marker				
ucOC	ECLIA	ng/mL	32.2	-

Possible causes for the variation within MSC value under drug tx.

- Causes related to various variations
The samples before and after the treatment should be collected at the same time because of the diurnal variation
Measurement errors over a long period of time (e.g., seasonal variation, change in patient status)
Measurement interval is too short
Change in the laboratory performance measurement or change the laboratory site
- Low compliance of drug and instructions
Inadequate timing with meals (bisphosphonates)
Insufficient medication (low compliance)
- Current drug for osteoporosis has no effect on bone markers

If there is no problem with treatment compliance, then an increase in dose or switch to another drug.

Appropriate time to measure metabolic markers

- Anti-resorptive drugs
Bone resorption markers : 3~6 개월 후
Bone formation markers : 반응이 더딘 관계로 6개월 이후
- Bone formation drugs
P1NP가 가장 반응이 두드러진다.
BAP, OC도 이용은 가능....
Bone formation markers : 1~3 개월 후



골표지자의 임상적 의의

- 1. Estimation of bone turnover state at the time of measurement.**
- 2. Prediction of the rate of BMD change in near future.**
- 3. Assessment of drug treatment.**
- 4. Evaluation of bone quality.**

진 용 준

Department of Neurosurgery,
Seoul Paik Hospital, School of Medicine, Inje University



Present position

- 2014.03–present Associate Professor, Department of Neurosurgery, Seoul Paik hospital, School of Medicine, Inje University
- 2010.03–2014.02 Assistant Professor, Department of Neurosurgery, Seoul Paik hospital, School of Medicine, Inje University

Academic position/Employment

- 2008.05–2010.02 Clinical assistant professor, Seoul National University Bundang Hospital, Sung–nam city, Korea
- 2006.05–2008.04 Spine fellowship, Seoul National University Bundang Hospital, Sung–nam city, Korea
- 2005.06–2006.04 Army surgeon, Korean Armed Forces Capital Hospital, Sung–nam city, Korea
- 1999.03–2003.02 Resident, Department of Neurosurgery, Seoul National University Hospital
- 1998.03–1999.02 General Intern, Seoul National University Hospital, Seoul, South Korea

Education

- 1994.03–1998.02 M.D., Seoul National University, College of Medicine, Seoul, South Korea
- 2003.03–2012.07 Ph.D., Doctor of medical science, Seoul National University, College of Medicine, Seoul, South Korea

Board Certification

- 2003 Korean board of Neurosurgery

Medical Licensure/Certification

- 1998 medical license of Korea

Membership

- The Korean Neurosurgical Society
- The Korean Spinal Neurosurgery Society
- Korean Cervical Spine Research Society
- The Korean Spinal Neurosurgery Research Society
- Korean Minimally Invasive Spine Surgery Related Society
- Korean Spine Oncology Research Society
- The Korean Spinal Deformity Society



골다공증 치료 가이드 라인 (골대사학회 및 골다공증 학회 권고안)

진 용 준

인제대

고령화 사회로 빠르게 진입하면서 골다공증의 심각성과 중요성이 커지고 있는 시점에 2015년에 개정된 대한골대사학회 및 대한골다공증학회의 골다공증 진단 및 치료 지침을 새로이 조명해 보고 2018년 새로운 개정될 예정인 내용에 대해서도 고민이 필요하게 되었습니다. 2015년 개정판을 복습하면서 비스포스포네이트 제제의 장기간 사용시의 합병증으로 턱뼈괴사 및 비전형 대퇴골 골절을 정리하고 약물 휴지기에 대한 필요성과 제안을 고려해야 합니다. 새로운 약제인 3세대 SERM, TSEC, RANKL 억제제, 카텡신 K 억제제, Romosozumab, strontium과 기존에 시장에 나온 골형성 호르몬인 teriparatide 등 골다공증의 치료의 다양한 옵션이 생기면서 골다공증 치료의 패러다임의 변화를 모색해야 할 시기입니다. 더욱 복잡해진 상황에서 골다공증에 의한 골절 발생시 치료도 다양한 시도가 필요한 상태입니다. 이런 신약들의 약진에도 불구하고 칼슘, Vit D, 영양관리, 예방 운동, 재활 운동등에 대한 근간이 되는 일반적인 치료들에 대해서도 다시 확인하는 것이 필요하겠습니다. 골다공증 진료 및 치료 지침에 맞게 간략하고 정리된 임상 연구 데이터를 다시 확인하고 실제 임상 진료에 바로 적용하는데 도움을 주고자 합니다.

MEMO

2017. **9.16** (Sat.)



Free Paper I

Basic Research In Spine Disorders

좌장 : 인제대 정용태, 국민건강보험공단 일산병원 장호열



척추변형 및 다분절 척추 재수술에서 아우트리거 로드기술을 이용한 수술적 치료

윤상덕, 임유석, 김성민, 조대진

강동경희대병원

PURPOSE : Instrumentation failure is a recognized complication after deformity correction and complex spinal reconstruction, Rod fracture is the most frequent hardware failure in long-segment spinal fusion surgery. This complication can cause spinal pain, functional compromise, instability and loss of deformity correction. To describe the outrigger and multiple rod technique in spinal revision surgery.

MATERIALS AND METHODS : 30 consecutive patients with between Oct 2014 and Sep 2016 were included in this study who were treated with multiple rod technique in spinal revision surgery. Outrigger rod placement was performed by supplementing primary spinal rods.

RESULTS : Outrigger rod technique may be beneficial for preventing rod fracture in patients undergoing surgery for three-column osteotomy for sagittal imbalance; psuedarthrosis surgery with previous hardware failure; long-segment spinal arthrodesis with impaired host fusion potentials. Furthermore, outrigger rod technique is another option for long-segment instrumented fusions that span the cervicothoracic or lumbosacral junction level. (eg, after extensive resection of vertebral elements in the management of metastatic malignancy).

CONCLUSION : The risk of rod fracture and hardware failure is substantial in the setting of long-segment spinal arthrodesis, corrective osteotomy and spinal multiple revision surgery. Effort to increase the mechanical strength of posterior constructs may reduce the occurrence of this complication. The outrigger rod technique increases spinal construct stiffness and may improve the longevity of the construct. However, a larger series with a long term follow-up period should be evaluated in this study.

염증반응 이후 경막세포의 유착기전 연구 : integrin $\alpha 2\beta 1$ 을 통한 collagen 결합능 상승과 matrix metalloproteinase의 역할

문흥주, 박윤관, 김주한, 이건영, 박웅배, 권우근

고려대학교 구로병원 척추신경센터

PURPOSE : Dural traction by peridural adhesion and direct neural compression by excessive fibrosis might be one of major factors causing axial and radicular pain after spine surgery. This study was designed to explore the intrinsic mechanism of peridural adhesion investigating 1. which extracellular matrix(ECM) could be major adhesive substrates to human dura matter cells (hDMCs), 2. the alteration on adhesion-related molecules in hDMCs and finally 3. secreted MMPs linked with ECM remodeling for adhesion after exposure to inflammation by using primary culture of hDMCs.

MATERIALS AND METHODS : hDMCs were cultured on the collagen I coated plate from human dura mater tissue(8 men and 2 women, mean age 55.4 ± 17.86) obtained during duroplasty following decompressive craniectomy. Adhesion assay to various extracellular matrixes(ECM), flow cytometry about transmembranous integrins, ELISA about secreted matrix metalloproteinases(MMPs)) and western blot about critical intracellular proteins with adhesion(focal adhesion kinase (FAK), talin 1, and F-actin) were performed with hDMCs after co-culturing with macrophage like THP-1 cells to investigate critical substrates, mediators and factors related with extracellular remodeling in processes of hDMC adhesion.

RESULTS : The adhesion profiles of hDMCs with collagen I, IV and fibronectin after co-culture was significantly increased 6.1, 4.8 and 1.5 times comparing to those of control group respectively ($P < .001$). The laminin I and fibrinogen showed no significant increase after co-culture. There were significant increase in expression of the integrin subtype $\alpha 2\beta 1$ about 6.3 times (142.7 ± 1.2 for control and 898.8 ± 5.4 for co-culture, $P < .001$) and $\alpha II\beta 3$ about 2 times (32.7 ± 0.4 and 65.8 ± 0.6 , $P < .001$). $\alpha 1$, which had highly expressed in naïve hDMCs, showed significant decrease after co-culture (196.9 ± 1.4 and 100.2 ± 0.8 , $P < .001$). FAK showed significant increase 1.99-fold in co-culture ($P < .001$). There was no significant alteration between control and co-culture group in talin and F-actin. The secretion of MMP-1 and MMP-3 at co-culture showed 62.4 and 14.8 times increase comparing to naïve hDMCs and 18.1 and 13.5 times to activated THP-1 cells, respectively. VEGF was also increased with co-culture to 1163.4 ± 870.7 pg/mL, which were 9.2 and 6.4 times higher than naïve hDCMs and activated THP-



1 cells. MMP-9 secretion at co-culture (481.9 ± 357.2 pg/mL) was significantly suppressed into 9.7% comparing to that of activated THP-1 cells only. TIMP-1 and TIMP-2 showed no specific alteration between the conditions.

CONCLUSION : hDMCs could be utilized for the study of dural adhesion. Collagen might be a critical substrate of hDMCs in terms of adhesion, mediated by integrin $\alpha 2\beta 1$ rather than $\alpha 1$. The altered secretion of MMP 1, 3 and 9 from hDMCs after exposure to inflammation might have critical roles in adhesion of hDMCs through ECM remodeling after peridural tissue injury.

Strategy for personalized medicine based on ALS patient-derived stem cells using CRISPR/Cas9-mediated genome editing

윤여민¹, 하윤¹, 김장환², 황동연³, 백다예¹

¹연세대학교, ²한국생명공학연구원, ³차의과대학

PURPOSE : Amyotrophic lateral sclerosis (ALS) is a neurologic disease that causes dysfunction of the motor neuron which is responsible for controlling voluntary muscles movement. Over time, it leads to muscle weakness, paralysis and eventually respiratory difficulty. The cause is not known in 90% to 95% of cases. About 5% to 10% cases are associated with genes. However, it has been reported that a number of novel genetic mutations causes ALS. Considering the various causes of the disease and poorly understood pathomechanism, the development of personalized therapy that target the patient's own genetic mutation and restore motor neuron function would provide the most promising precision treatment.

MATERIALS AND METHODS : Different type of cells from ALS patient is used as a platform for diagnosis and assessing the pathology. Next generation sequencing (NGS) discovered a point mutation in a gene named ATP7A which encodes a transmembrane copper-transporting ATPase. In order to assess the impaired ATP7A trafficking, induced neural stem cells (iNSC) is generated from fibroblast using direct conversion technique. The CRISPR/Cas9 system can target the sequence precisely and homology directed repair (HDR)-mediated gene editing allows a correction of point mutation in ATP7A. Human induced pluripotent stem cells (iPS) generated from patient fibroblast is used for gene correction with CRISPR/Cas9 system.

RESULTS : Loss of ATP7A function results in copper deficiency and degeneration of the nervous system. iNSC revealed the cellular dysfunction such as proliferation and apoptosis compared to normal cell line. CRISPR/Cas9 system corrected the point mutation in iPS. Reprogrammed cells from patient somatic cell are suitable to investigate the mechanism, pathology, gene-editing and this strategy would be the most promising approach to personalized precision medicine.

CONCLUSION : Next generation sequence revealed a point mutation in a gene named ATP7A in ALS patient. iPSC, NPC and iNSC is reprogrammed from ALS patient-derived fibroblast through various ways. Patient-derived stem cells showed cellular pathology compared normal stem cells in proliferation and differentiation. A point mutation in ATP7A gene was edited to normal sequence elaborately using CRISPR/Cas9 via homology directed repair.



NIHS DB를 이용한 경추 후종인대골화증 환자의 발생률, 사망률 및 다른질환과의 연관성 연구

김진호¹, 최선규², 문봉주³, 윤도흠¹, 김금년¹, 이성¹, 신동아¹, 하윤¹

¹연세대학교 신촌세브란스병원 신경외과학교실, ²연세대학교 의과대학, ³전남대학교병원

PURPOSE : Epidemiologic studies of OPLL have rarely been published in English-language clinical literature, as OPLL is primarily observed in ethnic people located in East Asia. The National Health Insurance Service (NHIS) of Korea provided national cohort data for 1 million people from 2002 to 2013. Here we report the incidence, mortality and morbidity of cervical OPLL using cohort data for 1 million Korean people.

MATERIALS AND METHODS : A nested case-control study was performed using the claims database provided by the NHIS of Korea, with a cohort of individuals identified with disease codes of cervical OPLL from 2002 to 2013. We examined prevalence, incidence, co-morbidity, and relative survival rate of cervical OPLL patients undergoing surgery, and age/gender matched controls were randomized extracted as three times than study group

RESULTS : The annual incidence per 1 million person was from 8 to 42. Men were treated surgically more frequently than women (67.16 vs. 32.84%, $p < 0.001$). The overall crude mortality rate was 7.64%, and the relative survival rate of all the OPLL cases and operated cases was not significantly different from the 3 times age/ gender matched controls. Diabetes, hypertension, cardiovascular disease and cerebrovascular disease coexisted significantly with OPLL compared to controls ($p < 0.001$). Additionally, between dead and survival patients among OPLL cases, co-morbidity was similarly significant ($p = 0.001$).

CONCLUSION : This is the first large cohort study about the epidemiology of OPLL with a nested case-control study. Annual incidence was about 8 to 42 per 1 million-person year. The incidence of OPLL was higher in men than in women, Chronic diseases such as diabetes, hypertension, cardiovascular and cerebrovascular disease were associated with OPLL.

파킨슨병의 비운동증상과 척추 수술 후 섬망과의 관계

김진호¹, 김기훈², 강석윤³, 신동아¹, 이성¹, 하윤¹, 김금년¹, 손영호², 이필휴²

¹연세대학교 세브란스병원 신경외과학교실, ²연세대학교 세브란스병원 신경과학교실, ³한림대학교 동탄성심병원 신경과학교실

PURPOSE : The clinical features of postoperative delirium are similar to the core features of alpha synuclein-related cognitive disorders, such as Parkinson's disease dementia (PDD) or dementia with Lewy bodies (DLB). Therefore, we hypothesized that the non-motor symptoms (NMSs) in Parkinson's disease (PD), which precede the cardinal motor features of PD, are likely to be risk factors for developing postoperative delirium. We investigated the association between PD-related NMSs and postoperative delirium in old people undergoing elective spinal surgery.

MATERIALS AND METHODS : This study was a prospective study. Participants were aged 65 years and older and scheduled to undergo elective spinal surgery. During the enrollment period, 338 individuals were screened, 104 participants were included in the analysis. We assessed eight easily-assessed and representative PD-related NMSs 1 day before the scheduled surgery using tests or questionnaires for each symptom. The presence of delirium was determined by using the short version of the Confusion Assessment Method (Short CAM).

RESULTS : Fifteen (14.4%) of the 104 participants (age, 71.7 ± 4.7 years; men, 34.6%) met the Short CAM criteria for post-operative delirium.

Multivariate logistic analysis showed that decreased olfactory function (odds ratio [OR] 0.63, 95% CI 0.44–0.91) and exhibiting RBD (OR 1.45, 95% CI 1.09–1.93) were significantly independent predictors of postoperative delirium.

CONCLUSION : Our study shows that hyposmia and RBD are significantly independent risk factors for postoperative delirium in general elderly population. Considering that NMSs may represent burden of alpha synuclein deposit, we postulate that an underlying alpha synucleinopathy may correlates with postoperative delirium.



황색인대 골화증을 가진 환자에서 흉수병증의 정도에 영향을 주는 영상적 파라미터

이 병 주, 노 성 우

서울아산병원

PURPOSE : Thoracic ossification of the ligamentum flavum (OLF) is a common cause of thoracic myelopathy. The measurement method for the thickness of the ligamentum flavum is not standardized, which causes confusion. We hypothesized that the area of OLF is a key morphologic parameter in the diagnosis of thoracic myelopathy due to OLF. The aim of this study is to investigate radiographic parameters affecting the degree of thoracic myelopathy in the patients with OLF

MATERIALS AND METHODS : A total of 203 patients who met the inclusion criteria were enrolled between January 1999 and December 2016. We measured the thickness of OLF (TOLF), cross sectional area of OLF (AOLF), anteroposterior canal diameter (APD), cross sectional area of the spinal canal (ASC), and the ratio of each of these parameters at the maximum thickness level. We divided the patients into two groups according to the presence or absence of thoracic myelopathy. We analyzed the relationship between the degree of ossification and myelopathy.

RESULTS : The best cut off point of ratio of AOLF was 33.00%, with 87.1% sensitivity, 87.3% specificity and AUC of 0.934 (95% CI, 0.899 – 0.969). The sensitivity and specificity of the ratio of AOLF were higher than those of other parameters. Postoperative clinical outcome was the best with 1.37 ± 0.82 of difference between post-JOA score and pre-JOA score, when patients with ratio of AOLF more than 40% and less than 45% underwent decompressive laminectomy for thoracic myelopathy due to OLF

CONCLUSION : The ratio of AOLF was the most important parameter. Thus, to predict thoracic myelopathy due to OLF, the treating doctor should more carefully analyze the ratio of AOLF than other parameters. If the ratio of AOLF is $> 33\%$, then the patient may be at a risk for myelopathy later in life, even if there is no myelopathy at present and surgical treatment is recommended before OLF take up half of the spinal canal.

근육섬유모세포와 황색 인대 비후 활동성

허준석¹, 박정율¹, 조태형¹, 이장보¹, 김주현¹, 허준호²

¹고려대학교 안암병원, ²경희대학교 의과대학 병리학교실

PURPOSE : Majority of the previous studies compared lumbar spinal stenosis (LSS) and lumbar disc herniation (LDH) patients for analyses of LFH. However, the separation of normal/hypertrophied LF has often been ambiguous and the severity of hypertrophic activity differed. Here we present a novel analysis scheme for LFH in which myofibroblast is proposed as a major etiological factor for LFH study.

MATERIALS AND METHODS : Seventy-one LF patient tissue samples were used for this study. Initially mRNA levels of the samples were assessed by qRT-PCR: angiopoietin like protein-2 (ANGPTL2), transforming growth factor-beta1 (TGF-β1), vascular endothelial growth factor (VEGF), interleukin-6, Collagen-1,3,4,5,11, and elastin. Myofibroblasts were detected by immune-stain using α-smooth muscle actin (αSMA) as a marker. To study the myofibroblast in TGF-β pathway, LF tissues were analyzed for protein levels of αSMA/TGF-β1 by Western blot. Also, from LF cells cultured with exogenous TGF-β1 conditioned medium, expression of αSMA/collagen-1 were assessed and the cell morphology was identified.

RESULTS : The comparative analysis of mRNA expression levels (LSS vs LDH) failed to show significant differences in TGF-β1 (p=0.08), however, we found significant positive correlation among ANGPTL2, VEGF, TGF-β1, collagen-1 and 3, which represents common trends in hypertrophic activity (p<0.05). We detected myofibroblast in the patient samples by αSMA staining, and the protein levels of αSMA were positively correlated with TGF-β1. In LF cell culture, exogenous TGF-β1 upregulated αSMA/collagen-1 mRNA levels and facilitated trans-differentiation to myofibroblast.

CONCLUSION : We conclude that the transition of fibroblast to myofibroblasts via TGF-β pathway is a key linker between inflammation and fibrosis in LFH mechanism.



비타민 D와 척추체주변근육과의 연관성 : 인체 자료와 실험쥐모형에서의 분석

방우석

경북대학교병원 신경외과

PURPOSE : Vitamin D deficiency (VDD) has been closely linked with skeletal muscle atrophy in many studies, but to date no study has focused on paraspinal muscle. Some studies have shown that degenerative changes (muscle atrophy and fatty infiltration) of paraspinal muscles is associated with various spinal degenerative diseases, such as chronic back pain, degenerative lumbar kyphosis, and stenosis. Considering the growing interest regarding the relationship between degenerative paraspinal muscle wasting and spinal disease, we sought to investigate the effect of vitamin D on paraspinal muscle. The aim of this study was to verify the paraspinal muscle changes according to serum vitamin D level.

MATERIALS AND METHODS : Ninety-one elderly women were enrolled in this study. We measured their serum vitamin D concentration and stratified them according to their vitamin D status in three groups: control (serum 25OHD3 concentration >40 ng/ml), vitamin D insufficiency (VDI)(20–40 ng/ml), and vitamin D deficiency (VDD)(<20 ng/ml). We then obtained magnetic resonance imaging (MRI) data of the lumbar spine and evaluated the quality (fatty infiltration, muscularity) and quantity of the paraspinal muscles in humans. The images were displayed and analyzed using PiView (INFINITT®, Seoul, Korea) digital image viewing software. The regions of interest (ROI) were outlined using a graphic cursor around the paraspinal muscles on the both sides (erector spinae muscle + multifidus muscle and psoas muscle) and the L4–5 intervertebral disc. Additionally, we designed experimental rat models for VDD and VDD–replacement. The control rats were housed in a temperature–controlled room on a 12–hour light/dark circadian cycle and were fed on a synthetic AIN–93G formulation diet. VDD rats were housed in a 24–hour dark room using a blackout curtain for limitation of vitamin D synthesis and were administered the same diet as the control rats excluding the vitamin D3 supplement. VDD replacement rats were housed under the same conditions as the VDD group for the first 16 weeks, following which they were maintained under the same conditions as those applied for the control group, for the next 16 weeks. We then analyzed the radiologic and histologic data of paraspinal muscles using micro–CT and immunohistochemical analysis through comparison with control rats (n = 25, each group). In

immunohistochemical analysis of rat model, we measured the concentration of intramyonuclear vitamin D receptor(VDR), and cell size of paraspinal muscle.

RESULTS : In the human studies, a significant decrease was noted in the overall paraspinal muscularity and increase in fatty infiltration in the VDD group as compared to the other groups, and the differences between the VDD group and the other two groups were statistically significant ($p < 0.05$). In the rat experiment, the mean serum 25OHD3 concentration in the VDD and VDD-replacement groups were significantly lower than that in the control group at 16 weeks. In immunohistochemical study, the expression level of VDR-positive myonuclei in paraspinal muscles were significantly lower in the VDD group than in the control group at both 16 and 32 weeks ($p < 0.05$). VDD-replacement group showed significantly higher expression levels of VDR-positive myonuclei in paraspinal muscles as compared to the VDD group at 32 weeks ($p < 0.05$). However, despite vitamin D replacement, the intramyonuclear VDR expression levels at 32 weeks in the VDD-replacement group did not rise to the levels in the control group ($p < 0.05$). And VDD group showed significantly smaller cell size of the paraspinal muscles as compared to the control group. On the other hand, vitamin D replacement group could partially restore the muscle cell size of the paraspinal muscles compare to VDD group ($p < 0.05$). In radiological analysis, the mean paraspinal volumes were visibly lower in the VDD group than in the control group at both 16 and 32 weeks ($p < 0.05$). And the mean paraspinal volume was also statistically higher in the VDD replacement group than in the VDD group at 32 weeks ($p < 0.05$). Overall, these results indicate that vitamin D status plays an important role in the atrophy of paraspinal muscles.

CONCLUSION : In the present study, we found strong correlations between serum vitamin D concentration and paraspinal muscularity. Although rats and humans differ in many aspects, such as lifestyle, posture, and walking mechanisms, we found that in the rat model, VDD can induce paraspinal muscle atrophy and decrease the concentration of intramyonuclear VDR, while vitamin D replacement promotes at least partial restoration of muscle volume and intramyonuclear VDR concentration in paraspinal muscles under VDD conditions. We believe that our findings will provide further insight into the role of vitamin D in paraspinal muscles.



수술을 요하는 요추 추간판탈출증 환자의 신체계측 분석

이 동 엽¹, 정 훈 재²

¹서울부민병원 신경외과, ²서울부민병원 정형외과

PURPOSE : The purpose of this study was to investigate the association between anthropometric features, such as standing body height (BH), body weight (BW), and body mass index (BMI), with incidence of lumbar disc herniation in Korean adults.

MATERIALS AND METHODS : A frequency-matched case-control study was conducted. We measured normal standing BH, BW, and BMI of 500 patients that underwent operations at our hospital. The study group included 250 consecutive patients (150 men and 100 women; mean age of 46.9, range 20-83) that underwent surgery for single level lumbar disc herniation. Controls were 250 patients (150 men and 100 women; mean age of 46.7, range 20-85) that underwent surgery for traumatic fracture at the distal part of the lower limb. Controls were frequency-matched by age (within three years) and gender with patients of the study group. Statistical analysis was performed using Chi-square test, independent t test, and Mann Whitney U test.

RESULTS : BW and BMI were significantly higher in the study group than in the control group ($p=0.008$ and $p=0.016$, respectively), especially in young adults age 20-39 ($p=0.033$ and $p=0.043$, respectively). In males, BH was significantly higher in the study group than in the control group ($p=0.03$). In females, BW was significantly higher in the study group than in the control group ($p=0.009$). Considering types of disc herniation, patients with ruptured disc revealed significantly higher BW and BMD than the control group ($p=0.015$ and $p=0.027$, respectively), but patients with protruded discs did not. As with level of disc herniation, patients with disc herniation at L5-S1 level revealed significantly higher BW than the control group ($p=0.021$). Patients that had their first spine operation revealed significantly higher BW and BMD than the control group ($p=0.022$ and $p=0.042$, respectively), but patients that had their second spine operation did not.

CONCLUSION : In Korean adults, anthropometric features play a significant role in development of lumbar disc herniation requiring operation.

Sprague-Dawley rats 에서 경추 2번 신경 절단후 냉각이질통:실험실 조사

조 대 철

경북대학교병원 신경외과

PURPOSE : The purpose of this study was to evaluate pain-related behaviors after bilateral C2 root resection and change in pain patterns in the suboccipital region in rats.

MATERIALS AND METHODS : Male Sprague-Dawley rats were randomly assigned to three groups (n = 25 / group); naïve, sham, and C2 resection. Three, 7, 10, and 14 days after surgery, cold allodynia was assessed using 20 µl of 99.7% acetone. c-Fos and c-Jun were immunohistochemically stained to evaluate activation of dorsal horn gray matter in C2 segments of the spinal cord 2 h, 1 day, 7 days, and 14 days after surgery.

RESULTS : Three days after surgery, the response to acetone in the sham group was significantly greater than in the naïve group, and this significant difference between the naïve and sham groups was maintained throughout the experimental period (p < 0.05 at 3, 7, 10, and 14 days). Seven, 10, and 14 days after surgery, the C2 root resection group exhibited a significantly greater response to acetone than the naïve group (p < 0.05), and both the sham and C2 resection groups exhibited significantly greater responses to acetone compared with 3 days after surgery. No significant difference in cold allodynia was observed between the sham and C2 root resection groups throughout the experimental period.

Two hours after surgery, both the sham and C2 root resection groups exhibited significant increases in c-Fos- and c-Jun-positive neurons compared with the naïve group (p = 0.0021 and p = 0.0358 for the sham group, and p = 0.0135 and p = 0.014 for the C2 root resection group, respectively). One day after surgery, both the sham and C2 root resection groups exhibited significant decreases in c-Fos -positive neurons compared with 2 h after surgery (p = 0.0169 and p = 0.0123, respectively), and these significant decreases in c-Fos immunoreactivity were maintained in both the sham and C2 root resection groups 7 and 14 days after surgery. The sham and C2 root resection groups presented a tendency toward a decrease in c-Jun -positive neurons 1, 7, and 14 days after surgery, but the decrease did not reach statistical significance.

CONCLUSION : We found no significant difference in cold allodynia and the early expression of c-Fos and c-Jun between the sham and C2 resection groups. Our results support the routine resection of the C2 nerve root for posterior C1-2 fusion, but, further studies are needed.



30대 이상의 정상 한국인에서의 시상면 균형에 관한 연구

손 세 일¹, 정 천 기²

¹차의과학대학교 분당차병원, ²서울대학교

PURPOSE : We aim to provide sagittal and pelvic parameters according to different age groups in an asymptomatic population all over 30 years old and to investigate the possible causes of changes in these parameters.

MATERIALS AND METHODS : Whole spine, standing lateral radiographs were taken in 128 asymptomatic Korean people over 30 years old. The spinal parameters (the total thoracic kyphosis (TTK), maximal lumbar lordosis (MLL), total lumbar lordosis (TLL), lower lumbar lordosis (LLL), thoracolumbar junctional angle (TLJA), and lumbar inclination (LI)), pelvic parameters (pelvic incidence (PI), sacral slope (SS), and pelvic tilt (PT)), and spinal balance parameters (spinal balance, sacropelvic balance, and spinopelvic balance) were measured. The body mass index, body protein mass, waist line, skeletal muscle mass, and body fat mass were also measured for potential causes.

RESULTS : TTK and TLJA were significantly increased in the group over 70 years of age compared to the other age groups ($P=0.0002$, <0.001). TLL was significantly decreased in the group over 70 years of age ($P=0.002$), whereas the PI values were similar to PI even in over 70 year age group. LLL did not differ in the group over 70 years of age ($P=0.29$), gradually increasing with an increase in age. SS was significantly decreased and PT was significantly increased in the group over 70 years of age as compared to the other age groups ($P=0.049$, 0.049 , respectively). PI was similar in all age groups ($P=0.75$). Spinal balance was significantly decreased in the group over 70 years of age ($P=<0.0001$). PT was significantly associated with body protein mass and skeletal muscle mass ($P=0.01$, 0.001 , respectively). Body protein mass and skeletal muscle mass were significantly lower in the group over 70 years of age ($P=0.02$, 0.02) and were possible causes.

CONCLUSION : Several sagittal and pelvic parameters are different in asymptomatic adults over 70 years of age. Decreased body protein mass and skeletal muscle mass are possible causes of these changes.

퇴행성 척추 질환 환자에게 Fitbit을 이용한 수술후 신체 활동 측정을 통한 예후 분석

강 지 인, 신 동 아, 하 윤, 김 금 년, 윤 도 흠, 이 성

연세대학교 신경외과학교실

PURPOSE : In patients with degenerative spinal disease, the number of gait after surgery is measured using a Fitbit after surgery. We will investigate which factors affect the postoperative gait steps of the patient.

MATERIALS AND METHODS : From March 2017 to June 2017, a total of 30 patients were measured for the number of footsteps from an immediate post op using a Fitbit. Patients with lumbar degenerative disease (herniated lumbar disc, spinal stenosis, degenerative spondylolisthesis, and spondylolytic spondylolisthesis.) were included in the study. Patients' demographic factors include patient's history, height, weight, BMI and radiculopathy, low back pain, weakness, and NIC. In addition, the level of surgery, fusion or laminectomy, and the preoperative VAS and postoperative VAS were also included in the analysis. The measurement of the number of steps was carried out on a Fitbit, and the day of discharge and the day of the operation were not measured for 24 hours, so they were finally excluded. For the number of steps, the median, the minimum, the maximum and the average of the measured steps were analyzed.

RESULTS : Eight patients were withdrawn due to poor compliance and final analysis was performed on 22 patients. In the univariate analysis, "Fusion surgery" was a statistically significant difference with the number of minimal gait. ($p=0.008$) In multivariate analysis, BMI and fusion were found to be factors affecting the minimal gait of patients. ($p=0.012$, $p=0.035$) In addition, multivariate analysis showed significant differences between BMI and median gait. ($p=0.032$) However, postoperative VAS did not affect gait.

CONCLUSION : Patients' fusion surgery and high BMI affected the number of postoperative steps in the patient, but this did not show a significant relationship with postoperative VAS.

2017. **9.16** (Sat.)



Award Presentation Session

좌장 : 중앙대 김영백, 의료중재원 박형천

[우수논문학술상]

The Effect of Cell Penetrating Peptide Combine with Runx2 On Mesenchymal Stem Cells

서울대 양승헌, 박성배



[우수논문학술상]
**The Effect of Cell Penetrating Peptide Combine with
Runx2 On Mesenchymal Stem Cells**

양 승 현, 박 성 배
서울대

MEMO

2017. **9.16** (Sat.)



Guest Lecture I

좌장 : 부산대 **송근성**, 경희대 **김성민**

1. Surgery of Spinal Ependymoma Asia Spine President, Osaka City University, Japan **Kenji Ohata**

2. Anterior Surgery in Thoracolumbar Spine
 President, Korean Society of Spine Surgery, Aju University, Korea **Chang-Hoon Jeon**

Kenji Ohata

Osaka City University



Education

- 1974–1980 Undergraduate, Faculty of Medicine Osaka City University, Japan,
- 1983–1987 Graduate, Graduate School of Medicine Osaka City University, Japan

Professional Training and Employment

- 1980–1987 Resident; Junior, Senior and Chief Resident, Department of Neurosurgery, Osaka City University, Japan
- 1987 Japanese Board of Neurosurgeon awarded (#1950)
- 1987–1988 Lecturer, Department of Neurosurgery Osaka City University, Japan
- 1988–1990 Research Associate, Department of Neurosurgery, Medical College of Virginia, USA
- 1990–1991 Clinical Fellow, Department of ENT, Fluda Municipal Hospital, Germany, Director: Prof. Dr. med. Wolfgang Draf
- 1991 Clinical Instructor, Department of Neurosurgery Osaka City University, Osaka, Japan
- 1992–1999 Assistant Professor, Department of Neurosurgery Osaka City University, Osaka, Japan
- 1999 Visiting Professor, Department of Neurosurgery Verona University, Italy
- 1999–2005 Associate Professor, Department of Neurosurgery Osaka City University, Osaka, Japan
- 2005– Honorary Visiting Consultant for Life, Department of Neurosurgery Seth G.S. Medical Collage, King Edward Memorial Hospital, India
- 2006– Professor and Chairman, Department of Neurosurgery Osaka City University, Japan
- 2008–2013 Parallel Professor, Department of Neurosurgery Tokyo Medical, University, Japan
- 2012– Associate dean, Faculty of Medicine Osaka City University
- 2015 Visiting Professor, Department of Neurosurgery AIIMS, India
- 2016– Dean, Graduate School of Medicine & Faculty of Medicine, Osaka City University

Major Committee Assignment

- 1999– Executive committee member: Japanese Congress of Brain Tumor Surgery
- 1999– Executive committee member: Japanese Society for Skull Base Society
- 1999– Executive committee member: Japanese Society of Spinal Surgery
- 1999– Executive committee member: Japanese Conference on Neurosurgical Techniques and Tools
- 2000– Executive committee member: Japanese Society of Acoustic Neuroma
- 2002– Committee member of Skull Base Surgery, WFNS
- 2004– Executive committee member: Asian Oceanian International Congress on Skull Base Surgery
- 2010 President: 15th Annual Meeting of Japanese Congress of Brain Tumor Surgery
- 2010– Executive committee member: International Congress on Meningiomas and Cerebral Venous System
- 2010– Secretary-general: Japanese Society of Spinal Surgery
- 2011 President: 20th Annual Meeting of Japanese Society of Acoustic Neuroma

Surgery of Spinal Ependymoma

**Kenji Ohata, M.D., Ph.D., Kentaro Naito, M.D., Ph.D., Toru Yamagata, M.D., Ph.D.,
Toshihiro Takami, M.D., Ph.D.**

Department of Neurosurgery, Osaka City University Graduate School of Medicine

Surgery for spinal intramedullary tumors remains one of the major challenges for neurosurgeons, due to their relative infrequency, unknown natural history, and surgical difficulty. We are sure that safe and precise resection of spinal intramedullary tumors, particularly encapsulated benign tumors, can result in acceptable or satisfactory postoperative outcomes. General surgical concepts and strategies, technical consideration, and functional outcomes after surgery are discussed with illustrative cases of spinal intramedullary benign tumors focusing on ependymoma. Selection of a posterior median sulcus, posterolateral sulcus, or direct transpial approach was determined based on the preoperative imaging diagnosis and careful inspection of the spinal cord surface. Tumor–cord interface was meticulously delineated in cases of benign encapsulated tumors. Our retrospective functional analysis of 24 consecutive cases of spinal intramedullary ependymoma followed for at least 6 months postoperatively demonstrated a mean grade on the modified McCormick functional schema of 1.8 before surgery, deteriorating significantly to 2.6 early after surgery (< 1 month after surgery), and finally returning to 1.7 in the late postoperative period (> 6 months after surgery). The risk of functional deterioration after surgery should be taken into serious consideration. Functional deterioration after surgery, including neuropathic pain even long after surgery, significantly affects patient quality of life. Better balance between tumor control and functional preservation can be achieved not only by the surgical technique or expertise, but also by intraoperative neurophysiological monitoring, vascular image guidance, and postoperative supportive care. Quality of life after surgery should inarguably be given top priority.



Anterior Surgery in Thoracolumbar Spine

Chang-Hoon Jeon

President, Korean Society of Spine Surgery, Aju University, Korea

MEMO

2017. **9.16** (Sat.)



Best Paper Competition

좌장 : 서울대 정천기, 경북대 성주경

시상면 불균형을 보이는 요추부 후만증에 대한 교정 수술 후 발생하는 PJF와 PJK의 유발 인자 및 방사선학적 결과

임유석, 윤상덕, 조대진

강동경희대학교병원

PURPOSE : Proximal junctional failure (PJF) and Proximal junctional kyphosis (PJK) are well recognized complications after adult spinal deformity surgery. PJF could be defined as fracture at the upper instrumented vertebra (UIV) or UIV+1, UIV fixation failure, proximal junctional angle(PJA) $> 20^\circ$ associated with severe pain, disability, segmental instability or neurological deficit. PJK is defined as PJA $> 15^\circ$ with or without clinical symptoms. The purpose of this study was to assess independent risk factors and radiographic results of PJF and PJK after corrective surgery for lumbar flatback deformity with sagittal imbalance

MATERIALS AND METHODS : Retrospective review of 105 patients has been treated for lumbar flatback deformity with sagittal imbalance from 2008 to 2016. Eight patients with Parkinson's disease and 4 patients with paralysis, one rheumatoid arthritis, 23 patients with a follow-up of less than one year were excluded. To investigate risk factors for PJK and PJF, demographic data (patient characteristics) were analyzed statistically: Age, body mass index (BMI), bone mineral density (BMD), Hounsfield unit (HU) value on the mid-body axial image of CT at UIV-1, UIV, and UIV+1, UIV+2. And radiographic parameters include the sagittal vertical axis(SVA), T1 pelvic angle(T1PA), PI-LL, thoracic kyphosis(TK), thoracolumbar junctional angle(TL), lumbar lordosis(LL), pelvic incidence(PI), pelvic tilt(PT) were measured preoperatively, postoperatively, 1 month and 6 months, final follow-up. In cases of PJF, post-operative radiographic parameters were measured by lumbar radiography.

RESULTS : A total of 69 consecutive patients were reviewed with mean follow-up 33 months (12-85). Mean age was 73 years (54-85). In 69 patients, 10 patients (14%) were diagnosed with PJF and 15 patients (22%) were diagnosed as PJK. Normal group (44 patients): PJK group (15 patients): PJF group (10 patients). The mean time to diagnosis of PJF was 4.78 months and PJK was 20.5 months. PJK type were ligamentous failure in 14 patients, implant and bone interface failure in 1 patient. PJF types were UIV or UIV+1 fracture in 8 patients, subluxation in 1 patient, and UIV implant failure in 1 patient. In the PJF group, Frankel scale was grade C in 1 patient, grade D in 2 patients and grade E in 7 patients at the last

follow up.

Age, BMI and BMD were not statistically significant among the three groups. But, normal(Non-PJK/PJF) groups had significantly higher HU measurements at UIV-1, UIV, UIV+1, UIV+2 (129.7 ± 35.5 , 132.5 ± 37.5 , 133.2 ± 37.1 , 131.7 ± 40.8) than the PJK (89.1 ± 16.2 , 88.1 ± 19.7 , 88.9 ± 20.3 , 90.4 ± 21.2) and PJF (91.7 ± 23.8 , 92.5 ± 28.4 , 90.3 ± 27.6 , 90.5 ± 26.4) groups ($P < 0.001$). SVA (16.0 ± 24.9 mm in non PJK/PJF group, 54.9 ± 28.0 mm in PJK, $P < 0.001$), TL (10.7 ± 7.4 in non PJK/PJF group, 20.1 ± 11.9 in PJK, $P = 0.01$), T1PA (13.1 ± 7.1 in non PJK/PJF group, 19.5 ± 7.6 in PJK, $P = 0.04$) and PJA (8.2 ± 3.7 in non PJK/PJF group, 21.3 ± 6.4 in PJK, $P < 0.001$) at postoperative 6 months were statistically significant. In the PJF group, there were no significant radiographic parameters at postoperative lumbar radiograph. PJF group were measured LL, PT, TLJ, PI but could not find any statistical significance between the other groups.

CONCLUSION : Age, BMI and BMD were not statistically significant differences among three groups. But Hounsfield unit (HU) of vertebral body at UIV+2, UIV+1, UIV and UIV-1 were significantly different between normal and PJK/PJF groups. It is suggested that HU of around UIV help to predict the PJK and PJF through this study. Also progression of TL junction angle and PJA more than 15 degree at postoperative 6 month might be predict PJK.

경추척추변형분류의 교정 제안: 다분절 후방경추유합술 이후 장기간 추적 자료를 이용한 분석

현 승 재, 김 현 집, 장 태 안, 김 기 정

분당서울대학교병원 신경외과

PURPOSE : Recently, a previous research proposed a CSD classification using a modified Delphi approach. However, C2–C7 SVA and TS–CL cut-off values for moderate and severe disability were based on expert opinion. To revise a cervical spine deformity (CSD) classification system using a long-term follow-up data after multilevel posterior cervical fusion surgery in terms of C2–C7 sagittal vertical axis (SVA) and T1 slope minus cervical lordosis (TS–CL).

MATERIALS AND METHODS : From 2007–2012, 30 consecutive patients with a minimum 5-year follow-up having multilevel posterior cervical fusion for cervical stenosis, myelopathy, and deformities met inclusion criteria. To determine the true impact of the alignment on health-related quality-of-life (HRQOL), patients who have pseudarthrosis, a misplaced screw, junctional pathologies, or adjacent level disc herniation were excluded. Radiographic measurements included: C0–C2 lordosis, C2–C7 lordosis, C2–C7 SVA, T1 slope, and TS CL. Pearson correlation coefficients were calculated between pairs of radiographic measures and HRQOL.

RESULTS : Average follow-up period was 7.3 years (range, 5.1–10.0 years). C2–C7 SVA positively correlated with neck disability index (NDI) scores ($r = 0.554$). Regression models predicted a threshold C2–C7 SVA value of 40.8 mm and 70.6 mm correlated with moderate and severe disability based on the NDI score, respectively. The TS CL also correlated positively with C2–C7 SVA and NDI scores ($r = 0.841$ and $r = 0.625$, respectively). Results of the regression analyses indicated that a C2–C7 SVA value of 40 mm and 70 mm corresponded to a TS CL value of 20° and 25° , respectively.

CONCLUSION : Regression models predicted a threshold C2–C7 SVA (value of 40.8 mm and 70.6 mm) and TS–CL (value of 20° and 25°) correlated with moderate and severe disability based on the NDI, respectively. The cut-off value C2–C7 SVA and TS–CL modifier of the CSD classification can be revised accordingly.

파킨슨 병과 골다공증성 척추 골절 : 한국인 대상 코호트 연구

이창규¹, 최선규², 신동아³, 이성³, 김금년³, 김인수¹, 하윤³

¹계명대학교 신경외과학 교실, ²연세대학교 신경외과학 교실, ³연세대학교 신경외과

PURPOSE : To evaluate the risk of osteoporotic compression fracture(OCF) in patients with Parkinson's disease (PD)

MATERIALS AND METHODS : Above 60 year-old patients who diagnosed with PD were collected between 2004 and 2013 in Korean National Health Insurance Database (n=3370). The comparison group (non-PD) was composed of randomly selected patients (5 per patient with PD; n=16850) who were matched to the PD group according to age and sex. Cox proportional hazard regressions were used to confirm the relations between osteoporosis, OCF, and surgery for OCF and PD. Household income and residential area of patients were also checked. Overall survival rates were calculated after adjusting for confounding factors such as hypertension, diabetes mellitus, and chronic kidney disease.

RESULTS : OCF developed in 16.4% of the PD group and in 10.6% of the control group. PD was associated with an increased risk of osteoporosis (Hazard ratio [HR], 1.32; 95% confidence Interval [CI], 1.22-1.43; p<0.001), OCF (HR, 1.52; 95% CI, 1.37-1.69; p<0.001), and surgery for OCF (HR, 1.52; 95% CI, 1.37-1.69; p<0.001). Household income was not significantly related with development of osteoporosis, OCF, and surgery for OCF. Residential area was statistically associated with development of osteoporosis, OCF, and surgery for OCF. Mortality of PD group was about 1.7 times higher than that of non-PD group after adjusting potential confounders, and mortality of PD group with OCF was higher than control, but not significantly (p=0.09). Survival rate of PD group with surgery for OCF was much higher than that of PD group with conservative treatment.

CONCLUSION : Patients with PD had a significantly increased risk of osteoporosis and OCF. Surgical prognosis for OCF in PD patients was much better than conservative treatment.

2016년 WHO 분류기준에 따른 4등급 악성 척수 수질내 교모세포종에서, 유전자변형이 생존분석과 예후에 미치는 영향

이 성¹, 윤도흠¹, 김세훈², 김공년¹, 하윤¹, 신동아¹, 최선규¹

¹연세대학교 의과대학 신경외과학교실, ²연세대학교 의과대학 병리학교실

PURPOSE : This study is the first report of the prognosis of spinal cord grade IV glioma on the basis of new WHO classification and include the largest numbers of patients in the single institute over 18 years. Accounting for less than 0.2% of all glioblastomas, high grade gliomas of the spinal cord are very rare. The optimal management of spinal cord gliomas remains controversial and no standard treatment protocol has been established. We discuss our approach to managing patients with grade IV primary spinal cord glioma and review surgical and clinical outcomes, prognostic factors.

MATERIALS AND METHODS : We retrospectively reviewed the data from all patients on whom we performed spinal cord tumor removal between 2003 and 2016. 25 patients were pathologically confirmed to have grade IV primary spinal cord glioma. The diffuse midline glioma, H3 K27M-mutant, and was included as a separate entity in the 2016 WHO classification. Surgical extent and disease progression were confirmed by the surgeon based on operative findings, postoperative MRI, and outpatient department (OPD) follow-up. Treatment modality including radiotherapy and chemotherapy, survival analysis, duration until tumor recurrence, pattern of recurrence, cause of death, pathological tumor molecular profiles including MGMT methylation, IDH1 mutation, K27M, 1p/19q del, EGFR amplification were identified and analyzed for prognostic factor. This study performed the integrative survival analysis by extracting individual patient data and elucidating more precisely the degree of association of the various factors with the survival outcome and to estimate the predictability of the overall survival (OS) by using Kaplan-Meier analysis.

RESULTS : Among 25 patients, male to female ratio was 18:7, average age was 39.1 years old at diagnosis. All patients presented with motor or sensory dysfunction at diagnosis. 13 patients died until July 2017. All patient underwent radiotherapy (45Gy to 54Gy) and chemotherapy using Temozolomide (5 to 7 cycles). All tumors were present in the cervical (40%), thoracic (53.3%), lumbar (6.7%) spine, spanning an average of 3 levels.

Gross total resection was achieved in 9 patient (36%), subtotal removal 9 (36%), partial removal 4 (16%),

biopsy 3 (12%) was done.

Median overall survival (OS) was 37.1 months, survival at 1 year and 5 years were 82.3 and 18.6% respectively (Figure 2). Median disease free survival (DFS) was 18.5 months, survival at 1 year and 5 years were 64 and 4% respectively.

Male gender showed a longer survival than female in OS and DFS, but had no statistical significance. Extent of surgery and extent of tumor involvement did not revealed any prognostic importance. Radiotherapy and chemotherapy showed longer survival tendency without statistical significance.

Immunohistochemical stain results in 15/15 patients' IDH1 mutation negative (wild type), MGMT methylation showed unmethylation in 14/15 patients and methylation 1/13 patients, H3.3 K27M was positive in 20/25 (80%) and negative 5/25 (20%) patients. There were no statistically prognostic factor (Extent of surgery, Radiotherapy, Chemotherapy, Age, Sex and pathological findings) except H3.3 K27M. K27M positive group showed longer overall survival then negative group (40.07 vs 11.63 months in overall survival, $p < 0.0001$, 20.85 vs 8.72 months in DFS, $p = 0.0241$).

CONCLUSION : The surgical outcome of patients diagnosed with Grade IV spinal cord glioma remains poor. K27M positive group showed longer overall survival then negative group significantly. It's opposite result with brain tumor. Though no other statistically significant prognostic factor was found, early operative treatment and postoperative adjuvant radiochemotherapy should be performed for spinal cord glioblastoma for favorable clinical outcome. To establish optimal treatment strategy, multicenter, nation-wide series of registry would be required in the future.



퇴행성 척추 질환의 치료를 위한 Oblique lateral lumbar interbody fusion (OLIF) 시행 후 요추 4-5 번 추간판 부위의 요근 (Psoas muscle)의 용적 변화 양상 : 수술 중 발생한 요근의 손상에 따른 근위축의 양상 및 임상적 결과에 따른 요근의 변화 양상

조 현 진, 김 진 성

가톨릭대학교 서울성모병원

PURPOSE : Recently, minimally invasive lateral lumbar interbody fusion has gradually increased popularity as substituted method of conventional lumbar fusion

There are two methods of DLIF(direct lateral lumbar interbody fusion) and OLIF(oblique lateral lumbar interbody fusion)

In MIS-DLIF, trans-psoas dissection poses a risk of injury to the psoas muscle and lumbar plexus.

As an alternative, MIS-OLIF uses a window between the prevertebral venous structures and psoas muscle, and gets an access to the target disc obliquely. Theoretically, MIS-OLIF preserves psoas muscle with reducing the complication of direct lateral approach. however, in most case, some psoas muscle violation can not be avoided during the OLIF.

So, the purpose of this study was to evaluation the degree of psoas muscle violation during surgery by confirming changes in volume of psoas muscle in a before and after surgery and also to analysis whether there is a correlation between the change in psoas volume and clinical outcomes

MATERIALS AND METHODS : From October 2013 to may 2016, 32 consecutive patients underwent L4-5 single level OLIF or multi-level OLIF that included L4-5 for the treatment of L2-5 level degenerative disease were identified and retrospectively reviewed with prospectively acquired records.

Degenerative disc disease and Spinal stenosis with/without spondylolisthesis of L2~5 were included, however fixed spinal deformity, infection, or trauma were excluded in this study

For clinical outcomes, self-reported measures including visual analogue scale (VAS), Oswestry disability index (ODI) and walking time for 1 day were used

The psoas muscle volume was obtained by measuring the cross sectional area volume of both psoas muscles at the middle point of L4-5 disc height.

RESULTS : Mean age of the patients included in this study was 65.4 ± 8.0 (52-83, Sex M: 10, F: 22) and preoperative diagnoses were Spinal stenosis / DDD in 19 patients (59%) and Spondylolisthesis in 13 patients (41%). single level OLIF (L4-5) was performed in 24 patients (75%) and more than 2 level OLIF

(include L4-5) was performed in 8 patients (25%).

There was statistically significant improvement of clinical outcomes. (VAS (back, leg), ODI, walking time for 1 day, all of them $p < 0.001$)

The volume of psoas muscle was significantly increased from preoperative to last follow up. (right: $p = 0.004$, left: $p = 0.027$)

And, unlike what we expected, there was no significant reduction in psoas volume at 3 months postoperatively because of violation of the left psoas muscle during surgery. (mean left psoas volume, pre-op : post-3month = 864.1mm^2 : 872.2mm^2) ($p = 1.0$)

The volume of both psoas muscle increased significantly in the good clinical outcome of VAS for back (VAS for back < 3) after the operation (Rt. $p = 0.04$, Lt. $p = 0.02$) and the volume of the psoas muscle did not change significantly in the bad group. (Rt. $p = 0.242$, Lt. $p = 0.742$)

The VAS for leg and walking time for 1 day also showed a significant increase in the volume of the psoas muscle in the group with good clinical outcome (VAS for leg < 3 : Rt. $p < 0.001$, Lt. $p = 0.02$) (walking time for 1day $\geq 90\text{min}$: Rt. $p = 0.002$, Lt. $p = 0.01$) but no significant change in the bad group. (VAS for leg: Rt. $p = 1.0$, Lt. $p = 1.0$) (walking time for 1day : Rt. $p = 1.0$, Lt. $p = 1.0$) However, in the ODI, the volume of the psoas muscle did not show a significant change according to the group (at last f/u, group with good outcome was identified with $\text{ODI} \leq 20$)

CONCLUSION : In the degenerative lumbar diseases, MIS-OLIF is a relatively safe procedure without definite necrotic change or reduction of volume of psoas muscle at the first follow after surgery. and Overall, the volume of the psoas muscle at L4-5 significantly increased postoperatively, especially in the group with good clinical outcomes.

새로운 비구속 타입의 인공 디스크를 사용한 경추 하이브리드 유합술의 인접 분절 퇴행과 운동성 보존에 대한 영향

허정우, 정호중, 조현진, 김진성, 류경식

가톨릭대학교 서울성모병원

PURPOSE : Multi-level anterior cervical fusion results in greater risk of adjacent segment degeneration (ASD) with a substantially greater increase in longitudinal strain immediately adjacent to fused level. Hybrid surgery, consisting of artificial disc replacement (ADR) combined with anterior cervical discectomy and fusion (ACDF), has been reported with favorable results for 2-level cervical disease. Novel unconstrained-type artificial disc with variable center of rotation demonstrated physiologic facet-guided movement enabling better motion preservation.

The purpose of this study is to compare the clinical and radiologic outcome of cervical hybrid surgery using conventional semi-constrained-type artificial disc and novel unconstrained-type artificial disc in patients with 2-level disc disease in terms of adjacent segment degeneration and motion preservation.

MATERIALS AND METHODS : Between October 2013 and December 2014, 82 patients with 2 consecutive level cervical disc disease (CDD) between C3/4 and C6/7 underwent hybrid surgery were retrospectively reviewed. All operations were conducted with two surgeons with the same surgical protocols. In study group (44 patients), novel unconstrained-type artificial disc (ROTAIO Cervical Disc Prosthesis; SIGNUS Medizintechnik GmbH, Alzenau, Germany) was inserted in ADR level and in control group (38 patients), conventional semi-constrained type was used. Standard ACDF surgery was done at fusion level in both group. All patients were followed clinically and radiologically for a minimum of 24 months.

Clinical outcomes were assessed by Neck Disability Index (NDI), visual analogue scale (VAS) scores for neck and arm pain, patients' overall satisfaction and the usage of postoperative analgesics. Additionally, radiological measurements including angular range of motion (ROM) of C2-C7 and adjacent segments and any radiological evidence of adjacent segment degeneration were recorded.

RESULTS : Both groups showed significant improvement in NDI and VAS scores postoperatively and continued improvements were observed in both groups until 2 years. Although no significant differences in NDI scores existed between 2 groups postoperatively, study group experienced a trend towards better results at 12 and 24 months ($p=0.333$, 0.018 respectively). Over 95% of patients in both group showed

good to excellent results at the last visit and a significant reduction of analgesic usage was observed ($p < 0.001$).

The C2–C7 ROM was significantly limited immediately after surgery in both group and then gradually recovered. The study group showed more rapid and greater C2–C7 ROM recovery compared to control group at the final follow-up ($30.1 \pm 10.8^\circ$ vs $24.2 \pm 11.4^\circ$; $p=0.005$).

Although, superior adjacent segment ROM for both group remained hypo-mobile compared to preoperative value during the follow-up periods, the control group exhibited gradual increase from 12 month to final follow-up after the surgery (6.4 ± 3.2 vs 8.9 ± 4.2 ; $p=0.005$, 6.8 ± 5.4 vs 10.5 ± 4.9 ; $p=0.005$ respectively). Significantly increased ROM at inferior adjacent segments was observed in both groups compared with preoperative values at the final follow-up, but the compensatory ROM was less in study group without statistical significance.

Adjacent disc space narrowing was observed equally in both groups. No new osteophyte formations and signs of prosthesis-related complication were recorded and in both group. There were low rate of complication and no secondary operation.

CONCLUSION : The hybrid surgery may be a promising alternative to fusion surgery for CDD, but studies suggest still some degree of adjacent segment degeneration observed. In this study, hybrid surgery with novel unconstrained-type artificial disc demonstrated better neck pain improvement, C2–C7 ROM recovery and less impact at superior adjacent level compared to conventional semi-constrained-type. Variable center of rotation enabling physiologic facet-guided movement without joint gapping in unconstrained-type artificial disc may be a promising solution to eliminate unwanted adjacent segment degenerations.

중증도 성인 시상면 변형과의 관련 인자 분석

류 달 성, 윤 승 환, 신제임스키

인하대학교병원 신경외과

PURPOSE : Adult spinal deformity is deemed the result of accumulated degenerative process. However, the pathogenesis of adult spinal deformity has not been fully understood until now. This study was conducted to compare the predisposing factors in patients with non pathologic, moderate deformity vs marked deformity and determine which is the key factor for marked sagittal deformity.

MATERIALS AND METHODS : This study was a retrospective analysis of prospectively collected data on patients with ASD. According to global sagittal alignment of the SRS-Schwab classification, total 124 patients were divided into non pathologic, moderate deformity (SVA<9.5cm) vs marked deformity (SVA>9.5cm). Sagittal alignment and pelvic parameter were measured at standing whole spine x-ray. Lumbar spine MRI were reviewed to evaluate following predisposing factors; Disc degeneration using Pfirrmann scale at all lumbar segments, disc protrusion or extrusion, moderate to severe canal stenosis, pre-existing fracture, spondylolisthesis, Modic endplate change. Cross section area (CSA) and fatty infiltration by Goutallier classification were measured to demonstrate quantity and quality of multifidus(MF), erector spinae(ES), psoas muscles(PS).

RESULTS : Demographics of marked deformity groups revealed quite different female dominant, lower height and weight, lower lumbar BMD) than that of mild to moderate deformity group although age was similar. ($p<0.05$) Pfirrmann disc degeneration grading were higher at all lumbar discs with marked deformity group. ($p<0.05$) And marked deformity group showed higher fatty infiltration grading and lower CSA in MF, ES, PS. ($p<0.05$) Pre-existing fracture, L5/S1 disc degeneration and smaller CSA of MF and PS demonstrated correlation with marked deformity group with multivariate logistic regression analysis. (OR 7.79, 1.91, 0.99, 95% CI 1.527-39.768, 1.086-3.382, 0.991-0.998, 0.994-0.999)

CONCLUSION : Marked deformity group showed statistically different characteristics with mild to moderate deformity group. Especially, smaller CSA of MF & PS, higher L5/S1 Pfirrmann grading and pre-existing VF were associated with marked deformity group.

후방 접근법 척추체 제거 및 전후방 유합술을 위한 허리신경총의 해부학적 고찰; cage 진입을 위한 공간 측정

김문규¹, 유승훈¹, 남용석²

¹울산대 강릉아산병원 신경외과, ²가톨릭대 응용해부 연구소

PURPOSE : Posterior lumbar approach is the most familiar procedure for spine surgeons, and the majority of fusion surgeries were performed using posterior approach. However, for vertebral corpectomy, anterior-posterior approach should be necessary in many cases because anterior approach allowed a large field and a corridor for a large cage, and posterior pedicle fixation can ensure stability effectively. But two-stage operations require more time and perioperative risks. Thus, several surgeons studied about posterolateral corpectomy with a single-stage circumferential fusion. Since Capener's description in 1954, Bilsky et al and Hunt et al had reported the results of single-stage of operations. However, there were rarely studied about how much space can be allowed for a cage in lumbar area. For this reason, authors studied the anatomic structures for posterolateral corpectomy and evaluation of the dimensions of the corridor for an implant without an injury of the nerve roots.

MATERIALS AND METHODS : Ten fresh-frozen cadavers (male 5: female 5, donated to The Catholic University of Korea) were dissected bilaterally (total; 20 sides). The wide dissections through the lumbar extracavitary approach and posterolateral approach were performed to clarify the regional anatomy of the lumbar area. After removal of back muscles, the dimensions of non-tethered area of lumbar nerve roots from theca sac were measured.

RESULTS : The lumbar nerve roots exiting from intervertebral foramen went down along the lateral surface of the lower segment pedicle and entered the free space between the deep and superficial originated psoas muscle under the transverse processes. The roots conjugated with each other at more lateral of the tip of the transverse processes in the psoas muscle, and there were the tethering points. The average dimensions of free space were 23.8 ± 3.99 mm (the dura-tethered points), 44.31 ± 15.66 mm (root to root). The L5-S1 area was too small to use posterolateral or extracavitary approach due to interference of sacrum, iliac crest and the origin site of longissimus muscle. In small cases (4 out of 20 at L1-2), roots conjugated at just lateral of the pedicle, and these variations also restricted operative fields.



CONCLUSION : The results could be a basic data for developing cages for posterolateral approaches and helpful for estimating the possible size of implants and limitations, and clarified the regional anatomy of muscle and nerve.

MEMO

2017. **9.16** (Sat.)



Guest Lecture II

좌장 : 가톨릭대 조경석, 성균관대 어 환

1. Diffusion Tensor Imaging and Cervical Myelopathy

President, Disorders of the Spine and Peripheral Nerves,
ANS / CNS Medical College of Wisconsin, USA **Marjorie Wang**

2. The Definition Change of Ir/Reducible AAD and Following Treatment Strategy

President, China Neurosurgical Society, China **Feng Zeng Jian**

Marjorie Wang

President, Disorders of the Spine and Peripheral Nerves,
ANS / CNS Medical College of Wisconsin, USA



Education

- 9/8/1987–5/27/1991 B.A. with Honors, Brown University
- 8/31/1992–6/8/1996 M.D. *Cum Laude*, Loyola Stritch School of Medicine
- 9/29/2002–6/11/2005 M.P.H. University of Washington School of Public Health,
- 6/23/1996–6/30/2002 Internship (General Surgery), Residency (Neurosurgery), University of Colorado
- 7/1/200–6/30/2006 Complex Spine Fellowship, Medical College of Wisconsin

Administrative Appointments

- 3/09–8/12 Clinical Director, SpineCare Clinic, Medical College of Wisconsin
- 7/17–present Service Line Co-Director, Spine, Froedtert/Medical College of Wisconsin Enterprises

Editorial Positions

- Section Editor *World Neurosurgery*; Editor: Edward Benzel, MD

Current National Elected/Appointed Leadership and Committee Positions

- 3/2017 AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerves, Chair
- 3/2017–3/2018 AANS Board of Directors, Ex-Officio member
- 5/2017–2022 American Board of Neurological Surgery, Scholar in Residence

Select Journal Publications/Original Papers in Diffusion Tensor MR Imaging

- Vedantam A, Jirjis M, Eckhardt G, Sharma A, Schmit BD, Wang MC, Ulmer JL, Kurpad S. Diffusion Tensor Imaging of the Spinal Cord: A Review. *Coluna Columna*, 12(1): 64–69, Jan/Mar 2013.
- Vedantam A, Schmit BD, Wang MC, Kurpad SK. Characterization and Limitations of Diffusion Tensor Imaging Metrics in the Cervical Spinal Cord in Neurologically Intact Subjects. *Journal of Magnetic Resonance Imaging*; e-published February 6, 2013; 38(4):861–7, 2013.
- Vedantam A, Eckardt G, Wang MC, Schmit BD, Kurpad SN. Clinical Correlates of High Cervical Fractional Anisotropy in Acute Cervical Spinal Cord Injury. *World Neurosurgery*; e-published September 17, 2013.
- Vedantam A, Jirjis MB, Schmit BD, Wang MC, Ulmer JL, Kurpad SN. Diffusion Tensor Imaging of the Spinal Cord: Insights From Animal and Human Studies. *Neurosurgery*; e-published September 23, 2013; 74(1): 1–8, 2014, Editor's Choice.
- Vedantam A, Eckardt G, Wang MC, Schmit BD, Kurpad SN. High Cervical Fractional Anisotropy as an Imaging Marker for Spinal Cord Injury. *Neurosurgery*: 2014 Aug;61 Suppl 1:167–70.
- Vedantam A, Rao A, Kurpad SN, Jirjis MB, Eckardt GE, Schmit B, Wang MC. Diffusion Tensor Imaging Correlates with Short-Term Myelopathy Outcome in Patients With Cervical Spondylotic Myelopathy. *World Neurosurgery*: 2017 Jan;97:489–494.

Diffusion Tensor Magnetic Resonance Imaging as a Biomarker for Cervical Spondylotic Myelopathy: New Techniques and Future Directions

Marjorie C. Wang, MD, Saman Shabani, MD,
Joey Grochmal, MD, PhD, Matthew Budde, PhD

Department of Neurosurgery, Medical College of Wisconsin, Milwaukee, WI 53262

Introduction : Diffusion tensor imaging (DTI) has shown promise as a biomarker for myelopathy (CSM) severity as measured by the modified Japanese Orthopaedic Association scale and patient reported surveys. Recent work also shows an association between DTI and quantitative tests of physical function. Prior limitations have included the additional burden of lengthy DTI scanning and processing, and imaging artifact, but new techniques show promise for utilization of DTI in clinical settings.

Methods : We performed a prospective study of patients undergoing surgery for CSM. Preoperative mJOA, SF36, DTI, functional, and clinical outcome measures were obtained. We studied the correlation between preoperative DTI parameters, including FA, mean diffusivity (MD), transverse and longitudinal apparent diffusion coefficients (tADC and lADC), mJOA, SF36, grip strength, 10-meter walk and 9-hole-PEG test. Limitations and recent developments in DTI scanning from the literature and in the Medical College of Wisconsin Center for Imaging Research were reviewed.

Results : Thirty patients with CSM were consecutively enrolled, of whom 4 subsequently declined surgery and were excluded. All patients underwent preoperative mJOA, SF36, grip strength, and 10-meter walk testing. 16 patients underwent 9-hole-PEG testing. Mean age was 53.5 (SD 8.5) years, 11 (42%) were male; the majority was right-handed (92.3%). Mean mJOA was 13.5 (SD 2.2); mean SF36 Physical Component Scale (PCS) was 35.4 (SD 9.7). Dominant hand grip strength was 30.8 kg (mean, SD 11.6); 10-meter time and speed were 7.1 seconds (mean, SD 3.4) and 160.7 cm/s (mean, SD 47.6); dominant-hand 9-hole PEG test 36.9 seconds (mean, SD 9.2). Mean FA at the level of maximum compression was 0.52 (SD 0.060); MD 1.0 $\mu\text{m}^2/\text{ms}$ (SD 0.2); lADC 1.5 (SD 0.4); tADC 0.7 (SD 0.2). DTI parameters were not significantly correlated with mJOA or SF36 PCS. However, MD, tADC and lADC correlated with the 9-hole-PEG test ($R=0.62$ $p=0.01$; 0.58 $p=0.12$; 0.64 $p=0.01$). DTI FA also correlated with 10-meter time (0.33 $p=0.09$) and DTI lADC correlated with 10-meter speed (0.34 $p=0.09$). Recent advancements show promise in utilizing DTI in a clinical setting in conjunction with routine MRI imaging, including double diffusion DTI and imaging in patients with instrumentation.



Conclusions : DTI parameters correlate with mJOA, patient reported outcomes, and quantitative measures of physical function in patients with cervical spondylotic myelopathy. New developments allow for imaging in a clinical setting and in patients with instrumentation. DTI has potential to be a biomarker CSM severity, and to help improve decision making for surgery.

Feng Zeng Jian

President, China Neurosurgical Society, China



- May, 2014– Vice chairman, department of neurosurgery, Xuanwu hospital, Capital medical university, Beijing
- Sep. 2007– Professor and director, Division of spine, Department of neurosurgery, Xuanwu Hospital, Capital Medical University, Beijing
- Apr. 2004– Sep. 2007 Associate professor and director of division of spine, Department of neurosurgery, Xuanwu Hospital of Capital Medical University
- Sep. 2002–Apr. 2004 Associate professor of neurosurgery in Beijing Hospital;
- Nov. 1997–Nov. 2002 Specialization in neurosurgery under the direction of professor Cantore, University of Rome, La Sapienza
- Jul. 1992–Jul. 1995 Master of neurosurgery in Beijing Hospital;
- Jul. 1990–Mar. 1997 Resident and Attending doctor of neurosurgery in Beijing Hospital;
- Sep. 1985–Jun. 1990 Bachelor of medicine, Shangdong Medical University (Medical school, Shangdong University).

Academic positions

- President, section of spine and spinal cord, branch of neurosurgery, Chinese medical doctor's association
- Vice-president, section of spine and spinal cord, branch of neurosurgery, Chinese medical association
- Vice-president, section of spinal endoscopy, branch of orthopedics, China council for medicine international promotion
- Executive member of committee, Asia-Pacific Cervical Spine Society

The definition change of ir/reducible AAD and following treatment strategy

FengZeng Jian, M.D., Jian Guan, M.D., Ph.D.,

Zan Chen, M.D., Ph.D, Hao Wu, M.D., Ph.D.

Division of spine, neurosurgery, Xuanwu hospital, Capital medical university

Recently, cervical traction under general anesthesia is used to evaluate if an atlantoaxial axial dislocation (AAD) is reducible or irreducible under X ray, and different surgical procedures, such as direct posterior fixation or combined with anterior transoral release, was then performed. But this evaluation technique has an obvious fault, because an important factor is neglected, that is the reduction force exerted on by the screws. It is not rare that partial or no reduction is achieved by cervical traction, but complete reduction is gotten using intraoperative screws; in this situation, transoral surgery can be avoided. So nowadays, determining an AAD is reducible or irreducible should depend on intraoperative manipulations, but not preoperative cervical traction. Because of the advance of varieties of posterior reduction technique, such as cantilever technique, distraction and facet joints release techniques, etc, direct posterior reduction should be first line of choice for AAD. Additionally, posterior technique is relatively easier and safer; and posterior decompression of the foramen magnum can be performed in the same time, which is useful to improve tonsillar herniation. Transoral odontoidectomy is reserved for patients with no good reduction of the AAD and no symptoms relief.

MEMO

2017. 9.16 (Sat.)



Plenary Session

대한척추신경외과 중장기 발전 전략 수립을 위한 포럼

좌장 : 연세대 조용은, 가천대 이상구

1. 대한척추신경외과의 현황과 과제

연세대 구성욱

2. 대한척추신경외과의 대국민 홍보 전략

가톨릭대 조정기

구 성 옥

연세대 강남세브란스병원



최근 주요 약력

- 1986-1992 연세대학교 의과대학 (의학사, 1992)
- 2001-2004 연세대학교 의과대학 (의학박사, 2004)
- 2005.03-2006.08 미국 에모리 의대 척추센터 교환교수
- 2012.03-현재 강남세브란스병원 척추신경외과 교수

최근 주요 경력

- 2008.09-2010.08 연세대학교 의과대학 교학부장
- 2013.01-2014.08 강남세브란스병원 기획관리 부실장
- 2015.01-2016.01 대한의용생체공학회 학술이사
- 2016.09-현재 강남세브란스병원 홍보실장
- 2016.09-현재 대한척추신경외과학회 기획 & 홍보 상임이사

대한척추신경과의 현황과 과제

구 성 옥

연세대

대한척추신경외과학회는 30주년을 맞이하여 대한척추신경외과학회 중장기 발전전략 수립 조사를 한국갤럽 헬스케어팀과 함께 진행하였다.

중장기 발전전략 수립을 위해 1)대국민 인식 조사와 2)척추신경외과학회 회원 대상 조사를 시행하였으며 대국민 인식조사는 정량 조사로 전화조사로 진행되었다. 척추신경외과학회 회원 대상 조사는 정성조사와 정량 조사를 모두 시행하였는데 정성조사는 21명의 회원 인터뷰와 비회원인 외부인사 9명 인터뷰로 하였다. 정량 조사는 회원을 대상으로 한 온라인 조사로 2017년 2월과 7월에 각각 1회씩 총 2회 진행하였다.

대국민 인식 조사는 전화조사로 만 35세 이상 75세 미만 전국 국민 1,024명 대상으로 척추 질환에 대한 인식과 치료 현황을 조사하였다. 만 35세 이상 75세 미만 1,024명 중 396명(38.7%)이 척추 질환으로 진단 받고 치료를 받은 것으로 확인되었는데 수술받은 396명 중 수술 전 몇 곳의 의료 기관을 방문했는지에 대한 답변을 보면 1개 기관 29%, 2개 기관 28%, 3개 기관 23%, 4개 이상 기관이 총 21%로, 29%를 제외하고 국민들은 2개 이상의 의료기관을 방문하는 것으로 확인되었다. 척추 수술에 대한 인식에 대한 질문에는 ‘좋다 13%’, ‘보통이다 28%’, ‘안 좋다 48%’로 안 좋다고 응답한 사람들의 비율이 높았는데, 그 이유로는 ‘수술 후 경과가 안 좋아서’, ‘수술 후 후유증이 우려돼서’ 등이 주로 언급되었다. 척추 수술에 대한 인식이 ‘좋다’고 응답한 응답자들은 대부분 수술을 받고 결과에 만족한 응답자들였다. 반면에 척추 질환으로 수술을 받은 환자 중 결과에 만족하지 않은 환자들은 척추 수술에 대한 부정적인 경험을 주변 사람들과 공유하고 있었다.

척추신경외과학회 회원들은 척추 전문의로서 현재 의료 환경에 대해 공통적으로 어려운 상황이라고 인식하고 있었다. ‘아주 심각하지는 않지만 어려운 상황이다’는 의견이 대학병원, 종합병원, 의원 소속 회원에서 비율이 높았다. 척추전문병원의 경우 ‘아주 심각해서 위기 상황이라고 말할 수 있다’의 비율이 가장 높았는데 반면 ‘타과에 비해 양호하다고 생각한다’는 비율도 상대적으로 높았다. 현재 의료 업무 시 힘든 부분은 1순위로 가장 많이 선택된 항목은 ‘보험 삭감이 심하다’ 이고 ‘의료 수가 및 정책이 불합리 하다’ 도 척추 전문 병원과 의원급 모두 공통으로 많이 선택한 항목이다. 의원급에서는 모두 ‘정상적인 의료 업무로는 병영경영이 불가능하다’를 선택했다.

의료비 삭감 시 취하는 태도는 현재 ‘대학병원’에서 근무하는 응답자는 다른 근무지의 응답자에 비해 이유를 알아보



고 ‘적극적으로 대응한다’의 비율이 높고 의원의 경우는 “그러려니 하고 포기한다”는 비율도 1/3로 높았다.

의료비 삭감에 대해서는 모든 회원이 심각하다고 하였으며 그 원인으로는 ‘잘못된 심평원 심사체계’, ‘불확실한 보험 인정 기준’을 꼽았다. 현재 ‘의원급’에서 근무하는 응답자는 다른 응답자에 비해 ‘불확실한 보험 인정 기준’이 심각한 의료비 삭감의 원인이라고 응답한 비율이 1/2 이상으로 높았다.

학회 발전을 위해 주력해야 하는 항목에 대해 회원들은 공통적으로 보험수가 개선과 대국민홍보활동을 꼽고 있었다. 대학병원, 종합병원, 척추전문병원 모두 향후 관심을 가져야 하는 새로운 분야 발굴이 중요하다고 하였고 특히 이 분야는 척추 전문병원에서 강조되었다. 대학병원은 세대교체에 따른 능력있는 후진 양성이 중요하다고 선택한 비율이 높았다.

무리한 과잉의 척추치료에 대해 학회 차원의 자정 노력이 필요하다에 대해 회원의 과반수 이상이 동의하고 있었다. 척추 전문 병원의 경우는 자정이 필요하다는 것에는 동의하지만 이는 학회가 나설 일이 아니다를 선택한 비율도 적지 않았다.

‘국민들의 척추 수술에 대한 인식이 어떠한 것 같은가’의 질문에 대해 회원 대부분 (96%)이 ‘국민들은 척추 수술에 대해 부정적 인식을 가지고 있을 것이다’라고 응답했고 그 원인을 일부 의사들이 척추 수술을 하지 말아야 할 환자를 수술한 것, 수술을 제대로 잘 하지 못한 것, 수술을 받아야 할 환자를 시술을 해서 치료 시기를 놓친 것 등을 꼽았으며 일부의 부정적인 사례만을 언론에서 다룬 것도 영향을 미쳤다고 생각하고 있었다.

정성 인터뷰를 통해 학회 회원과 비학회 의료전문가들의 척추치료 현안에 대한 생생한 목소리를 들을 수 있었다. 주요 현안으로는 보험 수가, 척추 시술 및 수술에 대한 인식, 척추치료의 자정 활동, 대국민홍보활동, 환자와의 커뮤니케이션, 향후 관심을 보여야 할 영역, 학회 운영, 미션/비전/전략수립 등에 관련한 회원들의 다양한 의견을 모을 수 있었다.



대한척추신경외과의 대국민 홍보 전략

조 정 기

가톨릭대

2017. **9.16** (Sat.)



Symposium III: Innovation in Neurospine Care

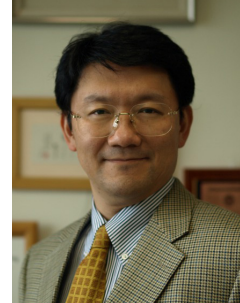
좌장 : 연세대 김근수, 울산대 노성우

1. Restoration and Enhancement of Physiological Musculoskeletal Function in the Degenerative Spine
President, Neurospinal Society of Japan, Japan **Kim Phyo**
2. 신경외과 수술용 로봇 개발
전남대 마이크로로봇 연구소장 및 교수 **박종오**
3. 척수손상으로 인한 마비 장애인의 보행 보조로봇
서강대 기계공학 교수 **공경철**
4. 환자 맞춤 치료를 위한 대용량 데이터와 머신러닝 활용사례
연세대 심장내과 **장혁재**



Kim Phyo

President, Neurospinal Society of Japan, Japan



Education

- 1980 M.D. Degree, University of Tokyo
- 1989 Ph.D. Degree, Pharmacology, Mayo Graduate School of Medicine
- 1992 D.M.Sc. (Doctor of Medical Science) University of Tokyo

Postgraduate Training

- 1980–84 Residency Training, Department of Neurosurgery, University of Tokyo
- 1984–89 Residency Training, Department of Neurologic Surgery, Mayo Clinic,
- 1985–89 Fellow, Ph.D. Candidate, Department of Pharmacology, Mayo Clinic

Appointment

- 1990 to 1996 Assistant Professor, Neurosurgery, University of Tokyo
- 1996 to 1999 Associate Professor, Neurologic Surgery, Dokkyo University
- Aug 1999 to date Professor and Chairman, Neurologic Surgery, Dokkyo University
- April 2012 to date Deputy President, Dokkyo University School of Medicine

Medical Licenses

- 1980 National Medical Board in Japan, Physician's License
- 1984 National Medical Board in Korea, Physician's License
- 1985 Minnesota Medical License, USA

Board

- 1990 Board-certified, Japan Neurosurgical Society
- 2003 Board certified Instructor Spine Surgery, Neurospinal Society Japan

Organization Memberships

- Japan The Neurospinal Society Japan : Chairman of the Executive Board (2013–2015, 2015–2017, 2017–2009), President (2006–7),
The Japan Neurosurgical Society Executive Board (2015–6, 2017–2019)
- USA: American Association of Neurological Surgeons, Congress of Neurological Surgeons
- Korea Korean Spinal Neurosurgery Society (Honorary Member)
President (2008–9) The 7th Biennial Japan–Korea Conference on Spinal Surgery (Asia Spine)

Restoration and Enhancement of Physiological Musculoskeletal Function in the Degenerative Spine

Phyo Kim, MD, PhD

Neurologic Surgery, Dokkyo University Hospital

The spine erectors are a large bundle of intertwined muscles, working in concert to maintain dynamic posturing in locomotion and in more vigorous exercises. Their power is exerted over a number of vertebral segments with the contractile force integrated and conducted by the myofascia, the action indicated in the notion of “myofascial meridian”.

In the cranio-vertebral junction, muscles such as oblique capitis inferior have high density of muscle spindles, and thus serve as the sensors / transducers for position, rotation and acceleration between the vertebra and the skull. Contraction in the uppermost portion of the spine erectors can be detected at the large lumbosacral myofascia, and further down in the fascia of the soleus muscle.

When treating various lesions affecting the neural structure in the spine, it is desirable to preserve the dynamic sensorimotor function of the erector musculoskeletal system. In the author’s practice with techniques to restore the attachments and function of the spine erector, the followings are common observations,

Degenerated cervical spine causing myelopathy often display diminution in the lordosis, a response to secure maximal AP diameter of the spinal canal. When adequate canal enlargement is achieved with the attachments and function of nuchal muscles kept intact, lordotic alignment is often restored. Myoarchitectonic spinolaminoplasty (MSLP) often results in restoration of lordosis, and exerts favorable influence on the alignment in the lumbo-sacro-pelvic complex. Correction of the ventral shift of the center of gravity (CG) of the head, neck and the upper torso, obviates effort of compensation by the lordotic lumbar spine.

Increase in the kyphosis in the thoracic segments and thoraco-lumbar junction, and progressive ventral shift of the CG is a common phenomenon accompanying aging. To maintain the balance, the lumbar spine responds with increase in lordosis. The adjustment requires flexibility of the lumbar spine and intact muscle strength. Fixed lumbar spine is certainly a hazard for the physiological adjustment and resultant stress in the adjacent joints is a source chronic post-fixation pain. Alternatively, the balancing



is supplemented by increase in the dorsal rotation of the pelvis. The latter causes sheer stress in the sacroiliac joint. Correction of thoracic kyphosis, or postoperative restoration of lordosis in the cervical spine, often ameliorates low back pain and that generated in the sacroiliac joint.

Based on the observations, we believe adequate decompression with restoration of dynamic musculoskeletal function is a logical approach to cope with degenerative spine diseases. Efficacy of such procedure, *myoarchitectonic spinolaminoplasty* in the cervical spine, as assessed in the long-term changes in the parameters of total spine x-ray, will be presented and discussed.

박종오

전남대학교 로봇연구소



최근 주요 약력

- 1982.03–1987.03 독일 Stuttgart대학교 로봇공학박사(Robotics)
- 1979.03–1981.02 KAIST 기계공학석사(Optimal Design)
- 1974.03–0978.02 연세대학교 기계공학사(Mechanical Design)
- 2014–현재 러시아연방 산업통산부장관 “신산업투자전략위원”
- 2006–현재 국제로봇연맹 집행이사 겸 한국대표

최근 주요 경력

- 2016.10–현재 마이크로의료로봇센터(MRC) 센터장
- 2008.03–현재 전남대학교 로봇연구소(RRI) 소장
- 2005.02–현재 전남대학교 기계공학부 교수
- 1999.12–2004.10 과학기술부 21세기 프론티어사업단 지능형마이크로시스템개발사업단장
- 1987.04–2005.01 한국과학기술연구원(KIST) 선임/책임연구원



신경외과 수술용 로봇 개발

박종오

전남대 마이크로로봇 연구소장 및 교수



공 경 철

서강대학교 기계공학과



최근 주요 약력

- 2004 서강대학교 기계공학/물리학 학사
- 2006 서강대학교 기계공학 석사
- 2009 University of California, Berkeley 기계공학 박사
- 2010 University of California, Berkeley 박사후연구원
- 2011-현재 서강대학교 기계공학과 교수

최근 주요 경력

- (주)SG로보틱스 설립 (2017), 현 대표이사
- 국제사이보그 올림픽, 사이배슬론, 착용형 로봇 분야 동메달
- UAE Robotics for Good, 결선 진출
- 국제자동제어연합(IFAC) 젊은 과학자상 수상
- 한국로봇학회 학보ART(Assistive Robot Technology)상 수상



Robotic Technologies for Assisting the Mobility of People with Impaired Walking Ability

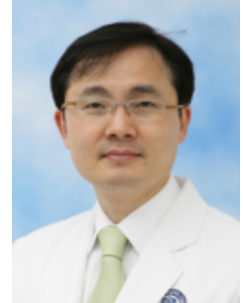
Kyoungchul Kong, Ph.D.

Associate Professor, Department of Mechanical Engineering, Sogang University, Korea

Robotics technologies are steadily penetrating in our daily lives. We are surrounded by robotic products and interact with them in many ways. In particular, such systems may potentially improve the quality of life of people with major or minor impairments in walking ability. Robotic assistance technologies for the complete and incomplete paraplegics require different technologies in actuation, sensing, and controls. In this talk, several key technologies for effectively assisting people with impaired walking ability are introduced. These technologies include 1) sensing technologies for observing the dynamic state of the human wearing a robot, as well as for identifying the intent of humans, 2) decision making algorithms to decide about the right amount of assistance, 3) actuation technologies to provide precise assistive forces, and 4) control algorithms for providing assistance as needed. In the design of mechatronic devices interacting with humans, the dynamic characteristics of the human body are an important issue. Furthermore, the compatibility between machines and humans must be optimized when the human and the robot must share the control of the combined overall system. If the assistive device is interacting with normal and healthy humans, the design may take advantage of the robust and intelligent controllability of the human brain system. In the case of assistive devices for patients with incomplete paraplegia, such approaches may not be appropriate, and the controller is required to be precise, robust and intelligent. In these aspects, various engineering approaches will be introduced in this talk, and experimental demonstrations will also be provided to verify the proposed methods.

장혁재

연세의료원 의과대학 내과학교실



최근 주요 약력

- 2009.08–2009.12 보건복지가족부 신의료기술평가위원회 위원장
- 2010.01–2012.07 폐고혈압을 이기는 사람들 이사장
- 2012.04–현재 한미생명과학재단 이사
- 2013.03–현재 미래창조과학부 심혈관 진단치료지원 통합SW 시스템 개발 사업 단장
- 2015.06–현재 국민안전처 Smart Emergency Medical Service 시스템 개발 주관 책임자

최근 주요 경력

- 2014.08–현재 연세대학교 의과대학 심장내과 심장 영상 센터장
- 2014.08–현재 연세대학교 의과대학 심장내과 심초음파 실장
- 2016.09–현재 세브란스병원 재난대응의료안전망사업단 라이프테크사업소 소장
- 2016.09–현재 연세대학교 의료원 의료정보실장(CIO)
- 2017.06–현재 (주)HOOH 헬스케어 대표이사



환자 맞춤 치료를 위한 대용량 데이터와 머신러닝 활용사례

장혁재

연세대 심장내과

Traditional prediction of the occurrence disease and treatment strategies have been screening test or recommending drug treatment for patients with a certain level of risk based on statistical method.

However, previous studies have shown that the side effects and over-costing occur too much, while patients with benefit are fewer from this uniform treatment strategy.

The prediction technology based on big-data is not to present a probabilistic hazard ratio risk based on statistical methods but to detect patients that required treatment.

Also, the technology lead to change traditional medical methods – based medical care – based medical behavior by suggesting a novel action strategy based on the individual health checkups or biometric information.

MEMO

2017. **9.16** (Sat.)



Emerging Technology

Update on Spinal Cord Injury Management

좌장 : 중앙보훈병원 **박관호**, 전북대 **은종필**

1. Clinical Guideline in Managing Peri-operative Spinal Cord Injury

강릉아산병원 **박진훈**

2. “No longer use of Steroid” in Spinal Cord Injury

조선대 **김석원**

3. Investigational New Drugs for Spinal Cord Injury

인제대 **신준재**

4. Recent Update of Pathophysiology of Degenerative Cervical Myelopathy

고려대 **이장보**

박진훈

울산대학교 의과대학 강릉아산병원



최근 주요 약력

- 1997.03.01–1999.02.28 Gyeongsang national university, Premedical school
- 1999.03.01–2003.02.28 Gyeongsang national university, Medical school (MD)
- 2006.03.01–2008.02.28 University of Ulsan, College of Medicine (Master degree)
- 2010.03.01–2012.02.28 University of Ulsan, College of Medicine (PhD)

POSTDOCTORAL TRAINING

- 2003.03.01–2004.02.28 Yeouido St. Mary's hospital, Catholic University, Seoul, Korea (Internship training)
- 2004.09.01–2008.08.31 Department of Neurosurgery, Seoul Asan medical center, University of Ulsan, College of Medicine, Seoul, Korea (Resident Training)
- 2009.03.01–2012.02.28 Neurosurgical Spinal Fellowship training in Seoul Asan medical center, University of Ulsan, College of Medicine, Seoul, Korea
- 2011.08.01–2011.08.31 Visiting doctor for Spinal deformity surgery at Johns Hopkins Hospital, Baltimore, Maryland, USA
- 2015.12.01–2016.02.28 Visiting doctor for Spinal deformity surgery, Toronto western hospital and Sick-kids hospital, Toronto, Canada (AO Spinal fellowship)

MEDICAL LICENSURE / CERTIFICATION

- Feb. 2009 Korean neurosurgical board certificate
- Feb. 2003 Korean medical doctor license

최근 주요 경력

Professional Societies

- 2009–present Korean neurosurgical society
- 2009–present Korean Neurosurgical spinal society
- 2015–present Korean Neurosurgical spinal deformity society
- 2015–present AO spine
- 2009–present Korean Neurosurgical cervical spinal research society
- 2012–present Korean Neurosurgical spinal deformity society
- 2012–Present Korean Neurosurgical spinal minimal invasive surgery society
- 2012–Present Korean Neurosurgical spinal tumor surgery society
- 2015–Present Korean neuro-traumatology Society
- 2013–2014 Korean Neurosurgical spinal academic committee
- 2016–2017 Korean neuro-traumatology Journal edition committee
- 2013–2014 Korean neurosurgical spinal WFNS committee



Clinical Guideline in Managing Peri-operative Spinal Cord Injury

박진훈

강릉아산병원

The role of decompression surgery in preventing secondary injury and improving the neurological outcome after spinal cord injury (SCI) has been proven. Despite tremendous scientific advancement in our understanding of SCI, physicians remain without a safe and robustly efficacious perioperative management that directly treats the neural injury. The importance of aggressive supportive care has been demonstrated and such care has markedly reduced the mortality related to acute SCI. It is therefore critical that neurosurgeons understand the rationale for the evidence based perioperative management and its pipeline.

This paper reviews newer data that demonstrate a benefit of early decompression of the injured spinal cord, a hemodynamic supportive care, and the controversy of steroid use the perioperative management for an improvement of outcome after SCI.

김 석 원

조선대병원



최근 주요 약력

- 1992-1998 조선대학교 의과대학 의학과 의학 학사
- 2001-2003 조선대학교 대학원 의학과 의학 석사
- 2006-2008 조선대학교 대학원 의학과 의학 박사

최근 주요 경력

- 현. 조선대학교병원 신경외과 교수
- 현. 대한신경외과학회 정회원
- 현. 대한척추신경외과학회 정회원
- 현. 대한노인신경외과학회 정회원
- 현. 대한외상학회 정회원
- 현. 대한최소침습척추수술연구회 정회원
- 현. 대한신경손상학회 상임이사 정회원

“No longer use of steroid” in spinal cord injury

Seok Won Kim

Department of Neurosurgery, Medical College of Medicine, Chosun University

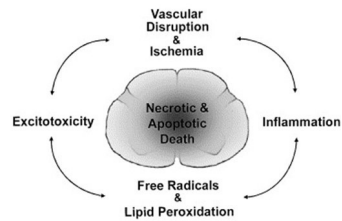
Introduction

• Spinal cord injury

- 1) Primary injury : determined at time of accident
 - ↳ Mechanical compression by fx. or dislocation
 - ↳ Destruction of spinal cord
 - ↳ No change to intervene
- 2) Secondary injury
 - ↳ Minutes or hours after injury
 - ↳ Maximum phase in 24hours later
 - ↳ Acute pathophysiologic process
 - ↳ Can be prevented

Pathophysiology

• Acute pathophysiologic process after spinal cord injury



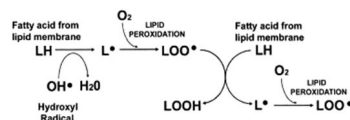
1) Vascular disruption

- ↳ Microvasculature mechanical disruption
 - ↳ Petechial hemorrhage
 - ↳ Intravascular thrombosis, spasm, edema
- Local hypoperfusion & ischemia

2) Free radical & lipid peroxidation (main factor)

Free radical : highly reactive to lipids, proteins, DNA
→ initiate lipid peroxidation

Oxidation of fatty acids → Generation of more free radical





3) Excitotoxicity and electrolyte imbalances

(1) Glutamate

- : most prevalent excitatory neurotransmitter in CNS
- : acting on ionotropic (NMDA, AMPA, Kinate) receptors

(2) Glutamate release & accumulation

- : response to ischemia
- : NMDA - influx of Ca
- : NMDA, AMPA, Kinate - influx of Na

4) Inflammatory/immunologic response

- Proinflammatory prostanoids : prostaglandin, prostacyclin, thromboxane
- Prostacyclin (PGI₂) : promote vascular permeability & edema
- Thromboxane A₂ : worsen venous thrombosis & ischemia

Steroid therapy in cord injury

- Began in 1960s
- Originated from steroid therapy for brain tumor edema
- But, precise mechanism of neuroprotection : **not completely understood**
- Possible theory
 - Inhibition of lipid peroxidation : main effect
 - Modulation of inflammatory & immune response
 - Improve vascular perfusion
 - Prevention of Ca influx

Animal studies(Past)

- Effect of MPS with acute SCI in cats (microvasculature & metabolism)
- High dose(15mg/kg/24hrs) VS Mega dose(60mg/kg/24hrs) VS Untreated VS Uninjured
- Result
 - High dose MPS : improve microvascular perfusion & metabolism
 - Mega dose MPS : no benefit in tissue metabolism

Douglas K et al. J Neurosurg 1982
Microvascular perfusion and metabolism in injured spinal cord after MPS treatment

Animal studies(Past)

- Effect of MPS with SCI in rats
- Neurologic recovery & spinal cord blood flow (SCBF)
- MPS VS Saline group
- Results
 - gray matter : 59 vs 49 ml/min/100g
 - white matter : 13.6 vs 10.7 ml/min/100g
- SCBF was better preserved in MPS-treated group

Holtz A et al. Acta Neurol Scand, 1990
Effect of MPS on motor function and spinal cord blood flow after spinal cord compression in rats.

Clinical studies

- National Acute Spinal Cord Injury Studies(**NASCIS I**)
- Multicentre, prospective, randomized, double-blind trial (1985)
- 330 patients : treated *within 48 hours* of SCI
- MPS
 - 1) 100-mg bolus, then 25 mg every 6 hour for 10 days
 - 2) 1,000-mg bolus, then 250 mg every 6 hour for 10 days
- Result
 - : **No significant difference in neurologic recovery**
 - : High infection in high dose group

Bracken MB et al. J Neurosurg 1985
MPS and neurological function 1 year after spinal cord injury. Results of the NASCIS.

NASCIS II

- Multicentre, prospective, randomized, double-blind trial (1994)
- 487 patients : treated *within 12 hours* of SCI
- 1) 24hr MPS : 30mg/kg bolus, then 5.4 mg/kg/hr for 23hours
- 2) 24hr Naloxone : 5.4 mg/kg bolus, then 4.5 mg/kg/hr for 23hours
- 3) Placebo
- Result
 - 1) MPS within **8 hours of injury** → **only significant neurologic improvement**
 - 2) Naloxone – not effective
 - 3) Mortality, morbidity at 1 year : similar

Bracken MB et al. *J Neurosurg* 1994
MPS or naloxone treatment after acute spinal cord injury: 1-year follow-up data. NASCIS II.

NASCIS III

- Multicentre, prospective, randomized, double-blind trial(1997)
- 499 patients with SCI
- 1) Standard 24hr MPS : 5.4mg/kg/hr
- 2) 48hr MPS : 5.4mg/kg/hr
- 3) 48hr Tirilazad mesylate : 2.5mg/kg every 6 hour for 48 hours
- Result
 - 1) Initiated within 3hr : equal neurologic & functional recovery in all groups
 - 2) Initiated after 3hr : better recovery in 48hr MPS
 - 3) But, more sepsis & pneumonia in 48hr MPS

Bracken MB et al. *JAMA* 1997
Administration of MPS for 24 or 48 hrs or TM for 48 hrs in the treatment of acute SCI

Debates

- **Despite using steroid in many centers, raising concern about complications**

Other experts are unconvinced

In NASCIS II study,

- 1) Actual gain in motor scores : interpreted as marginal
- 2) Potential adverse effects of steroid : underemphasized

Reports against past steroid therapy

- Review of NASCIS II & III : compared with **post-hoc comparisons**
- NASCIS II & III failed to demonstrate primary outcome improvement
- MPS in SCI : not proven as standard Tx.
- Steroid's efficacy & impact : weak evidence & may be random event
- 24hr MPS : experimental use in clinical SCI
- 48hr MPS : not recommended (d/t complications)

Hurlbert RJ et al. *J Neurosurg*. 2000
MPS for acute spinal cord injury: an inappropriate standard of care.

Reports against past steroid therapy

- Systematic review & evaluation of accumulated study : NASCIS II, III & other studies
- Result
 - 1) Statistical artifacts
 - 2) Improved functional recovery : not clinically significant
- CONCLUSION

: Insufficient evidence " MPS - standard treatment in acute SCI "

Sayer FT et al. *Spine J*. 2006
MPS treatment in acute SCI: the myth challenged through a structured analysis of published literature

Animal studies(Recent)

- Effects of MPS & Interleukin-10(IL-10)
- Tissue damage, axonal preservation & functional recovery with SCI in rats
- MPS vs IL-10 vs Combination vs control
- MPS, IL-10, Combination group : reduced the volume of damaged tissue
- MPS, Combination group : reduced the loss of spinal tissue
- But, **did not improve axonal preservation or functional recovery**

Takami T et al. *J Neurotrauma* 2002
MPS and IL-10 reduce gray matter damage in the contused Fischer rat thoracic spinal cord but do not improve functional outcome



Animal studies(Recent)

- Effect of MPS on SSEP and SCBF in 36 dogs with cord compression & after decompression
- MPS (18) VS Saline (18) group

Time Point	Methylprednisolone (n=18)	Saline (n=18)
Baseline	~22	~22
0	~5	~5
d-5	~18	~10
d-5	~25	~15
d+180	~20	~12

- MPS : no significant benefit on neurological restoration
reduce SCBF by affecting normal autoregulation

Carlson GD et al. *J Bone Joint Surg Am.* 2003
Sustained spinal cord compression: effect of MPS on regional blood flow and recovery of SSEP

Recent reports against steroid therapy

- Meta-analyses of previous many reports
- In prior analysis : not considered neurologic injury level & baseline severity of impairment
- MPS use for acute SCI : no medical evidence
- High-dose MPS is associated with severe complications (infection, respiratory compromise, GI bleeding, death)
- Use of glucocorticoids in acute SCI : not recommended.**

Hurlbert RJ et al. *Neurosurgery* 2013
Pharmacological Therapy for acute spinal cord injury

Recent reports against steroid therapy

- A propensity score-matched cohort study
- NASCIS-II MPS group vs No steroid group
- Propensity score matching
Age, sex, time, neurologic injury level & Baseline severity of neurological impairment
- NASCIS-II MPS protocol**
: **Not improve** motor score in acute SCI
: **Significantly higher complication rate** (P < 0.05)

Score Type	NASCIS-II	No steroids
Total Motor Score	~15	~12
Upper Extremity Motor Score	~10	~8
Lower Extremity Motor Score	~8	~6

Outcome	NASCIS-II MPS (n=44)	No steroids (n=44)	P value
Mortality	0	0	-
Urinary tract infection	11	9	0.61
Decubitus ulcer	6	2	0.27
Pneumonia	7	4	0.52
Deep vein thrombosis/ pulmonary embolism	2	0	0.49
Surgical site infection	0	0	-
Sepsis	1	1	-
Total	27	16	0.02

Nathan E et al. *J of neurotrauma* 2015
MPS for the treatment of patients with acute SCI: A propensity score-matched cohort study

Survey research

- 78 members in Cervical Spine Research Society, USA
- Use of steroids in acute SCI : significantly decreased → 2006(89%) vs 2013(56%)
- In this survey, 71% had observed complications
76% believed that complications were severe enough to limit steroid use
- 25.6% of using steroid think useless, but used it for medicolegal concerns

Schroeder GD et al. *Spine* 2014

Conclusion

Steroid use in acute SCI

- : Not a standard Tx.**
- : Associated with Cx.**
- : Should not be routinely used**

신 준 재

인제대학교 상계백병원 신경외과



최근 주요 약력

- 연세대학교 의학과 석/박사
- 연세대학교 신촌 세브란스병원 인턴/전공의, 영동(강남)세브란스병원 전임의
- 인제대학교 상계백병원 신경외과 부교수
- 스탠포드 대학, 방문(연구) 교수
- 샌프란시스코 캘리포니아 주립대학, 방문(연구) 교수

최근 주요 경력

- 대한 척추신경외과 학회 종신회원(Korean Spinal Neurosurgery Society)
- 미국 신경외과 학회 정회원(Congress of Neurological Surgeon (CNS))
- 북미 척추학회 정회원 (North American Spine Society (NASS))
- AO Spine 정회원 (Arbeitsgemeinschaft für Osteosynthesefragen (AO) Spine)
- 미국 신경외과학회 메이필드 우수상 (Mayfield and Outcomes Awards, 28th Annual Meeting of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves (2012))



Investigational New Drugs for Spinal Cord Injury

Jun Jae Shin

Inje University Sanggye Paik Hospital, Neurosurgery

The majority of acute spinal cord injuries (SCI) are cervical region because its area is greatly flexible. Cervical SCIs result in a devastating reduction in functional independence and quality of life (QoL), which is quadriplegia or ventilator-dependency. The thoracic SCIs lead to complete or incomplete paraplegia but allows more independence and higher QoL than cervical SCIs. It is necessary for researchers to identify investigational new drugs capable of improving neurological impairments to address the SCI patients.

Pathophysiology of SCI targeted for treatment

Two stages, primary and secondary phase

① Primary phase(within minutes): mechanical factors affects the SCI, neurological dysfunctions at and below the injury level. Disruption of microvasculatures → hemorrhage and edema → extracellular volume ↑ → impair the perfusion of the blood → thrombosis/vasospasm by release of coagulation factors, vasoactive amines → ischemic status ② Secondary phase(2 hours~2 days): Ionic dysregulation (loss of ionic homeostasis, Ca^{2+} dysregulation → activation of calpains, mitochondrial dysfunction, free radical production → necrotic/apoptotic cell death) & Excitotoxicity (excessive activation of glutamate receptors → influx of sodium-calcium ions through NMDA/non-NMDA receptors) ③ Pharmacological ways to prevent the excessive influx of Na^+ - Ca^{2+} ions using ion channel blockers or glutamate receptor antagonist ④ Permeability ↑ of BBB at early acute stage (direct mechanical damage by primary injury and disruption of endothelial cells, astrocytic processes). The inflammatory process initiated by infiltration of inflammatory cells→ activation of residual microglia → phagocytosis neuronal/oligodendroglial apoptosis, demyelination → cystic formation ⑤ Neuronal regeneration is limited in the injured spinal cord because inhibitory moles of axonal outgrowth. Myelin-associated proteins (Nogo-A, MAG, OMgp) is crucial myelin inhibitory molecules expressed by oligodendrocytes. These molecules bind to Nogo receptor (NgR), activate the downstream Rho/Rho-associated kinases (ROCK) pathway → lead to growth cone collapse, inhibition of neurite outgrowth. ⑥ Scar formation: glial scar (extracellular matrix molecules-chondroitin



sulfate proteoglycans(CSPGs), which inhibits axonal growth → overcoming the inhibitory environment represents a focus for promoting axonal growth and functional recovery after SCI.

→ neuroprotective therapies, neuroregenerative strategies by using Rho protein antagonist, anti-Nogo ab, chondroitinase ABC, are expected to have the potential for SCI.

Immediate phase (< 2 h)	Early acute phase (< 2 days)	Subacute phase (< 14 days)
Hemorrhage Edema Thrombosis Vasospasm Ischemia	Ionic imbalance (dysregulation of Na and Ca concentrations) ^{*,‡} Glutamate-mediated excitotoxicity ^{*,§} Permeability of blood-brain barrier Infiltration of neutrophils Activation of inflammatory mediators [¶] Activation of microglia [¶] Free radical formation Metabolic perturbations	Phagocytosis Infiltration of macrophages Apoptosis Demyelination (loss of oligodendrocytes) Initiation of glial scar

Target in ^{*}riluzolei; [‡]magnesium; [§]FGF2; [¶]minocycline.

Investigational drugs

Five drugs that have been through Phase II clinical trials in SCI. The drugs are all administered systematically and have already been proved to be safe and tolerable in Phase I trials. ① Riluzole ② Minocycline ③ Rho protein antagonist ④ Other drugs: Magnesium chloride within PEG (polyethylene glycol), rbFGF (recombinant basic fibroblast growth factor)

Riluzole: During early stage of 2nd injury, neuronal ionic balance is disrupted → voltage-sensitive channels activation → intracellular Na⁺ ↑ → influx of Ca²⁺ intracellular acidosis/cyotoxic edema → Excessive influx Na⁺ & Ca²⁺ triggers pathologic extracellular release of excitatory neurotransmitter glutamate → cell death. Therefore, Drugs (lidocaine, phenytoin, tetrodotoxin) to block Na⁺ channel & prevent excessive influx of Na⁺

Benzothiazole anticonvulsant, acting as Na⁺ channel blocker. FDA approved orally for ALS

Clinical trials: Phase I clinical trial for acute SCI: 36 pts (28 Cr, 8 Th) 2010.4.-2011.6. at 6 center NACTN (NCT00876889) within 12hr SCI, ASIA (A,B,C). Riluzole (50mg) every 12hr orally or L-tube, starting within 12hrs SCI for 28 doses. Safety - liver enzyme elevation 14-70% pts, but normal level within a few days after test. No serious adverse effect or death. Mean 15.5 motor score gain (p=0.021)

International, multicenter, double-blinded, randomized, placebo-controlled clinical trial Phase II/III (RISCIS trials, Riluzole in Acute Spinal Cord Injury, NCT01597518): cervical SCI (C4-C8 SCI, ASIA A,B,C). Not enroll because not sensitive thoracic region, 2014.1-current.

Phase III clinical trial in CSM (NCT01257828) 270 pts at 16 centers in North America, 2011.12.-

Minocycline: Second-generation semisynthetic tetracycline (antibacterial agent). Permeate CNS through BBB, longer half-life, compared to tetracycline. Neuroprotective role in reducing posttraumatic neural inflammation, preventing cell death. In ischemic stroke animal model, inhibited microglial activation, pro-inflammatory mediators, which induced apoptosis. In other CNS dis model (MS, SCI, Parkinson's



dis, Huntington's dis, ALS), applied.

In 2003, SCI model first applied. ① reduced apoptotic oligodendrocytes, microglia ② activated microglia/MO density, and corticospinal tract dieback ③ reduced mitochondria release of cytochrome c that activate apoptosis ④ reduced production of proNGF, which promotes oligodendrocyte apoptosis by inhibiting the phosphorylation of p38MAPK

Clinical trial: As a neuroprotective drug, Intra-spinal cord drug availability.

Phase I/II clinical trial in acute SCI pts in 2010 (NCT 00559494), single center, double-blinded, randomized, placebo-controlled study, ASIA, SF-36 at 6,12,26,52 wks after SCI, iv minocycline 7 days, 14 motor score improve in cervical SCI

Phase III in acute cervical SCI (NCT01828203), 2013.6.-2018.6

Phase II/III clinical trial in Israel (NCT01813240), 2013.5.-2015.4.

Rho protein antagonist: Rho is a small intracellular GTPase. Rho GTPases play various roles in neuronal development, apoptosis, cell survival. Rho protein antagonists could have the potential for promoting axonal regeneration and preventing cell death in damage CNS. C3 transferase/ROCK inhibitor block Rho and ROCK function. During secondary phase of SCI, myelin-associated inhibitors (Nogo-A, Omag, MAG) and a glial scar-associated extracellular matrix molecule(CSPG) play crucial roles to prevent axonal regeneration.

Myelin-associated inhibitors bind to NgR → activate GEFs → RhoA is activated → stimulating ROCK signaling.

CSPG bind protein tyrosine phosphatase (PTP δ) → act Rho signaling pathway → ROCK activation → phosphorylated MLC and CRMP2 → myosin-actin binding → actomyosin contraction → growth cone collapse and neurite retraction → contractility and blebbing of cell membrane → cell death

C3 transferase (C3): enzyme from Clostridium botulinum block Rho function by ADP-ribosylation.

In animal model, Axons extended in injured optic n site. Promote axonal regeneration. neuroprotective effect, apoptotic cells reduced. Improved cell-permeable C3 variant (BA-210) developed. because C3 transferase has disadvantage, low cell penetration. BA-210 is absorbed by and within spinal cord parenchyma.

Rho/ROCK inhibitors (C3,fasudil,Y27632,ibuprofen,siRhoA,p21): in experimental SCI, improved locomotor outcome by 21%.

Clinical Trial: Phase I/IIa (using BA-210) (NCT00500812), 2005.2.-2009.2. 48 pts (16 cer, 32 tho) acute, complete SCI underwent spinal surgery within 7 days after injury. 31% in cervical SCI, 6.3% in thoracic SCI, improved from ASIA A to C or better at 12 m after treatment.

At present, double-blind, randomized, placebo-controlled Phase IIb/III clinical trial (NCT02053883) in acute cervical SCI, 2015.7.-2016.5.

Magnesium Chloride within PEG(polyethylene glycol): Mg is a physiologic antagonist of NMDA receptors.

CNS injury → glutamate levels ↑ → overstimulation of NMDA receptors → massive influx Ca²⁺ → cell death. Therefore, Mg can block massive Ca²⁺ influx through NMDA receptors, prevent Ca²⁺-induced cellular damage. Mg protects the blood–spinal cord barrier, attenuate lipid peroxidation/ultrastructural damage → functional recovery. However, human intolerance dosage (300–600mg/kg) in most studies. To solve the problem, Mg–PEG (Medtronic) improved the process of getting Mg from blood to the injured spinal cord without requiring large Mg doses → Neuroprotective, locomotor recovery ↑

Clinical trial: Phase II double–blinded, randomized, placebo–controlled in acute SCI (NCT01750684), 2013.7–2015.6.

Fibroblast growth factor (rFGF2): Rescued motor neurons, reduced acute respiratory deficits by reducing glutamate–mediated excitotoxicity. Molecular mechanism for recovery SCI is not completely defined.

Clinical trial: Phase II multicenter, randomized, double–blinded, placebo–controlled clinical trial (NCT01502631) in acute cervical SCI, 2012.1.–2014.11.

Drugs in clinical trials for SCI

	Phase	Study type	No. of patients	Level of injury	ASIA grade	Age	Hours since injury	Location	Start date	Completion date	Status	NCTID
Riluzole	I	Observational	36	C4-T12	A, B, or C	18 – 70	12	US, Canada	April 2010	June 2011	Completed	00876889
	II/III	Interventional	351	C4-8	A, B, or C	18 – 75	12	US, Canada, Australia	January 2014	December 2018	Recruiting	01597518
Minocycline	VI	Interventional	52	C0-T11	NR	16 or over	12	Canada	June 2004	August 2010	Completed	00559494
	III	Interventional	248	C0-8	NR	16 or over	12	Canada	June 2013	June 2018	Recruiting	01828203
BA-210 (Rho antagonist)	II/III	Interventional	444	NR	NR	18 – 65	NR	Israel	May 2013	April 2015	Not yet recruiting	01813240
	I/IIa	Interventional	48	C4-T12	A	16 – 70	NR	US, Canada	February 2005	February 2009	Completed	00500812
AC105 (magnesium)	IIb/III	Interventional	135	C4-6	A or B	18 – 62	NR	NR	July 2015	May 2016	Not yet recruiting	02053883
	II	Interventional	40	C4-T11	A, B, or C	18 – 65	NR	NR	July 2013	June 2015	Enrolling by invitation	01750684
SUN13837 (FGF2)	II	Interventional	164	C3-8	A, B, or C	A: 16 – 80 B and C: 16 – 70	12	US, UK, Canada, Czech Republic, France, Poland, Spain	January 2012	November 2014	Recruiting	01502631

AIS: ASIA impairment scale, ASIA: American spinal injury association, NCT: National clinical trial, NR: Not registered

이 장 보

Department of Neurosurgery
Korea University Anam Hospital



Academic Education

- 1995 M.D. Korea University, Medical College
- 1991 M.S. Korea University, Graduate School
- 2004 Ph.D. Hokkaido University, Graduate School, Japan

Research & Professional Experience

- 2001–2004 Research Fellow, Department of Neurosurgery, Hokkaido University, Japan
- 2004–2007 Instructor, Department of Neurosurgery, Korea University Anam Hospital
- 2008–2010 Postdoctoral Fellow, Spinal Cord Injury Lab, University of Toronto, Canada
- 2007–2010 Assistant Professor, Department of Neurosurgery, Korea University Anam Hospital
- 2011–present Associate Professor, Department of Neurosurgery, Korea University Anam Hospital

Research Interest

- Spinal cord injury with neuroprotection
- Spinal cord injury with stem cells
- Cervical Spondylotic Myelopathy with animal model, Apoptosis

Award

- 2010 Cervical Spine Research Society 3rd Place Basic Science Research Paper

Academic Society

- 2014–Present The Korean Neuro–Pain Society, Director of Research Board
- 2014–Present The Korean Spinal Neurosurgery Society, Director

Recent Update of pathophysiology of Degenerative Cervical Myelopathy

Jang-Bo Lee

Department of Neurosurgery, Korea University Anam Hospital

Although surgical decompression is considered the gold standard treatment for cervical spondylotic myelopathy (CSM), a proportion of cases show postoperative decline or continue to exhibit substantial neurological dysfunction. To investigate this further, we first examined data from the prospective multicenter AOSpine North America CSM study, finding that 9.3% of patients exhibited postoperative functional decline (Δ mJOA, ≤ -1) and that 44% of patients were left with substantial neurological impairment 6 months postoperatively. Notably, 4% of patients experienced perioperative neurological complications within 20 days after surgery in otherwise uneventful surgeries. To shed light on the mechanisms underlying this phenomenon and to test a combination therapeutic strategy for CSM, we performed surgical decompression in a rat model of CSM, randomizing some animals to also receive the U.S. Food and Drug Administration–approved drug riluzole. Spinal cord blood flow measurements increased after decompression surgery in rats. CSM rats showed a transient postoperative neurological decline akin to that seen in some CSM patients, suggesting that ischemia–reperfusion injury may occur after decompression surgery. Riluzole treatment attenuated oxidative DNA damage in the spinal cord and postoperative decline after decompression surgery. Mechanistic *in vitro* studies also demonstrated that riluzole preserved mitochondrial function and reduced oxidative damage in neurons. Rats receiving combined decompression surgery and riluzole treatment displayed long–term improvements in forelimb function associated with preservation of cervical motor neurons and corticospinal tracts compared to rats treated with decompression surgery alone.

Cervical spondylotic myelopathy (CSM) is the commonest cause of spinal cord impairment worldwide and despite surgical treatment, it is commonly associated with chronic neuropathic pain and neurological impairment. Based on data suggesting a key role of sodium and glutamate mediated cellular injury in models of spinal cord compression, we examined whether riluzole, a sodium channel/glutamate blocker, could improve neurobehavioral outcomes in a rat model of CSM. To produce chronic progressive compression of the cervical spinal cord, we used an established model of graded mechanical cord compromise developed.

2017. **9.16** (Sat.)



Free Paper II

Osteoporosis / Aging / Tumor

좌장 : 수원월스기념병원 **박춘근**, 순천향대 **장재철**

요부의 퇴행성 질환을 가진 여성의 요부 신전 근육의 크기와 등척성 근력의 특징

서용곤¹, 박원하¹, 이종서¹, 강경중²

¹삼성서울병원, ²경희대학병원

PURPOSE : To find out the characteristics of lumbar extensor muscle size and isometric muscles strength and examine their correlations in women with lumbar degenerative diseases

MATERIALS AND METHODS : Between 2007 and 2009, 74 female patients, who consecutively underwent posterior lumbar interbody fusion (L1~S1) due to lumbar degenerative disease, were recruited and data was prospectively collected before surgery. Mean age was 66 years (range, 46~72). Cross-sectional area (CSA) of back extensor muscle was measured at 5 intervertebral disc level between L1-2 to L5-S1 and total sum of CSA of back extensor muscle at each disc level was calculated. Back extensor muscle strength was evaluated by measuring isometric strength using a MedX lumbar instrument at 7 angular positions (0, 12, 24, 36, 48, 60, 72°). Oswestry Disability Index (ODI, 0~100) and visual analogue scale (VAS, 0~10) of back pain were checked. Body composition parameters (body weight and body mass index (BMI)) were also obtained. Comparison and correlation analyses among these variables were performed

RESULTS : Mean CSAs of lumbar extensor muscle at each level (L1-2 ~ L5-S1) and total sum were 34.3, 36.3, 35.1, 31.4, 21.9, and 156.2 cm², respectively. Mean isometric strengths at each angle (range, 0 ~ 72°) were 32.5, 50.1, 72.0, 88.7, 100.7, 112.2, and 126.2 ft-lb, respectively. Mean ODI and VAS were 54.6 and 6.6 and mean body weight, BMI were 59.9 kg, 24.9 kg/m², respectively. The CSAs of upper lumbar level (L1-4) and total sum CSAs were associated with isometric strengths, especially at mid lumbar flexion angles (24~48°). The isometric strengths were negatively correlated with patients' age and ODI and positively associated with body weight and BMI mainly at higher lumbar flexion angles (48~72°)

CONCLUSION : In women with lumbar degenerative disease, lumbar extensor muscle sizes of upper levels (L1-4) were larger than those of lower levels (L4-S1) and were positively associated with muscle strengths. The upper levels in patients with lumbar degenerative diseases seem to play a compensatory role when the lower lumbar levels have degenerative lesions.

The effect of biocomposite screws on bone regeneration in a rat osteoporosis model

정 제 훈, 임 수 빈

순천향대학교 부천병원

PURPOSE : The aim of this study was to evaluate the efficacy of biocomposite screws used in ovariectomy (OVX) induced osteoporotic rats.

MATERIALS AND METHODS : Twenty-four female Wistar rats (250–300g, 12 weeks old) were divided into 4 groups; Sham group (control), OVX-induced osteoporosis group (OVX), OVX and biodegradable (PLGA (poly-lactic-co-glycolic acid) without β -TCP (tricalcium phosphate) screw insertion group (OVX/BSR), OVX and biocomposite (PLGA with β -TCP) screw insertion group (OVX/CSR). Three groups underwent bilateral OVX and of these, two groups had two different types of screw inserted at the proximal tibia. At 25 weeks after OVX, the bilateral tibiae were extracted. The extracted tibiae were scanned by exo-vivo micro-CT and were evaluated by H&E and Masson's trichrome stain for pathological assessment.

RESULTS : The control group had the highest values of bone mineral density (BMD), bone volume(BV)/total volume(TV), and trabecular number (Tb.N) and the lowest values of trabecular thickness (Tb.Th) and trabecular separation (Tb.Sp) compared to the ovariectomized groups. In the pairwise comparison between ovariectomized groups, OVX/CSR group showed significantly higher BMD, BV/TV and Tb.N than the other two groups (OVX and OVX/BSR) and significantly lower Tb.Sp. In micro-CT images, there was clear evidence of new trabecular formation near the screw insertion site in the OVX/CSR group only. Analyses of H&E and Masson's trichrome stained sections showed more and thicker trabecular bone around the implant in the OVX/CSR group compared to the OVX and OVX/BSR group.

CONCLUSION : Biocomposite screws can improve local bone quality and facilitate osteoconductivity in an osteoporotic rat model.

근감소증 변수 및 척추근퇴행과 시상균형매개변수와의 관계

고 명 진¹, 김 영 백¹, 이 상 윤², 박 승 원¹

¹중앙대학교병원, ²서울대학교보라매병원

PURPOSE : Sarcopenia on lumbar paraspinal muscles (LPM) is receiving renewed attention as a cause of spinal sagittal imbalance. However, the correlations between sarcopenic variables and SSB have not been investigated thoroughly. This study aimed to delineate the relationships between conventional sarcopenic variables and spinal sagittal balance (SSB) indices.

MATERIALS AND METHODS : The medical records of 203 consecutive patients with current low back pain were retrospectively reviewed. Demographic variables, conventional sarcopenic indices, spinopelvic parameters of SSB including the ratio of lumbar lordosis (LL) to pelvic incidence (PI), PI-LL mismatch, isokinetic back muscle strength, and lumbar spine computed tomography (CT) scan with LPM cross-sectional area (CSA) and density assessments were examined. The independent effects of sarcopenic variables for SSB were determined by multivariable regression analysis, adjusted for age, sex, appendicular skeletal muscle mass, gait speed, hand grip strength, back extensor strength, and CSA/density of LPM using spine CT.

RESULTS : Age, appendicular skeletal muscle mass, gait speed, hand grip strength, and back extensor strength were significantly correlated with SSB and CSA/density of LPM on CT. However, the independent factors related to both LL/PI and PI-LL were LPM CSA ($\beta = -0.384$; $P < 0.001$ and $\beta = -0.347$; $P = 0.001$, respectively), and gait speed ($\beta = -0.206$; $P = 0.034$ and $\beta = -0.209$; $P = 0.035$, respectively) in multivariate regression models ($R^2 = 0.242$ and $R^2 = 0.205$, respectively).

CONCLUSION : Our data suggest that both LPM CSA and gait speed play an important role in maintaining SSB.

요추체간 유합술에서 골 충전재로서의 탈회골기질 (DBM) : DBM 과 자가골의 동시 이식술을 통한 전향적 비교 연구

김 범 준, 진 성 원, 김 원 형, 이 승 환, 이 해 빈, 김 세 훈

고려대의료원 안산병원

PURPOSE : Solid bone fusion is an essential process in spinal stabilization surgery. Recently, as several minimally invasive spinal surgeries have developed, a need of artificial bone substitutes such as demineralized bone matrix (DBM), has arisen. We investigated the in vivo bone growth rate of DBM as a bone void filler compared to a local autologous bone grafts.

MATERIALS AND METHODS : From April 2014 to August 2015, 20 patients with a one or two-level spinal stenosis were included. A posterior lumbar interbody fusion using two cages and pedicle screw fixation was performed for every patient, and each cage was packed with autologous local bone and DBM. Clinical outcomes were assessed using the Numeric Rating Scale (NRS) of leg pain and back pain and the Korean Oswestry Disability Index (K-ODI). Clinical outcome parameters and range of motion (ROM) of the operated level were collected preoperatively and at 3 months, 6 months, and 1 year postoperatively. Computed tomography (CT) was performed 1 year after fusion surgery and bone growth of the autologous bone grafts and DBM were analyzed by ImageJ software.

RESULTS : Eighteen patients completed 1 year of follow-up, including 10 men and 8 women, and the mean age was 56.4 (32-71). The operated level ranged from L3/4 to L5/S1. Eleven patients had single level and 7 patients had two-level repairs. The mean back pain NRS improved from 4.61 to 2.78 ($p = 0.003$) and the leg pain NRS improved from 6.89 to 2.39 ($p < 0.001$). The mean K-ODI score also improved from 27.33 to 13.83 ($p < 0.001$). The ROM decreased below 2.0 degrees at the 3-month assessment, and remained less than 2 degrees through the 1 year postoperative assessment. Every local autologous bone graft and DBM packed cage showed bone bridge formation. On the quantitative analysis of bone growth, the autologous bone grafts showed significantly higher bone growth compared to DBM on both coronal and sagittal images ($p < 0.001$ and $p = 0.028$, respectively). Osteoporotic patients showed less bone growth on sagittal images.

CONCLUSION : Though DBM alone can induce favorable bone bridging in lumbar interbody fusion, it is still inferior to autologous bone grafts. Therefore, DBM is recommended as a bone graft extender rather than bone void filler, particularly in patients with osteoporosis.

퇴행성 요추부 측만증의 전방접근법을 통한 수술적 치료

조 대 진

강동경희대학교병원 신경외과

PURPOSE : There are increasing numbers of patients with adult scoliosis with an aging society, and recently various surgical methods have been attempted. There are no clear guidelines about surgical procedures.

There is little literature on anterior approach and staged operation for adult scoliosis correction operation. We have mostly performed anterior approach and staged operation. So we analyzed the results of adult degenerative scoliosis using anterior approach to evaluate the relative merits of this method.

MATERIALS AND METHODS : Retrospective study of Degenerative Lumbar Scoliosis(DLS), Degenerative KyphoScoliosis(DKS) patients undergoing surgery.

A total of 30 patients was enrolled. The 14 ALIF and 16 Oblique ALIF were performed on them. Clinical and radiographic coronal and sagittal parameters were analyzed.

RESULTS : Most patients were women(M:F=6:24). Mean baseline age were 69.2 years. There are 22 patients in the DLS group and 8 patients in the DKS group. Three complications have been reported. One is post operation superficial wound infection. One case of a rod fracture at osteotomy site. And another case is proximal junctional problem. We performed anterior approach and staged procedure(Posterior-Anterior-Posterior) in most patients, using Oblique ALIF and ALIF technique. And we used DLIF cages of various angles(4,12,16 degree). As the angle of the DLIF cage increased from 4 to 16, lordosis equivalent to ALIF was obtained.

CONCLUSION : The anterior approach for lumbar interbody fusion in DLS, DKS patients also has good surgical results. Oblique ALIF has several advantages over conventional ALIF. First, the anterior tension band structure can be maintained. Second, whole lumbar (5 level) fusions that including L1-S1, are available, and third, it is more advantageous than ALIF for convex side correction. Fourth, there is an advantage that the L5-S1 approach is possible even if the vessel anomaly is present. Finally, there is an advantage over ALIF in anterior revision.

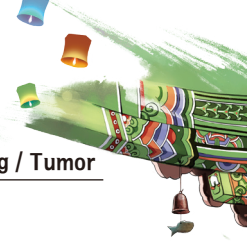
신경공 경우 추체간 유합술후 케이지 이동 및 후방탈출의 위험인자: 골다공증이 위험도를 높이는가?

박 만 규, 김 경 태, 조 대 철, 성 주 경

경북대학교병원 신경외과

PURPOSE : Transforaminal lumbar interbody fusion (TLIF) using cage is an effective treatment for patients with degenerative lumbar spine diseases. Although TLIF is a widely accepted, postoperative complications occur. A frequent cause of implant failure is cage migration (CM). CM may lead to progressive spinal deformity and narrowing of the disc space, thus preventing successful fusion. A more serious complication is cage retropulsion (CR) because the migrated cage can exacerbate neurological deficits. Because of poor outcomes, it is important to identify related risk factors. However, most previously identified risk factors did not reach statistical significance, perhaps because of insufficient sample size. As the population ages, the number of patients with osteoporosis is increasing. Any correlation with osteoporosis is significant since it potentially affects mechanical cage support. In particular, we focused on osteoporosis and surgical risk factors, which has not been adequately analyzed.

MATERIALS AND METHODS : Between January 2011 and December 2015, 784 patients had a total of 881 levels treated with TLIF at 3 spinal surgery centers. Patients were divided into two groups according to whether or not they experienced CM. Our study classified cage migration (CM) into two subgroups: intradiscal cage migration (ICM) or cage retropulsion (CR), according to the degree of cage involvement of the spinal canal. Migration of a cage within the intervertebral space was defined as ICM. CR was defined as the movement of the posterior margin of the cage into the spinal canal. Multiple factors were reviewed for each patient, including demographics, spinal diagnosis, fusion level, and cage insertion level. Postoperative X-ray was done at 1, 3, 6, 9, 12, 18 months, and we evaluated the fusion rate at 1.5 years postoperatively by computerized tomography (CT). ROM, disc height were measured with preoperative radiographs and CT. We defined a pear-shaped disc as one that had a convex surface on the posterior halves of the superior and inferior vertebral disc end plates, and a concave surface on the anterior halves of the end plates. We evaluated the positioning of the cage, the cage number (unilateral single vs. double), and the pedicle screw depth on postoperative radiography. We examined surgical records to determine the type of cage employed at surgery, the cage angle and any endplate injury which



occurred. Cage position was classified as either anterior or posterior based on its relation to the midpoint of the vertebral body. To analyze pedicle screw depth, we divided the vertebral body into 4 parts, starting from the posterior vertebral body margin. A parameter, obtained by subtracting preoperative disc height from cage height, was defined as “cage height minus disc height”. By comparing preoperative and postoperative lateral radiographs, we measured a “listhesis correction angle”, that was obtained by subtracting the postoperative listhesis angle from the preoperative listhesis angle.

RESULTS : In our study of 784 patients, out of the 881 levels treated with TLIF, there were 56 instances of CM (6.4%). Of the 56 levels with CM, 17 levels (1.9%) were designated as CR. Of the 17 patients with CR, 10 patients complained of radicular pain and 4 patients required revision surgery. For CM, 18 of 56 levels showed osteoporosis (32.1%, $P < 0.0001$), and for CR, 9 of 17 levels had osteoporosis (52%, $P < 0.0001$). In multivariate analysis, osteoporosis showed statistical significance as a risk factor for both CM (OR 5.72, $P < 0.0001$) and CR (OR 7.86, $P = 0.0003$). Pear-shaped disc was significantly associated with both CM, occurring in 10 of 56 (17.9%, $P = 0.001$) and CR, seen in 7 of 17 (41.2%, $P < 0.0001$), compared to 51 of 825 levels without CM (6.2%). In multivariate analysis, a pear-shaped disc was associated with CM (OR 6.83, $P = 0.0019$) and CR (OR 8.28, $P = 0.0011$). Endplate injury occurred more frequently in CM, where it was seen in 29 of 56 levels (51.8%, $P < 0.0001$), and the CR, where it was seen in 12 of 17 levels (70.6%, $P < 0.0001$).

Endplate injury was a significant risk factor for both CM (OR 14.94, $P < 0.0001$) and CR (OR 18.70, $P < 0.0001$) in multivariate analysis. The posterior position of cage was not a significant factor in CM, but a significant factor in CR (OR 6.45, $P = 0.0414$). Unilateral single cage was present more frequently in levels with CM, occurring in 13 of 56 levels (23.2%). In multivariate analysis, unilateral single cage was a significant risk factor for both CR (OR 4.40, $P = 0.0332$) and CM (OR 2.42, $P = 0.0178$). The initiation of CM was found in 35 (62.5%) within 0–1 months, 20 (35.7%) within 1–3 months within 3–6 months after surgery. The termination of CM was detected in 24 (42.8%) within 1–3 months, 30 (53.6%) within 3–6 months. A difference in fusion rates was identified, there was a statistically significant difference between no CM and CM (97.1% vs 46.4%; $p < 0.0003$). Also, comparison of no CM and CR revealed a significant difference (97.1% vs 17.6%; $p < 0.0001$).

CONCLUSION : Our findings suggest the following significant risk factors for CM and CR 1) osteoporosis, 2) pear-shaped disc shape, 3) endplate injury, and 4) single cage. Additionally, 5) posterior position of cage could be risk factor in CR. One strength of this study is our use of multivariate analysis to identify risk factors for CM and CR, in contrast to other studies. By discussing all of the demonstrated risk factors, we hope to aid in the prevention of these complications. Moreover, we wish to stress the significance of surgical risk factors, such as single cage, posterior cage position and endplate injury, which may be preventable. We recommend techniques to prevent CM and/or CR in performing TLIF 1) Surgeons need to check the BMD and pear-shaped disc before TLIF 2) The cage should be inserted in anterior location without damaging the bony endplates and 3) The use of a double cage would be better, especially in patients who have potential risk factors, such as osteoporosis and pear-shaped disc.

척추외과 의사 의료용 캐드(CAD) 프로그램을 직접 활용하여 시행한 척추종양 제거수술의 수술 전 가상시뮬레이션

이정환¹, 김동하², 최병관¹, 남경협¹, 이치승¹, 한인호¹

¹부산대학교병원, ²양산부산대학교병원

PURPOSE : As medical computer-aided design (CAD) has improved, virtual three-dimensional (3D) medical images have been gaining more easily without any special practice. These images can be applied to various clinical fields. This article illustrates virtual preoperative simulation for excision of spinal tumors using medical CAD software.

MATERIALS AND METHODS : Mimics® 17.0 (Materialise NV, Leuven, Belgium) software was used for image editing and visualization. CT scans were imported into Digital Imaging and Communications In Medicine (DICOM) format. Reconstructed surgical field were rotated at various angles to find proper approaches for surgery. The organs covering the tumor could be hidden to confirm the surgical steps required for tumor removal. And, the tumor also was hidden for confirmation of surrounding structures after totally tumor removal.

RESULTS : Two cases are reported : large schwannoma of the sacrum and malignant peripheral nerve sheath tumor of the thoracic spine. Virtual preoperative planning was successfully performed. The software was used directly by the surgeon. During the actual surgery, each surgery proceeded as planned, and excision of the tumor was successful.

CONCLUSION : The process of virtual preoperative simulation for spinal tumor surgery was found to be not inordinately complicated. And, virtual simulation was helpful in determining surgical steps as well as understanding the surgical anatomy.

척수종양 수술에서 MEP와 D-WAVE의 신경감시 비교

강 지 인, 이 성, 윤 도 흠, 김 금 년, 하 윤, 신 동 아

연세대학교 신경외과학교실

PURPOSE : To evaluate the feasibility and the accuracy of D-wave monitoring in spinal cord tumor surgery comparing to motor evoked potential(MEP) monitoring.

MATERIALS AND METHODS : From March, 2016 to May, 2017, 24 cases of spinal cord tumor (intradural tumor) were monitored MEP and D-wave simultaneously. No musculoskeletal blocker was used except anesthetic induction. Real time monitoring was undergone during operation. Each proportion of successful measuring was represented to monitorability. Measured significant wave changes of amplitude and frequency of each modality were collected and transcribed to abnormal or not. Also reports of abnormality of each modality were compared with patients' real neurologic deficit during immediate post-operation and discharge using McCormick scale. We analyzed MEP and D-wave immediately after tumor removal and MEP and D-wave after dural repair.

RESULTS : Monitorability was 95.83% in MEP (23 successes of 24) and 83.33% in D-wave (20 successes of 24). However, D-wave has higher specificity, positive predictive values of 100% than MEP. Also in univariate study, D-wave has significant difference in the change of McCormick scale after immediate post-operation, ($p=0.033$) By the way, 1month follow up of McCormick scale after operation is not statistically significant with D-wave and MEP. ($p=0.152$ vs $p=0.754$)

CONCLUSION : D-wave showed higher positive predictive value and specificity compared to MEP. There was no difference in the predictive value of the neurological symptoms of the patient 1 month later.

Microsurgery vs Endovascular ; which is adequate for initial treatment of spinal dural AVF?

허 연¹, 이 덕 희², 서 대 철², 안 재 성¹, 임 승 철¹

¹울산대학교 서울아산병원 신경외과, ²울산대학교 서울아산병원 영상의학과

PURPOSE : Spinal dural AVF is a rare disease entity and diagnosis is also very difficult: the lesion is very small and complex, and the angioarchitecture is very diverse; also spinal angiography is technically challenging. For this reason, various classification has been reported since 1960's and have changed over time in the literature. Study on the factor affecting the outcome of treatment was also insufficient. Endovascular treatment of spinal AVF has been established as a primary treatment in most of the institutes due to the development of the endovascular technique, but it has been reported in several articles that the outcome is lower than microsurgery. The purpose of this study is to analyze the outcome of endovascular treatment and microsurgical treatment of spinal AVF and to identify the factors affecting the outcome, and to present a guideline for determining the treatment modality.

MATERIALS AND METHODS : We performed a retrospective analysis of a consecutive series of spinal AVF patients who presented to our institution from January 2004 to June 2017. Total 41 patients were treatment as spinal dural AVF. Modality of treatment (microsurgical or endovascular), clinical variable (age, sex, clinical presentation, clinical outcome) and angiographic feature of AVF (classification, feeder location, number of feeders, diameter of feeder, location of most proximal site of intradural radiculomedullary vein, presence of retrograde flow, presence of collateral flow to fistula, drainage system) were recorded. Also any event during operation was recorded and complication associated with procedure was recorded. Clinical outcome was analyzed by gait disturbance and micturition using Aminoff and log scale score of disability. Radiological follow up was performed through spinal angiography or spinal MR after the treatment. Neurological improvements and disappearance of cord swelling and engorged perimedullary veins in MRI were indicative of fistula closure without recurrence. Patients with clinical deterioration or suspected recurrence on spine MRI or angiographic were reclassified and recorded for secondary treatment modality.

RESULTS : Among 41 patients with spinal dural AVF, 34 patients underwent embolization as initial treatment, 4 patients underwent microsurgical ligation as initial treatment, and 3 patients refused



treatment. In patients who underwent primary embolization, embolization was aborted in 8 patients, partial treatment with residual fistula in 10 patients, and complete occlusion in 16 patients but 5 of them confirmed recurrence in a follow up study. Among the patients who failed initial treatment, 6 patients underwent embolization as secondary treatment, and only half of them were successful in the treatment. 9 patients underwent microsurgery as secondary treatment and all patients were able to identify complete occlusion of the fistula. Also all four patients who underwent microsurgery as initial treatment had complete fistula occlusion. Finally, the initial success rate of endovascular treatment in spinal dural AVF is 40.6% and the secondary success rate is 50%. On the other hand, the initial and secondary success rate of microsurgical treatment is 100%. In the clinical outcome as well as in the radiological outcome, residual fistula or recurrence was found to be associated with poor prognosis ($p=0.017$). In the analysis of factors related to primary treatment failure, the diameter of feeder ($p=0.010$), presence of retrograde flow ($p=0.015$), presence of collateral flow to fistula ($p=0.049$), site of embolization (artery only, artery + vein)($p=0.008$) were found to be statistically significant. There were no surgical complications in the microsurgical treatment group. However, of the patients who underwent endovascular treatment, minor complications such as arterial tear or endothelial injury occurred in 4 patients and posterior spinal artery territorial infarction occurred in 1 patient.

CONCLUSION : Endovascular treatment is preferred, because it is safe and non-invasive. However, microsurgical treatment has a superior clinical and radiologic outcome in the treatment of spinal dural AVF and is safe in treatment related complications. In particular, it is recommended that microsurgical treatment be considered first in cases which endovascular treatment is likely to fail ; narrow diameter of feeder, presence of retrograde flow or collateral flow.

골다공증이 케이지 단독 전방유합술후 임상적 영상학적 결과에 미치는 영향

박재영, 이정길, 문봉주, 김상덕

전남대학교병원 신경외과

PURPOSE : The purpose of this retrospective study is to compare clinical and radiological outcomes of patients having osteoporosis or not, who underwent stand-alone anterior cervical discectomy and fusion

MATERIALS AND METHODS : One hundred fourteen consecutive patients who underwent single-level stand-alone ACDF with a PEEK cage between 2005 and 2016 were included. Osteoporosis was based on T-score and $T < -2.5$ was defined as osteoporosis. Patients were divided into the osteoporosis and non-osteoporosis groups. And osteoporotic patients were divided into the treated and no treated groups again. Treatment included oral activated vitamin D 800 IU/day, calcium 1200 mg/day, and diphosphonate. factors were investigated in relation to the occurrence of subsidence and fusion: age, preoperative overall cervical sagittal angle, segmental angle of the operated level, interbody height, cage height, cage location (distance between anterior margin of the body endplate and that of the cage).

RESULTS : There were significant differences at final follow-up between the 2 groups in segmental angle ($p=0.01$), interbody height ($p=0.02$)

CONCLUSION : Osteoporosis affected at radiological outcome following stand alone anterior cervical discectomy and fusion

한국 노인의 척추 시상면 불균형과 관련된 관련된 직업: 농부

문봉주¹, 류달성², 김병우³, 오재근⁴, 하윤⁵, 윤승환², 이정길¹, 김금년⁵, 진동규⁵

¹전남대학교병원, ²인하대학교병원, ³삼포도나무병원, ⁴한림대학교병원, ⁵연세대학교

PURPOSE : A sagittal imbalance disease, was first described by Takemitsu et al, and is caused by unique life styles such as the prolonged crouched posture during agricultural work and performing activities of daily living on the floor. Previous papers reported that sagittal imbalance disease was frequent only in the farming districts of ‘oriental’ countries such as Korea and Japan. However, previous papers evaluated using x-ray not other factors such as MRI, muscle volume, compression fracture, laboratory results and etc. Therefore we evaluate the agriculture work associated factors for Korean elderly spinal sagittal imbalance using other factors as mentioned.

MATERIALS AND METHODS : We recruited 103 Korean participants who had more than SVA 5cm in Korean Elderly Sagittal Imbalance Cohort Study. We evaluated the radiological parameters, MRI, compression fracture, vitamin D, PTH, CTX, osteocalcin, BMD and muscle fatty change, muscle volume, and health related quality of life (HRQOL) from patients survey. We analyzed the associated factors of spinal sagittal imbalance depending on occupation.

RESULTS : Seven among 103 participants excluded because they refused MRI. Forty six participants were farmers and the others (50) were housewives, sellers and office workers. Farmer group and non-farmer group were dichotomized. The farmer group had more SVA(141mm vs. 99mm, P=0.001), more PT(31 vs. 24 degrees, P=0.004), lesser LL (20 vs. 30 degrees, P=0.009)and lesser TK(24 vs. 33 degrees, P=0.03) than non-farmer group. BMI, BMD, Muscle fatty change and Muscle volume were not different between two groups. Back VAS (8.26 vs 6.96, P=0.008) and ODI (23.5 vs. 19.1, P=0.003) in farmer group were higher than in non-farmer group although SF-36 is not different in two groups. Cholesterol, HDL, HbA1c, Vitamin D, PTH, CTX, and osteocalcin had no difference between two groups.

CONCLUSION : Farmer group had more sagittal imbalance and more back pain; higher back VAS and ODI even though muscle factors, bone factors, and general laboratory condition were not different between farmer group and non-farmer group. These results supported the long hours spent in the crouched posture while performing agriculture work was a risk factor for severe sagittal imbalance.

경수 신경병증 수술 이후 중등도 이상의 요통의 변화

정종명¹, 정천기¹, 최윤희²

¹서울대학교병원 신경외과, ²서울대학교병원 의학협력센터

PURPOSE : Sometimes, patients with cervical myelopathy have concurrent moderate to severe low back pain (msLBP). However, a natural course of msLBP after surgery for cervical myelopathy was rarely reported. If we are aware of the postoperative change in msLBP after surgery for cervical myelopathy, unnecessary lumbar surgery could be reduced. The primary object of the present study was to show postoperative change in concurrent msLBP.

MATERIALS AND METHODS : Patients with cervical myelopathy and msLBP (visual analogue pain score $\geq 5/10$) were prospectively screened, with 53 patients (M:F=28:25; mean age, 63.1 years) enrolled. Cervical laminoplasty was performed in 49 patients, and anterior cervical discectomy and fusion was in 4. Moderate to severe lumbar spinal stenosis (msLSS) was combined in 20/53 patients. The severity of cervical myelopathy was assessed using the Japanese Orthopedic Association score (JOA). The patients were followed up at postoperative 1, 3, 6, 12 months and yearly thereafter. The primary endpoint was improvement of visual analogue pain score on back pain more than 2.6/10. Follow-up period was mean 14 ± 6 months.

RESULTS : JOA was significantly improved after cervical spinal surgery. The change of msLBP was fluctuated; improvement was observed in 31/53 (58%), 26/53 (49%), 28/53 (53%) and 25/53 (47%) patients at postoperative 1, 3, 6 and 12 months, respectively. Lumbar decompression operation was performed in 5 patients at postoperative 4, 6, 7, 15 and 16 months. No case showed aggravation of msLBP compared to pre-operation. Patients with msLSS showed improved msLBP in 50% (10/20) of patients at postoperative 12 months.

CONCLUSION : Staged surgery may be recommendable because improvement of msLBP was expectable in 50% of patients after surgery for cervical myelopathy.

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Free Paper I

Minimal Invasive Surgery

좌장 : 서울대 장태안, 한림대 조용준

Can the biportal endoscopic surgery achieve enough canal decompression for degenerative lumbar stenosis? Prospective case control study

홍 현 진, 박 준 근

울스기념병원 신경외과, 척추센터

PURPOSE : Unilateral laminotomy with bilateral decompression (ULBD) was widely accepted surgical treatment for lumbar degenerative canal stenosis. Recently, minimally invasive full endoscopic ULBD have been attempted instead of microsurgery. Although favorable postoperative outcomes of percutaneous endoscopic lumbar decompression has been presented, there were no reports of postoperative radiologic outcomes; whether endoscopic decompressive surgeries can achieve enough canal decompression or not.

The purpose of this study is to investigate the radiologic outcome of percutaneous unilateral biportal endoscopic (UBE) decompression comparing to conventional microscopic decompressive surgery. Also, we additionally studied clinical results of percutaneous UBE decompression.

MATERIALS AND METHODS : The study design was a case control study. Since March 2016, we had prospectively performed microscopic ULBD in 56 patients and percutaneous UBE decompression in 67 patients. Patients were classified into two groups by operation methods (microscopic group and UBE group). Only patients who were followed more than 6 months after operations were enrolled.

The area of dura was measured by an automatic area calculation program of PACS systems. The preoperative and postoperative dura areas were measured at six axial cuts of T2 weighted MR images. The degree of postoperative dura expansion was calculated by difference between postoperative and preoperative dura area.

We analyzed clinical parameters such as visual analogue scale (VAS) of back and leg pain, Oswestry disability index (ODI), and perioperative complications. Radiologic and clinical outcomes were analyzed by two investigators without any information of surgery. Radiologic and clinical outcomes were compared between two groups (microscope group and UBE group).

RESULTS : Finally, 88 patients were enrolled in this study. There were 42 patients of microscope group and 46 patients of UBE group. The mean follow-up period was 8.5 ± 4.3 months. Postoperatively, dura was significantly expanded in each group ($P < 0.05$). And there was no difference of dura expansion between two groups ($P > 0.05$). VAS and ODI were significantly improved after surgery in each two

groups ($P < 0.05$). Immediate postoperative pain score was significantly higher in microscope group rather than in UBE group ($P < 0.05$). There was no significant difference in the incidence of perioperative complications such as epidural hematoma and durotomy between two groups ($P > 0.05$).

CONCLUSION : The results of this study demonstrate that the full-endoscopic ULBD using biportal endoscopic approach may be a safe and effective treatment for the lumbar stenosis and an alternative to the conventional microsurgical technique. We were able to perform enough canal decompression using UBE technique similar to microscopic surgery. At the same time, it offers the advantages of a minimally invasive intervention. However, we need long-term follow-up and a more detailed study for more accurate results of this technique.

요추 1번-5번 측방경유요추체간유합술 (DLIF)과 사측방경유요추체간 유합술 (OLIF)의 영상의학적 결과에 관한 케이지 (cage)의 의의

고 명 진, 김 영 백, 박 승 원

중앙대학교병원

PURPOSE : Direct lateral lumbar interbody fusion (DLIF) and oblique lumbar interbody fusion (OLIF) which are lateral approach techniques using a same cage have been popularized for treatment of degenerative lumbar spine diseases.

There have been many studies on lumbar spine angles after lateral lumbar interbody fusion. However, few studies have directly compared it after undergoing DLIF and OLIF.

In this study, we compared the various clinical and radiological parameters after undergoing DLIF and OLIF, and investigated the factors influencing them.

MATERIALS AND METHODS : Total of 343 consecutive patients who underwent DLIF or OLIF at L1-L5 between May 2011 and December 2016 by a single surgeon were retrospectively reviewed. Patients with severe spinal deformities, acute traumatic fracture, spinal metastasis, infectious spondylitis, and a history of previous lumbar fusion operations were excluded. Patients underwent fusion operation at L5-S1 level were also excluded.

We performed DLIF from May 2011 to August 2014, and OLIF from September 2014 to December 2016. Until July 2013, 12-degree cage was not available in Korea, so only 6° cage was used. After that, 6° and 12° cages were used together. We divided patients into three groups according to the techniques and cage types: DLIF with 6° cage (Group A), DLIF with 6° and 12° cages (Group B), and OLIF with 6° and 12° cages (Group C).

We measured segmental sagittal angle (SSA), segmental coronal angle (SCA), mean disc height (MDH), intervertebral foramen height (FH), cage location (CLo), cage subsidence (CSb), and fusion rate on plain radiography.

We assessed clinical outcomes by using visual analog pain scale (VAS) and Oswestry disability index (ODI).

In each group, we compared the radiological and clinical outcomes using paired t-test or Wilcoxon rank-sum test. In among groups, we compared those using Kruskal-Wallis test, and Mann-Whitney

test as post hoc test for the statistically significant factors in the Kruskal–Wallis test. In addition, we compared fusion rate using chi-square test and chi-square test as post hoc test. Furthermore we conducted multiple regression analysis about significantly different factors.

All analyses were performed using SPSS 18.0 (IBM Corp., Armonk, NY, USA). A p-value of <0.05 was considered statistically significant except in post hoc test. A p-value of <0.017 was considered statistically significant in post hoc test.

RESULTS : 129 patients with DLIF and 84 patients with OLIF met inclusion and exclusion criteria. The number of patients in Group A, B, and C was 91, 38, and 84, respectively. Among 3 Groups, there were statistically significant differences in cage angle (CA, degree, $p<0.001$) and CLo ($p<0.001$). The mean CA was the largest in Group B (12°), followed by Group C (9.6°) and Group A (6°). The CLo of Group C was the most anterior, followed by Group B, Group C.

In all Groups, postoperative 7 days after (Postop) and postoperative 1 year after (1YA) – MDH, FH, and SSA were significantly increased compared to preoperative (Preop) and SCA was significantly decreased ($p < 0.001$). In comparison between the 3 Groups, there were significant differences in difference Preop and Postop (D)–FH ($p < 0.001$) and D–SSA ($p < 0.001$). D–FH was larger in Group A than Group B and C, and there was no difference between Group B and C. D–SSA was significantly larger in Group B and C than Group A, and there was no difference between Group B and C. Multivariate regression analysis was performed for D–FH and D–SSA in relation to CLo and CA. There was a significant correlation between D–FH and CLo ($B=5.126$, $p < 0.001$) and CA ($B=-0.305$, $p < 0.001$), and D–SSA was also correlated with CLo ($B=-18.271$, $p < 0.001$) and CA ($B=0.168$, $p=0.039$).

In comparison between the 3 Groups, there were significant differences in Postop–CSb ($p < 0.001$), 6MA–CSb ($p < 0.001$), and 1YA–CSb ($p < 0.001$). Postop–CSb was significantly lower in C Group than A Group, and there was no difference between A Group and B Group, and B Group and C Group. 6MA and 1YA–CSb were significantly lower in Group C and Group B than in Group A, and there was no difference in Group B and Group C. In multivariate regression analysis, Postop–CSb ($B=0.183$, $p=0.001$) and 1YA–CSb ($B=0.137$, $p=0.001$) were significant correlated with CLo.

Fusion rate and clinical outcomes (VAS, ODL) were no significant difference in comparison between the 3 Groups.

CONCLUSION : DLIF and OLIF are useful surgical methods to improve the radiological and clinical outcomes in degenerative lumbar disease. According to our results, the closer CLo was to the anterior and the larger CA, the larger D–SSA and the smaller D–FH. In addition, the more CLo was to the anterior, the less CSb deteriorated. Therefore, if CA is appropriately selected while placing CLo as anterior as possible in the DLIF and OLIF surgery, it would be a more effective method to satisfy both indirect decompression and sagittal angle correction.

제5요추-제1천추간 추체간유합술법에 따른 결과 비교 : 추간공경유 요천추유합술과 사측방경유 요천추유합술

문 하 용

중앙대학교병원

PURPOSE : Various new spinal fusion techniques have been developed and used to treat degenerative diseases of the lumbar spine. Transforaminal lumbar interbody fusion (TLIF) has been widely used for a long time due to a variety of advantages including safety, high fusion-rates, and direct neural decompression. However, TLIF may be accompanied by the risks such as posterior spinal muscle injury, dural tear, and CSF leakage. Additionally, TLIF at L5-S1 level (TLIF51) has a limitation to create a sufficient segmental angle because of its difficulty in inserting a large interbody cage through a small facetectomy space. OLIF51 is an approach inserting a large cage at L5-S1 level through the left side retroperitoneal space in an oblique lateral direction. We performed 55 cases of OLIF51 during 2015-2016. The purpose of our study is to evaluate the usefulness of OLIF51 at the level of L5-S1 by comparing to the classical technique of TLIF at the same L5-S1 level.

MATERIALS AND METHODS : It is a single-center study of patients with degenerative lumbar diseases who underwent lumbar fusion operation including L5-S1 level. Forty-five patients of the TLIF51 group and fifty-five patients of the OLIF51 group were included. Clinical and radiological outcomes were investigated and compared between the two groups. The TLIF51 group underwent unilateral open TLIF with a single PEEK cage (Capstone, Medtronic, USA) and posterior fixation with open pedicle screws and rods system (Zenius, Medyssey, USA). The OLIF51 group underwent minimal invasive lumbar interbody fusion with a large round PEEK cage (Perimeter, Medtronic, USA) through a retroperitoneal approach at the left side and posterior fixation with percutaneous pedicle screws and rods system (Longitude, Medtronic, USA). Visual Analogue Scale (VAS) of back/leg pain and Oswestry Disability Index (ODI) were checked and compared between the groups. Operation time and estimated blood loss (EBL, mL) were checked in the patients received single level OLIF51 or TLIF51. Preoperative and postoperative AP and lateral X-rays were checked. We measured mean disc height (mm) and foramen height (mm) at the L5-S1 level. The segmental sagittal angle, coronal angle, and lumbar lordosis were measured using 36-inch radiographs. We compared the clinical and radiological outcomes between the TLIF and OLIF groups

by using a Student's t-test, Mann-Whitney U test, and the chi-squared test. Descriptive data were presented as mean±SD, and statistical significance was accepted when $p < 0.05$.

RESULTS : There was no statistical significance in the mean age, sex ratio, and BMD between the two groups. Foraminal stenosis was the main pathology at the L5-S1 level, which was a common phenomenon in both groups. The preoperative VAS scores and ODI were not different statistically between the two groups. The postoperative VAS scores and ODI were significantly improved compared to the preoperative values in each group, but there was no significant difference between the groups. The mean cage height was 12.62mm and 10.42mm in the OLIF51 and TLIF51 groups, respectively. ($p < 0.05$) In the OLIF51 group, indirect decompression was done in the majority of patients except for three who received posterior direct neural decompression. The amount of EBL decreased significantly in OLIF51 than TLIF51 group ($102.14 \pm 50.26\text{mL}$ in OLIF51 group, $217.50 \pm 153.73\text{mL}$ in TLIF51 group, $p < 0.05$). The operation time was not different between the two groups. Preoperative mean disc height and foramen height at the L5-S1 was not different between the two groups. Mean disc height was significantly increased postoperatively in both two groups (From $9.30 \pm 2.27\text{mm}$ to $14.34 \pm 2.58\text{mm}$ in OLIF51 group, from $9.80 \pm 2.32\text{mm}$ to $12.45 \pm 2.34\text{mm}$ in TLIF51 group). Foramen height was also significantly increased (From $14.43 \pm 2.31\text{mm}$ to $17.48 \pm 2.06\text{mm}$ in OLIF group, from $14.01 \pm 2.80\text{mm}$ to $15.39 \pm 2.92\text{mm}$ in TLIF group). The degree of increment in the mean disc height and foramen height were greater significantly in the OLIF51 group than the TLIF51 group. ($p < 0.001$) Preoperative segmental angle at L5-S1, lumbar lordosis, and coronal angle were not different between the two groups, respectively. The segmental angle was increased from $14.82 \pm 6.59^\circ$ to $22.09 \pm 4.44^\circ$ in OLIF51 group and from $13.71 \pm 5.22^\circ$ to $17.86 \pm 5.15^\circ$ in TLIF51 group. ($p < 0.001$) Postoperative lumbar lordosis of OLIF51 group was bigger than that of TLIF51 group and coronal angle for whole spine was not different statistically.

CONCLUSION : Both OLIF and TLIF are good surgical techniques with less invasive and safe procedures for degenerative lumbar spinal diseases. According to our data, we can use a larger interbody cage with OLIF51, which can provide higher mechanical stability. We can also use a higher profile cage with TLIF51, which is effective for indirect decompression of foraminal stenosis. The OLIF51 can make higher lordotic angle, which may prevent the iatrogenic flat back.

경피적 내시경 요추 추간판제거수술 후 재발은 과소평가되었을지도 모른다: 독립적인 관찰자에 의한 분석

이 동 엽¹, 정 훈 재²

¹서울부민병원 신경외과, ²서울부민병원 정형외과

PURPOSE : Recurrent herniation is a major concern of reoperation after percutaneous endoscopic lumbar discectomy (PELD). Most previous studies demonstrated that PELD had a comparable recurrence rate with open disc surgery. In contrast, few studies suggested more common reoperation due to recurrent herniation after PELD than after open disc surgery. In this study, an independent observer investigated the reoperation due to recurrent herniation after PELD and analyzed the risk factor for the recurrent herniation after PELD.

MATERIALS AND METHODS : A retrospective, cross-sectional study was conducted. Sixty patients that underwent PELD for single-level lumbar disc herniation from August 2015 to July 2016 were enrolled in this study. PELD was conducted by two minimally invasive surgeons. Recurrent herniation after PELD were defined as follows: 1) successful PELD on immediate postoperative magnetic resonance images (MRI), 2) transient symptom-free interval at least more than one week, and 3) recurrent pain due to recurrent herniation on the same level with the same direction, confirmed by follow-up MRI. The incidence of and risk factors for reoperation due to recurrent herniation after PELD were analyzed by an independent observer.

RESULTS : Eight patients (13.3%, seven men and one woman with mean age of 48.8 (range, 36–64)) underwent reoperation for recurrent herniation. Four underwent PELD and four underwent open microdiscectomy for recurrent herniation. The mean interval until reoperation for recurrent herniation was 5.1 months (range, 0.3–22). In six of eight patients (75%), reoperation was conducted within 1.5 months after primary surgery. Multivariate analysis revealed significant association with reoperation for recurrent herniation between the male gender (odds ratio (OR) 10.22, 95% confidence interval (CI) 1.03 to 101.51) and standing body height (OR 0.97, 95% CI 0.96–0.99).

CONCLUSION : The incidence of reoperation for recurrent herniation after PELD was higher than previously reported. The mean interval until reoperation was brief. Male gender and tall stature were closely associated with reoperation for recurrent herniation. Further prospective studies with large populations are recommended.

요추부 척추강, 외측 함요 협착증에 있어 기존의 전통적인 감압술에 비해 미세 침습적 감압술의 장점은 무엇인가? - 3가지 다른 요추부 감압술의 비교분석 (미세 현미경, 원통형 견인기, 내시경적) : 예비보고

이 철 우, 윤 강 준

강남베드로병원

PURPOSE : There are many surgical options to treat the lumbar spinal canal and lateral recess stenosis. Traditional open laminectomy by using microscope is still described as the method of choice when operating on degenerative lumbar spinal stenosis. Nonetheless, tissue-sparing procedures are becoming more common. Among those MIS decompression techniques for lumbar canal and lateral recess stenosis, Techniques by using tubular retractor and percutaneous endoscope have been reported to have many surgical advantages due to it's minimal invasiveness such as less postop. back pain and benefits for rehabilitation. But It's clinical efficacy and safety was not proved to the extent to satisfy most spine surgeon.

The objective of this study is to compare the results of spinal decompression using the full-endoscopic interlaminar technique (E), Tubular retractor (T) and a conventional microsurgical laminotomy technique (M) in the patients with degenerative lumbar central spinal stenosis.

MATERIALS AND METHODS : 200 patients who received microsurgical, tubular or full-endoscopic decompression surgery for their lumbar canal and lateral recess stenosis from September 2016 to June 2017 were included in this study (E:119, T:22, M:59). Mean F/U period was 6.23 months. Clinical (VAS, ODI, Mcnab criteria), radiologic (postop. enlarged canal diameter, postop. instability) and surgical outcome parameters (postop. Change of CPK level, Op. time, Hospital stay) were evaluated and compared between 3 groups. Failed cases and complications were reviewed in all groups.

RESULTS : Overall clinical success rate was 89.4%. All groups showed favorable clinical outcome. The clinical and radiologic results were similar in all groups. Regarding surgical outcome, E group showed longer operation time than M, T groups (E: 95.66, M:55.03, T: 65.54/min). But, less surgical invasiveness of E, T groups compared to M groups was confirmed by several outcome parameters such as less immediate postop. Back pain (VAS) (E: 2.14, M:5.32, T: 3.54), less increase of CPK enzyme (E: 109.73→142.35, M: 99.11→168.18, T: 107.2→251.8) and shorter hospital stay (E: 2.12, M: 4.85, T: 2.83/Day). The rate of complications and revisions was not significantly different between 3 groups.



CONCLUSION : MIS lumbar decompression technique is clinically feasible and safe to treat the lumbar canal and lateral recess stenosis and it has many surgical advantages such as less muscle trauma, minimal postop. Back pain and patient's fast recovery compared to traditional open microscopic technique.

요추 추간판탈출증에서 경피적 내시경 추간공확장술의 유용성

최 경 철

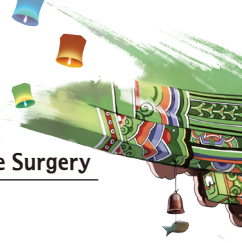
안양일스기념병원

PURPOSE : Endoscopic foraminoplasty facilitates the engagement of the working cannula via the intervertebral foramen, allowing cannula access near the herniated disc (HD) for the successful application of percutaneous endoscopic lumbar discectomy (PELD). The purpose of this study was to evaluate the efficacy of foraminoplasty for HD and propose applicable situations for foraminoplasty in PELD.

MATERIALS AND METHODS : A retrospective review of consecutive patients who underwent PELD was performed. Patients were divided into the foraminoplasty group (FG) and non-foraminoplasty group (NFG). Group differences in disc location and radiologic parameters, such as disc height (DH), foraminal width (FW), lamina angle, facet angle, superior articular process thickness, and iliac height, were evaluated. Clinical outcomes were assessed using a Visual Analogue Scale (VAS) for back and leg pain.

RESULTS : A total of 136 patients (36 FG and 100 NFG) were enrolled. The FG had a significantly smaller DH and higher prevalence of high-grade down migration, downward sequestration, and recurrent HD compared to that in the NFG. For HDs at the L5-S1 level, the FG had a significantly greater iliac crest height, and smaller DH and FW compared to that in the NFG. For central HDs, the FG had a wider lamina angle and smaller DH compared to that in the NFG. Improvements in back and leg pain were similar in the two groups.

CONCLUSION : Percutaneous endoscopic lumbar foraminoplasty may be effective for small DH, migration, sequestration, recurrent HD, HD in L5-S1 with a high-iliac crest, and central HD with a wide lamina angle.



요추 내시경 수술에서 디스크 제거량과 수술 후 영상의학적 결과 분석

황성환, 김치헌

서울대학교병원 신경외과

PURPOSE : Herniated intervertebral disc disease (HIVD) is a common cause of lower back and leg pain. Percutaneous endoscopic lumbar discectomy (PELD) is indicated when non-surgical treatments such as medication and interventions are intractable. Ruptured discs and loose fragments inside discs are removed during PELD. Nerve root decompression is usually assessed by visualizing the free movement of the traversing nerve root or epidural fat, the free passage of a probe into the epidural space, the depression of the annulus, and the removal of the expected ruptured discs and loose fragments based on preoperative magnetic resonance (MR) images. However, these criteria are subjective, and the quantity of the disc removal necessary for successful outcomes after PELD has not been investigated. The present study investigates the amount of discectomy of PELD and its clinical and radiological outcomes.

MATERIALS AND METHODS : PELD was performed in 109 consecutive patients (M:F = 53:56; mean age, 37.4 years) using the transforaminal or interlaminar route. Ruptured disc fragments were first removed in all patients, and the graspable loose fragments under the disc were removed. After surgery, all removed disc fragments were placed into disposable syringes and manually compressed to measure their volume. The volume of herniated disc outside the disc boundary was calculated in MR images. The measured and calculated disc volumes were retrospectively compared. Clinical success was defined as an improvement in both the Oswestry Disability Index (ODI) and leg pain, as well as no recurrent symptoms. Radiological success was defined as the disappearance of herniated disc material outside the disc boundary based on postoperative MR images taken within 1 day after surgery. The follow-up period was 7.2 ± 5.2 months.

RESULTS : Successful clinical outcomes were obtained in 96/109 (88.1%) patients in a median time of 3 months. Re-operation was performed in 3 patients due to recurrent discs in 2 patients and a residual disc in 1 patient. Predictors of clinical success were not identified, and the quantity of the removed disc was not associated with the clinical outcome. Radiological success was achieved in 93/109 (85.3%) patients. Of 13 patients with radiological failure, 2 patients showed clinical failure. A logistic regression analysis

showed that the relative volume of the removed disc (%) compared with the volume of preoperative herniated disc based on the MR images was the only significant predictor ($P < 0.001$; OR = 0.96). When 100% of the calculated disc amount was removed during the operation, the probability of residual disc was 30%. When 131% of the calculated disc amount was removed, the probability of residual disc was 10%.

CONCLUSION : The amount of disc removal during PELD was not a significant predictor of clinical success after the primary ruptured fragments were removed. The relative volume of the removed disc based on the preoperative MR images might predict the postoperative MR images.

The reverse knot X-shape suture in annular repair during microscopic lumbar discectomy; technical note and clinical outcomes

김주한, 박응배

고려대학교 의과대학 구로병원 신경외과교실

PURPOSE : Although repairing of the annulus fibrosus defect after lumbar discectomy may decrease the incidence of acute recurrent herniation, manual repairing technique has not been well studied due to narrow operative field during microscopic lumbar discectomy. Until now, many annular repair devices and techniques were designed but most of them were cost-inefficient. The aim to this study was to evaluate new technique for annular repair during microscopic lumbar discectomy.

MATERIALS AND METHODS : A total 25 herniated disc patients who underwent microscopic lumbar discectomy since 2015 were repaired annular defect using reverse knot X-shape suture technique. We presented this technique by illustration and video clip. We also measured operation time, postoperative visual analog scale (VAS) for back and leg pain, and radiologic parameters compared to non-repaired group (n=35).

RESULTS : All of patient was successfully repaired annular defect by reverse knot X-shape suture technique (Figure 1) in the L4-5 and L5-S1 region. Although there was no recurred herniated disc and no significant differences in clinical outcome with radiological findings between both group, Immediate postoperative leg VAS in repaired group improved compared to non-repaired group.

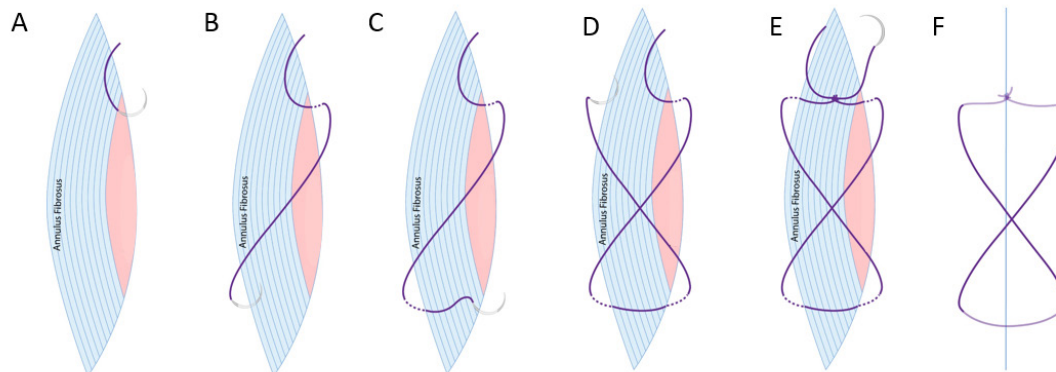


Figure 1



CONCLUSION : The manual reverse knot X-shape suture technique in annular repair can be performed safely and effective under conventional microscopic discectomy without postoperative complication or recurrence of disc. Furthermore, this easy-to-use new technique applied in patients was cost effective compared to the other annular repair device. Although there is no significant clinical and radiological outcome difference compared to non-repaired group, repairing of annular defect can significantly improve the short term surgical outcome. Therefore, we consider that this technique could give the additional benefit of conventional microscopic discectomy.

양방향 내시경과 단일 내시경에서 요추 수술후 근육손상 효소의 비교

이 남, 김 문 찬

부산 힘내라병원

PURPOSE : This study aimed to compare the invasiveness of unilateral biportal endoscopic surgery (UBE) and percutaneous endoscopic lumbar discectomy (PELD) in patients with degenerative spinal disease by measuring serum levels of creatine phosphokinase (CPK) and lactate dehydrogenase (LDH).

MATERIALS AND METHODS : Twenty-four patients with a degenerative spinal disease including spinal stenosis and herniated lumbar disc in the lumbar region underwent decompression surgery. Among them, 10 patients underwent UBE (UBE group, n = 10) and 14 patients underwent PELD (PELD group, n = 14). The biological markers were determined at before and 0, 1, 3, 5 days after surgery. Operation time was evaluated between groups and the clinical outcome was also assessed using visual analogue scale (VAS).

RESULTS : The mean age was higher in UBE group than PELD group significantly (76.2 ± 11.73 vs. 51.5 ± 14.75 , $p < 0.015$). The mean CPK levels did not show significant difference at preoperatively, immediately postoperative, 1 day after surgery. However, both 3 days and 5 days after surgery, it showed higher levels in UBE group (238.0 ± 123.8 vs. 88.0 ± 32.78 , $p = 0.001$; 88.0 ± 32.78 vs. 47.27 ± 22.84 , $p = 0.027$). The mean LDH levels did not show significant difference between groups during investigated period. The operation time was significantly shorter in PELD group (52.25 ± 7.86 minutes vs. 135.66 ± 14.11 , $p < 0.001$). There was no significant difference of VAS scores between groups.

CONCLUSION : UBE procedure showed higher CPK levels at 3 and 5 days after surgery. However, the mean age and operation time were also higher in UBE group. Therefore, we believe that to deduce more precise conclusions, larger cohort samples should be evaluated.

최소침습 경사측방접근 요추 유합술의 학습곡선: 단일 척추의사의 57명의 환자에서의 경험

허 정 우, 정 호 중, 조 현 진, 김 진 성, 류 경 식

가톨릭대학교 서울성모병원

PURPOSE : Minimally invasive oblique lateral lumbar interbody fusion (MIS-OLIF) using a tubular retractor and pre-psoas approach has recently been gaining popularity because of its potential for minimizing para-spinal muscle damage and reducing recovery time. However, the published literature has not characterized the surgeon's learning curve with the technically demanding technique of a MIS-OLIF. The purpose of this study is to define and analyze the learning curve for MIS-OLIF with a single spine surgeon's experience based on intra- and perioperative parameters. This study is retrospective analysis of single surgeon's consecutive case series in a single institution

MATERIALS AND METHODS : Fifty-seven consecutive patients with single or multi-level degenerative lumbar diseases who were treated by MIS-OLIF were included in the study. Surgeries were performed using oblique pre-psoas approach with a tubular retractor, and a cage was inserted using an orthogonal maneuver by a single surgeon. The corresponding segments were fixed with additional percutaneous pedicle screws. MIS-OLIF without posterior decompression was performed in 33 cases and MIS-OLIF plus posterior decompression was performed in 24 cases.

Corrected operative time per level, operative blood loss, postoperative drainage, transfusion rate, and ambulation recovery time were measured. Intraoperative and postoperative complication incidences were also identified. Clinical results were assessed using the visual analogue scale (VAS).

The learning curve was assessed using a logarithmic curve-fit regression analysis. In the single-level OLIF group (n=21), 12 patients were defined as the "early" group (among the first 30 cases of the series), and the subsequent 9 cases were defined as the "late" group for comparison.

RESULTS : Corrected operative time gradually decreased as the series progressed, and an asymptote was reached after about 30 cases. Average VAS scores for lower back pain and radiating pain also significantly decreased from an average of 6.9 to 3.8 and 7.6 to 2.5, respectively.

In the single-level OLIF series, operative time was significantly shorter in the late group (99 ± 54 min) than the early group (141 ± 21 min), and blood loss during the operation was significantly reduced



in the late group (482 ± 269 mL) compared with the early group (542 ± 157 mL). Ambulation recovery time and VAS scores for back and leg pain did not differ between the two groups. There were two cases of retroperitoneal hematoma in the early second group requiring revision surgeries.

CONCLUSION : The MIS-OLIF is a technically difficult procedure to the practicing spine surgeon with regard to unfamiliar retroperitoneal approach. Although it is not easy to master this minimally invasive technique, Operative time and blood loss improved with the surgeon's experience. After the initial learning curve, this technique could be an effective and reliable option for the surgical treatment of lumbar degenerative disease. Further studies are warranted to delineate the methods to minimize the complications associated with the learning curve.

퇴행성 요추관 협착증에서 국소마취하진정 상태에서 극돌기간 감압술 후 2년 이상 임상 결과 분석

진 용 준

인제의대 서울백병원 신경외과

PURPOSE : The purpose of the retrospective study is to evaluate the clinical efficacy after microsurgical management of lumbar spinal stenosis using the interspinous approach under local anesthesia with sedation

MATERIALS AND METHODS : Sixty-three patients undergoing decompressive surgery for lumbar spinal stenosis using the interspinous approach under local anesthesia with sedation, including cases with spondylolisthesis with or without instability, were included in this study. The middle-term outcome was evaluated in a follow-up study (mean follow-up period : 28 months). The clinical outcome was evaluated retrospectively using self-rating questionnaires: the Oswestry Disability Index, visual analogue scale (0-10), and level of satisfaction. In 22 cases with spondylolisthesis, the risk of postoperative instability was evaluated on the basis of dynamic radiographs of the lumbar spine. Postoperative complications were collected.

RESULTS : The Oswestry Disability Index showed a mean improvement in symptoms from 58% to 18%, and the visual analogue scale showed that the intensity of leg pain decreased from 8.5 points to 2.1 points. 93.7% of cases indicated that they were moderately satisfied(good) or very satisfied(excellent). Among spondylolisthesis cases, dynamic radiographs revealed only one(1.6%) postoperative instability without symptomatic leg pain due to foraminal stenosis. Postoperative complications (11 of 63 cases, 17%) were as follows : facet joint pain (3 cases), symptomatic synovial cyst requiring revision (3 cases), symptomatic epidural hematoma requiring revision (2 cases), foraminal stenosis aggravation following listhesis progression (1 case), spinous process fracture (1 case), ruptured disc herniation (1 cases)

CONCLUSION : The clinical outcome over 2 years postoperatively after using the interspinous approach for lumbar spinal stenosis showed a favorable maintenance of improvement in symptoms. Radiological data showed that this approach does not alter the stability of the spine. However, facet-related problems should be considered as dominant complications during postoperative follow-up period.



양방향 척추내시경 디스크제거술, 신경감압술(TED); 초기 경험

권 흠 대, 조 재 만

에스포항병원

PURPOSE : Open lumbar discectomy and PELD are the most common surgical methods for herniated lumbar disc. Recently, arthroscopy has been introduced to perform lumbar discectomy or decompression. It is called by various names called UBE(Unilateral Biportal Endoscopy), BESS(Biportal Endoscopic Spine Surgery), PEBD(Percutaneous Endoscopic Biportal Decompression) and endo PUB(Endoscopic Posterior Unilateral biportal Surgery). The name has not been established yet. The advantage of two-portal endoscopic discectomy(TED) are as follows. First, the surgical field is very clear & magnified, so operator can clearly see the structures around the root and thecal sac. Even the small vessels that run on the dura and root are very well identified. Second, it provides a very familiar anatomy for a general neurosurgeon who is not specifically trained. Third, postoperative pain is less than OLD(Open Lumbar discectomy) due to minimal muscle injury. So here, we report our early experience of TED.

MATERIALS AND METHODS : We performed two-portal endoscopic discectomy(TED) for 47 patients for short-term from June 2017 to August 2017. A retrospective chart review was done. The patients were followed up postoperatively and were assessed with regard to clinical outcome via NRS after post OP 2days, 2week, 4 week. All operation were performed with two-portal endoscopic discectomy or decompression (TED). After confirming the surgical level with the C-arm, two skin marking for two-portal (scopic-portal, working-portal) are made. In case of HLD, a transverse line was drawn from the middle of intervertebral disc space, then two skin incisions were made 1 cm off from the line in cranial - caudal direction, ipsilateral to lesion. In case of extraforaminal disc, instead, two skin incisions were made 1 cm apart from in cranial - caudal direction on the intersection between a first transverse line drawn of lower pedicular margin and a second vertical line drawn 2 cm off from lateral pedicular line. And then a natural inflow-outflow irrigation system through two holes was performed to create working-portal & scopic-portal. 0 degree arthroscope was inserted into the cranial hole (scopic-portal) and surgical tools (Burr drill, RF system, Kerrison punch etc.) were inserted into the caudal hole (working-portal) to performed laminectomy and discectomy. Then, the surgical procedure

(TED) was exactly the same as the conventional microscopic discectomy & decompression. Then, Partial hemilaminectomy, Flavectomy & discectomy or decompression was followed. To get a clear view, bleeding control is the most important. Bone wax could be used for bone bleeding. A troublesome epidural bleeding could be controlled via RF coagulator, irrigation pressure, even Gelforms. A drainage catheter was inserted.

RESULTS : Of the 47 total cases, 2 cases were failed and were excluded. One case with HLD on L3-4, Rt EF was failed because we could not make working space because of our lack of experiences. The second case with spinal stenosis on L4-5 was failed because there were severe adhesions and no interlaminar space due to previous laminectomy. In 45 cases included in this study, there were 24 male patients and 21 female patients. The mean age was 56.3. The operation site was 9 cases of L-S spine and 36 cases of lumbar spine. The surgery level was 3 cases of L2-3, 8 cases of L3-4, 28 cases of L4-5, 8 cases of L5-S1. There were 36 cases with HLD and 9 cases with spinal stenosis. The lateralization of nerve compression was 14 cases on the right side, 30 cases on the left side and 3 cases on the both sides. The degree of disc herniation was 3 cases high upward migration and 12 cases high downward migration. All 6 cases HLD, EF underwent foraminoplasty. In 3 cases of recurrent disc herniation, adhesiolysis & removal of particle were successfully performed with TED. In terms of complication, there were facet violation 2 cases, drainage catheter irritation 2 cases, dural tear 2 cases and epidural hematoma 2 cases. Due to the irritation of catheter, Patient had buttock, leg pain. These symptoms were improved after catheter removal. In two cases, post OP MRI showed epidural hematoma however, there were no symptoms because of sufficient decompression. Patients with dural tear had no symptoms like headache, nausea, etc. but ambulation was performed after bed rest for 3days. There was no post operative infection. Although there was a short period of time, there has been no recurrence to date. The mean OP time was 140 mins. The operation time tended to decrease as the cases increased. the preoperative mean NRS was 8.4, which was significantly improved to 2.2 at 2 days postoperatively, to 1.6 at 2 weeks, to 1.1 at 4 weeks postoperatively. Eight patients with motor weakness had improved.

CONCLUSION : There were limitations to the initial experience with two-portal endoscopic discectomy and decompression (TED) in a short period of time. this article is a retrospective study and had short follow up duration. However, our experience suggested that TED could be as good as conventional surgery, given the benefits of a clear vivid surgical view, a familiar surgical anatomy, and moreover, easy learning. Because the official name is not yet established, it may be called TED because TED provide a more accurate description of the surgical procedure, and besides, easy to pronounce & familiar.

2017. **9.16** (Sat.)



Luncheon Seminar I

좌장 : 중앙대 박승원, 가톨릭대 류경식

1. Clinical Evidence of O-arm Navigated Pedicle Screw Placement Accuracy & Precision

Tsukazaki Hospital **Nobuyuki Shimokawa**

– O-arm & Navigation Korea Reimbursement Update

2. Bone Strength Treatment: Once Weekly Teriparatide

서울대 **김치현**

Nobuyuki Shimokawa

Tsukazaki Hospital Spine Center & Neurosurgery



Professional Training and Employment

- 1991–1992 Resident, Neurosurgery, Osaka City University, School of Medicine, Osaka, Japan
- 1993 Staff Neurosurgery, Morimoto Hospital, Osaka, Japan
- 1994–1995 Resident, Neurosurgery Osaka City University School of Medicine, Osaka, Japan
- 1996–1997 Chief Resident, Neurosurgery Osaka City University, School of Medicine, Osaka, Japan
- 1998–2009 Staff, Neurosurgery Tsukazaki Hospital, Hyogo, Japan
- 2010–2011 Head, Neurosurgery Tsukazaki Hospital, Hyogo, Japan
- 2012–2013 Head of Spine Center & Neurosurgery Tsukazaki Hospital, Hyogo, Japan

Education

- 1985–1990 Osaka City University, School of Medicine, Osaka, Japan

Licensure and Certification

- 1997 Board certification as Neurosurgeon by Japan Neurosurgical Society
- 2006 Board certification as Spinal Surgeon by Japanese Society of Spinal Surgery
- 2010 Board certification as Senior Member and Review Board of SPINAL SURGERY by Japanese Society of Spinal Surgery
- 2010 Director of the Japan Society for the Study of Surgical Technique for Spine and Spinal Nerves
- 2011–2013 Editing Manager of SPINAL SURGERY
- 2012 Review Board of Neurologia medico-chirurgica
- 2012 Board of the Japan Society of Neurotraumatology
- 2012 Board of the Japan Society of Neurosurgical Emergency
- 2012 Board of the Japan Medical Society of Spinal Cord Lesion

Professional Associations

- Japan Neurosurgical Society
- Japanese Society of Spinal Surgery
- Japan Spine Research Society
- Japan Society for the Study of Surgical Technique for Spine and Spinal Nerves

Clinical Evidence of O-arm Navigated Pedicle Screw Placement Accuracy & Precision

Nobuyuki Shimokawa MD^{*}

^{*}Corresponding Author Spine Center/Tsukazaki Hospital, Himeji City

INTRODUCTION : Posterior cervical fixation using lateral mass screw and cervical pedicle screw (CPS) is getting available for various disorders^{1-3]}. The purpose is to report our development of surgical technique for CPS insertion using O-Arm, about full-time navigation system particularly, and to present the safety and feasibility of CPS placement using it.

MATERIALS AND METHODS : Consecutive one hundred fifty eight patients underwent posterior cervical fixation using CPSs since January 2007. 111cases were treated with preoperative CT based navigation system or without navigation system. In second period, 39 cases were treated with O-arm navigation system, and then in third period, 8 cases were treated with full-time O-arm navigation system.

RESULTS : We inserted 878 CPSs and classified their accuracy at each period with Neo's classification using postoperative CT scan, in period 1 grade 0(507 screws, 91.9%), grade 1(18 screws, 3.6%), grade 2(19 screws, 3.7%), grade 3(4 screws, 0.8%),in period 2 grade 0(299 screws, 96.5%), grade 1(9 screws, 2.9%), grade 2(1 screws, 0.3%), grade 3(1 screws, 0.3%), in third period grade 0(58 screws, 95.1%), grade 1(3 screws, 4.9%), grade 2 and grade 3 (0 screw, 0%). No neurovascular complications associated with surgery were encountered.

DISCUSSION : Various techniques with navigation system make the critical misplacement of CPS more reduce^{4,5]}. We believe what is the most important for safe CPS insertion is preoperative detail further evaluation including the indication of CPS.

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Bone Strength Treatment: Once Weekly Teriparatide

김치현

서울대

2017. **9.16** (Sat.)



Biospine

좌장 : 차의과대 **한인보**, 울산대 **전상용**

1. Introduction to the First Biospine-AP 2018 Meeting and ISSLS 고려대 **김주한**
2. Discovering a New Treatment for SCI from the Interpretation of Preclinical Studies 강원대 **김충효**
3. Development of Spinal Fusion System Using Biodegradable Polymer 연세대 **신동아**
4. Mechanism and Materials of Spine Implant Global Biomedical Systems; CEO **안경기**



Introduction to the First Biospine-AP 2018 Meeting and ISSLS

김 주 한
고려대

김 충 호

강원대병원



최근 주요 약력

- 서울대학교 의과대학 졸업
- 서울대학교병원 신경외과 전공의
- 분당서울대학교병원 신경외과 임상교수
- 강원대학교병원 신경외과 부교수

최근 주요 경력

- 척추신경외과 학회 이사, 윤리위원, 학술위원
- 경추경구회 학술위원
- 척추 골다공증연구회 학술위원
- 척추신경외과학회지, 말초신경외과 학회지 심사위원



Discovering a new treatment for SCI from the interpretation of preclinical studies

김 충 호

강원대

20세기 초반 과학의 기술의 발전으로 암이나 내분비 질환 등에 새롭고 획기적인 치료제가 발견되었고 척수손상에 있어도 세포 또는 세포 이하의 기전을 이해하게 되어 이를 이용한 척수 손상 치료제가 발견될 것이라고 기대되었으나 수많은 전임상, 임상 실험이 진행되었음에도 불구하고 척수나 뇌손상을 획기적으로 회복시킬 수 있는 치료법은 아직 발견되지 않고 있다.

이번 강좌에서는 먼저 꽤 많은 전임상 연구에서 척수손상의 회복을 보고함에도 임상실험에서는 실패하는 원인을 찾기 위해 먼저 전임상 척수 손상 동물 모델과 척수 손상의 연구에서 주로 사용되는 중배엽줄기세포의 특성과 한계를 살펴보고 이후로 현재 진행되고 있는 척수 손상의 기전에 기반한 임상 연구들을 살펴 치료제 개발의 현재를 돌아보고자 한다.

먼저 척수손상 모델로 많이 사용되는 척수 손상 모델은 크게 transection model, contusion model, compression model로 나뉜다. Transection model 중 total transection은 complete SCI model에 해당하지만 실험동물의 사망률이 높아 잘 쓰이지 않고 일부를 절개하는 손상 모델은 재현성에 한계를 가져 일부에서 사용되고 있다. Contusion model은 임상의 척수 손상과 가장 비슷한 기전에 의한 손상모델로 가장 널리 사용되어 왔으며 손상 기구에 따라 척수 손상의 정도를 낙하의 높이를 통해 조절하는 NYU impactor, Impaction of force를 통해 조절하는 Infinite Horizon impactor, 척수의 displacement를 통해 조절하는 OSU impactor가 알려져 있다. Clip compression model은 비교적 저렴한 상품화된 clip의 closing force를 이용하여 Severe, Moderate, minor SCI를 줄 수 있다고 보고 되었다. 동물 척수 손상 모델을 통한 전임상 연구를 할 때 또한 rat의 anatomy를 통해 정확히 흉추 T10-11 이나 6-7 또는 경추나 요추에 원하는 부위에 손상이 정확히 이루어졌는지 또한 손상 정도가 일관성 있게 발생하는 지가 가장 중요하다. IH impactor의 경우를 예를 들면 일정한 force도 준다고 해도 털 제거된 후궁이나 주변 연부조직에 impactor tip이 걸리거나 척추체를 고정하고 손상을 주기 때문에 tension이 변하면 displace 정도가 일정하지 않아 일관성 있는 척수 손상을 얻을 수 없기 때문에 손상 그래프를 통해 정확한 척수 손상이 일어났는지 확인하는 것이 필요하다. 또한 척수 손상 전임상 연구를 해석할 때 일반적으로 많이 사용되는 IH impactor 75kd force는 백서의 behavioral test로 임상 척수 손상 분류에 적용하면 mild to moderate SCI에 해당하며 이를 임상연구에 적용시 환자의 척수 손상 정도에 따른 적응증을 선택할 때 이를 고려해야 한다.

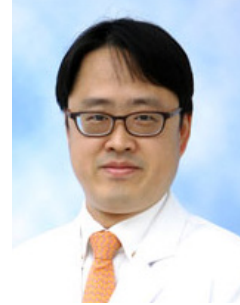
중배엽 줄기세포는 쉽게 얻을 수 있고 많은 양으로 배양할 수 있어 많은 임상 연구에서 사용되고있으며 신경보호

와 관련된 여러 인자(VEGF, FGF-2, HGF, NGF, and BDNF)를 분비하며 축삭 성장의 matrix로 작용할 수 있으며 신경계로 분화가 가능하다. 또한 몇몇 보고에서는 glutamate-induced neuron injury를 완화시킬 수 있고 GABA receptor를 통해 척수손상의 회복을 돕는다고 보고되고 있다. 하지만 동시에 추출하는 조직 및 배양방법에 따라 일정치 않은 세포 질(variation of cell quality)과 다양한 세포 성질(heterogeneity of cell characteristics), 일정치 않은 반응성(uneven reactivity)을 가지며 유전자 조작 없이는 낮은 신경계 분화율을 가져 직접적인 신경조직의 회복을 기대하기 힘들고 백혈병 발병 및 다른 조직으로 분화의 가능성이 있다. 이러한 중배엽 줄기세포특징을 통해 전임상 연구를 계획하거나 다른 연구를 해석할 때 줄기세포의 정성과 정량관리가 중요하며 판매되는 줄기세포일지라도 실험실에서 이에 대한 검증이 필요하다. 또한 어떤 passage의 세포이고 일정한 성질과 반응성을 가지고 있는 지 또한 신경계로 분화를 시켰는지 삽입된 세포의 수와 이식방법 또한 고려해 보아야 한다. 혈관을 통한 이식의 경우 망상활성화 시스템(reticular activation system)와 대식세포에 의해 대부분의 세포가 제거되며 주사기를 통한 직접 이식의 경우 바늘과 주입되는 물질에 의해 조직 손상이 일어날 수 있고 미세주입기로 주입하는 경우 세포가 바늘에 뭉쳐져(clamping) 손상되거나 신경의 공간으로 유출될 수 있다는 재현성을 저해하는 요인들을 최소화하려고 노력해야 한다.

현재 미국에서 진행되고 있는 척수 손상관련 임상 연구로는 Rho inhibitor VX 210을 이용한 Phase IIb/III SPRING trial (Spinal Cord Injury Rho Inhibition invstiGation), Na channel blocker인 Riluzole을 이용한 Phase 1/IIa RICIS (Riluzole in Spinal cord Injury Study), Phase 1 ahSC study (autologous human schwann cell in chronic spinal cord injury), hESC-derived Oligodendrocyte Progenitor Cells을 이용한 Phase I/IIa AST_OPC1 study이 진행 중에 있다.

신 동 아

Yonsei University, Department of Neurosurgery



Education

- 1998 M.D. Degree, Yonsei University College of Medicine
- 1998–1999 Internship, Severance Hospital
- 1999–2003 Residency, Severance Hospital
- 2003 Board Certified, Korean Board of Neurosurgery
- 2004, 2006–2007 Clinical Fellow, Severance Hospital (Director: Do Heum Yoon)
- 2007–2012 Assistant Professor, CHA University
- 2012–Present Clinical Associate Professor, Yonsei University
- 2010–Present Assistant Co–Professor, GIST

Professional Affiliation

- Korean Neurosurgical Society
- Korean Spinal Neurosurgery Society
- Korean Neuro Pain Society
- Korean Spinal Intervention Society
- International Spinal Intervention Society
- American Association of Neurological Surgeons
- North American Spine Society



Development of Spinal Fusion System Using Biodegradable Polymer

신 동 아
연세대

안 경 기

GBS Commonwealth



최근 주요 약력

- Research Associate of Univ. of Michigan
- Ph.D. of Mechanical Engineering, POSTECH
- Master of Industrial Engineering, POSTECH
- Bachelor of Mechanical Engineering, Yonsei University

최근 주요 경력

- CEO of GBS Commonwealth
- CBO of PMT Republic, USA
- R&D Director of L&K
- Co-Founder & CEO of Aegis Spine, USA



Mechanism and Materials of Spine Implants

안 경 기

Global Biomedical Systems: CEO

The treatment of spinal disorders requires the consideration of a number of factors and understanding the structure and the type of material we are implanting is important. Alloys have different mechanical properties and behave differently under different physiologic conditions. Spinal implants need to have good performance in the characteristics of biofunctionality and biocompatibility. In this presentation, various materials commercially used for spinal implants will be introduced. Several of the important properties that are considered when selecting a material to design spinal instrumentation are explored. This allows for an assessment and comparison of each material and a possible determination of which is the best for specific surgery or the best for use in specific situations. The new materials that could be used for spinal instrumentation in the near future are also introduced for better surgical outputs.

2017. **9.16** (Sat.)



Free Paper II

Trauma / Cervical Spine / Deformity

좌장 : 인제대 **손문준**, 이화의대 **조용재**

불안정 흉요추 방출성 골절에서 "측면 추경절제술"을 이용한 감압 및 원주형 재건술 : 수술기법 및 18명의 수술환자에 대한 고찰

문흥주, 권우근, 박웅배, 이건영, 김주한, 박윤관

고려대학교 구로병원 척추신경센터

PURPOSE : In the surgical treatment of thoracolumbar(T-L) fractures, there are still no generally agreed consensus known as the golden standard. However, the main issues have been proper neural decompression and rigid stabilization with minimal sacrifice of other stable segments. In that sense, this technical report introduced retro-pleural/peritoneal "lateral pediclectomy" for the decompression of the canal encroached fragment and reconstruction using expandable titanium cage, lateral fixation devices and percutaneous pedicle screw at single stage for substantial stabilization and reducing fusion segment.

MATERIALS AND METHODS : This study presented technical points related with the surgery for unstable T-L fractures introducing "lateral pediclectomy" for decompression and circumferential, short-segment fusion for substantial stabilization with comprehensive illustrations and video. 18 patients (M:F = 11:7; mean age, 54.63 ± 23.49 years) who suffered from single unstable, compressive T-L fracture were treated with this technique by one neurosurgeon (HJ Moon) at a single academic institution (Korea university Guro Hospital, Neurospine center) between January 2014 and December 2016 (T12: 9 cases, L1: 7 cases, L2: 2 cases). These cases also reviewed retrospectively in terms of radiologic (CT scan and X-ray), clinical outcomes and complications at postoperative 6 months period.

RESULTS : Four detailed illustrations and video showed comprehensive surgical considerations and tactics effectively in terms of approach, decompression, fusion and stabilization. There was no radiologic complication implying mal-union or mal-alignment on the postoperative 6 months CT scan. There was also no neurologic deterioration and infection at the same period. 2 patients (11.%) of iatrogenic injury and 1 patient of trauma related injury of dura were secured without delayed complications. 3 patients (16.7%) of transient weakness in left hip adduction after immediate post-operation were observed and recovered within 2 weeks in all the patients. 6 patients (33.3%) complained of dysesthesia and/or hypoesthesia on wound site.

CONCLUSION : The present technique suggests "lateral pediclectomy" as a distinct anatomic landmark and surgical tactics to access and remove bony fragment effectively and safely. This provides a more



straightforward assess to the burst fragment and helps the surgeon to make better intra-operative decompression strategies. Moreover, this circumferential instrumentation with anterior support and fusion might not only provide substantial stabilization, but also spare the healthy adjacent segments.



흉추 및 흉요추 접합 부위에서 발생한 외상 및 퇴행성 질환의 후방 흉추체간 케이지 유합술 임상 결과

남한가위, 김모이네, 전 상 응

서울아산병원 신경외과

PURPOSE : To evaluate the feasibility and outcome of posterior thoracic cage interbody fusion (PTCIF) technique in the thoracic and thoracolumbar (TL) spine disease.

MATERIALS AND METHODS : Following Institutional Review Board approval, we retrospectively reviewed patients diagnosed as traumatic injury or degenerative disease in thoracic or TL spine and underwent PTCIF from 2012 to 2017 at our medical center. Clinical data, including patient's age, sex, and operative indications were recorded. The pre- and postoperative neurological status was evaluated using the American Spinal Injury Association (ASIA) impairment scale. Intraoperative data like cage types, unilateral or bilateral cage insertion, and estimated blood loss (EBL) were collected. Thoracic degenerative disease involved stenosis, TDH and OLF in our series. Exclusion criteria were patients with spinal bone tumor or infection. All surgeries were performed by a single surgeon (SR, J). Before surgery, all patients were performed magnetic resonance imaging (MRI) and computed tomography (CT) to diagnose and determine the levels of surgery. Intraoperative monitoring standards using somatosensory and motor evoked potential (SSEP and MEP), and electromyography (EMG) were recorded for all patients except trauma patients with complete paraplegia. Serial plain x-ray was performed after the operation to evaluate the accuracy of graft position and instrumentation. Thin-section CT with sagittal and coronal reconstruction was used to evaluate the bone fusion rates as 3 months for 1 level PTCIF, and 4 months for more than 2 levels. The bone fusion was defined as the formation of bony continuity between the upper and lower end plates and adjacent to cages in the PTCIF level. When patient was discharged after the operation, subsequent plain x-ray was guided at regular follow-up to assess the integrity of instrumentation and maintenance of alignment. If patients experienced any related symptoms, more regular visit was recommended.

RESULTS : A total of 22 patients underwent PTCIF surgery between 2012 and 2017 in our single institute. One patient was loss to follow-up, but confirmed to have no surgical complications via phone interview 6 and 12 months after the operation. Other 2 patients had a follow-up period less than 3

month. Finally, 19 patients were enrolled in our study with a minimum follow-up of 3 months. The patients consisted of 9 men (47.4 %) and 10 women (52.6 %). The mean age was 58.2 years (range 28 – 78 years) with the mean follow-up period of 23.5 months (range 3 – 53 months). Traumatic spinal injury was diagnosed in 5 patients and degenerative disease in 14 patients. One level PTCIF was performed in 10 patients and 2 levels in 7 patients. All PTCIF procedures were performed 1 or 2 levels between T10 and L1, except for 2 patients who were conducted down to L2–3 level. The mean EBL was approximately 841 mL (range 100 – 4000 mL) and the mean hospital stay was 14.68 days (range 9 – 34 days). There were no intraoperative complications like dural tears, spinal cord injury or CSF leakage in our study. Also, significant changes in motor and sensory evoked potentials during surgery were not observed in any patient. After the operation, all trauma patients with spinal cord injury did not aggravate their neurologic function, whereas all degenerative cases demonstrated neurological improvement. Follow-up CT about 3 – 4 months after the operation revealed the formation of bony continuity within cages or just outside the cages between the upper and lower endplates at the PTCIF level. The plain x ray at last follow up also showed successful bone fusion in all patients. Procedure related complications like cage migration or screw displacements were not identified during follow-up. However, 1 patient developed a transient superficial wound infection which was successfully managed with antibiotic administration. Another patient showed transient arm weakness due to brachial plexopathy related to intraoperative surgery position and needed rehabilitation program

CONCLUSION : The paucity of clinical series analyzing outcomes of thoracic spine disease treated with cage interbody fusion by the posterior approach resulted in a significant limitation in comparing with other surgical approaches. Nevertheless, our study exclusively showed that PTCIF is a convenient, simpler and less invasive treatment approach for patients with need of spinal cord decompression and fusion in the thoracic and TL spine. The great advantage is, unlike anterior approach often performed for thoracic spine disease, that most spine surgeons are familiar with PTCIF approach and its related regional anatomy. This procedure should be considered as an alternative technique for patients requiring decompression with fusion at the thoracic and TL spine.



제1-2경추간 불안정에 대한 제1경추외측고 및 제2경추경 나사못을 이용한 환추-축추고정술후 하부경추부 시상부 배열의 변화

김 대 현

대구가톨릭대학교병원 신경외과

PURPOSE : To evaluate the association between C1-C2 fixation angle and postoperative C2-C7 alignment in the sagittal plane after midline open or minimally Invasive Surgical (MIS) C1 lateral mass screw with C2 pedicle screw fixation (C1LM-C2Ped, Goel & Harms technique).

MATERIALS AND METHODS : We retrospectively followed up 42 patients who underwent midline open C1LM-C2ped (31 patients), MIS C1LM-C2ped(8 patients) or Magerl with wiring procedure (3 patients) to treat C1-C2 instability. The Occiput-C1, C1-C2, and C2-C7 angles were measured preoperatively, immediately postoperatively, and follow-up.

RESULTS : The mean followup period is 26.4 months. The mean preoperative atlantoaxial angles in the bilateral MIS and midline open groups were 25.9° and 18.9°, respectively, and the mean postoperative atlantoaxial angles in the same groups were 26.9° and 19.7°, respectively, without a statistically significant difference between the 2 groups ($p < 0.05$). The mean preoperative angles of C2- angles in the bilateral MIS and midline open groups were 16.3° and 14.3°, respectively, and after surgery, the angles were 11.8° and 11.6°, respectively, without a statistically significant difference between the 2 groups ($p < 0.05$). The postoperative angle of C1-2 showed a negative correlation with the extent of change observed in the C2-7 angle pre- and postoperatively in midline open group($r=-0.428$, $P=0.012$). The postoperative change of C2-7 angle decreased larger in postoperative C1-2 angle $> 20^\circ$ patient group than in postoperative C1-2 angle $< 20^\circ$, but there were not statistically significant ($p=0.122$). In patients with Rheumatoid arthritis, especially the postoperative change of C2-7 angle decreased larger in postoperative C1-2 angle $> 20^\circ$ patient group than in postoperative C1-2 angle $< 20^\circ$, but there were not statistically significant ($p=0.201$). The Oc-C1 angle decreased after surgery in open midline groups, but the difference was not statistically significant.

CONCLUSION : Increased lordotic change in the C1-C2 angle was associated with increased kyphotic changes in the C2-C7 angle after both midline open and MIS C1LM-C2ped screw fixation techniques. The C1LM-C2ped screw fixation technique effectively controlled C1-C2 sagittal alignment during



surgery. To decrease the risk of postoperative subaxial kyphotic changes, the C1□C2 fixation angle should be carefully determined. However, there may seem to be less likelihood that the muscle and ligament being damaged in the upper cervical spine would affect abnormal alignment in the lower cervical spine.



외상성 척추골절에서 후방 유합 수술결과의 비교 : 고식적 척추경 나사못 고정술 vs 극돌기간 압박 고정술

이 남¹, 신 동 아², 김 금 년², 하 윤², 이 성², 김 도 영²

¹부산 임내라병원, ²연세대학교 세브란스병원

PURPOSE : There have been several previous studies evaluating clinical outcomes between short-segment and long-segment fixation surgery. However, there have been limited comparative studies valuating changes in the sagittal Cobb angle. This study aimed to evaluate the surgical outcomes between conventional pedicle screw fixation and pedicle screw plus interspinous compressor (TieGERTM; Mantiz, Daegu, Korea) fixation in patients with traumatic thoraco-lumbar vertebral body fracture.

MATERIALS AND METHODS : Twenty-eight patients with a vertebral body fracture in the thoracic and lumbar region underwent posterior fusion surgery. Among them, 15 patients underwent conventional pedicle screw fixation (control group, n = 15) and 13 patients underwent pedicle screw plus interspinous compressor fixation (experimental group, n = 13). The radiological and operation parameters were determined before and 12 months after surgery. The clinical outcome was also assessed using short form health survey (SF-36).

RESULTS : The postoperative 1 month sagittal Cobb angle showed a significant reduction in the experimental group, but it did not significantly change in the control group (experimental group 23.60° to 17.25°, p = 0.014; control group 18.64° to 16.82°, p = 0.398). The postoperative 12 months Cobb angle showed a significant increase in both groups (control group 18.91° to 20.85°, p = 0.003; experimental group 19.15° to 20.80°, p = 0.005). There was one case of screw loosening in the control group during the entire investigation period. The mean operation time was significantly reduced in the experimental group (control group 178.5min vs. experimental 132.3min, p = 0.02). SF-36 score was higher in the control group but was not significant.

CONCLUSION : The pedicle screw fixation plus interspinous compressor technique can be a reasonable alternative to conventional fixation in terms of restoration and preservation of the Cobb angle after surgery.

경추1번 나사못과 이중막대를 이용한 경추1번 방출성 골절의 운동성 보존 치료

박영섭, 황수현, 허원

창원경상대학교병원

PURPOSE : The treatment of C1 fractures is controversial. Motion preserving treatment with halo fixation always bears the risk of insufficient healing from the minimal motion of vest regardless of long duration of inconvenience. Another treatment option, a C1-2 fusion can markedly decrease the rotatory motion of the neck. Recently motion-preserving fixation methods using lateral mass screw was reported.

MATERIALS AND METHODS : We modified this method to minimize lateral spread of the fractured C1. The aim of this report is to describe a new treatment option for C1 Jefferson fractures. The screws were connected with a rod, closure screws and transverse connector.

RESULTS : We present a patient with a C1 burst fracture who was successfully treated with fixation of C1 using a lateral mass screw and dual rod construct. This is the first report of a C1 burst fracture stabilized by a motion-preserving technique with a posterior C1 lateral mass screw with dual rod construct.

CONCLUSION : C1 dual rod technique is an alternative surgical option for C1 Jefferson fracture. This technique could minimize lateral spread of the fractured C1 fragment, and could preserve C1-2, C0-2 joint motion.



어떤 경추 수술 방법이 C5 palsy를 유발하는가? : 경추 수술 방법에 따른 C5 palsy 발생률 차이

이 광 수, 진 동 규

강남세브란스병원 척추신경외과

PURPOSE : C5 palsy after cervical spine surgery is a serious but poorly understood complication. It could lead to muscle weakness and numbness of the upper arm. It will take a lot of time and money to recover.

It is known that the incidence is different according to the surgical method and it is reported that posterior approach surgery is more frequent than surgery of anterior approach. The purpose of this paper is to investigate the incidence of C5 palsy in patients with various surgical procedures and to infer the cause of this complication.

MATERIALS AND METHODS : A retrospective study and a cervical operation in a single group of spinal neurosurgery at a single institution. The period from January 1, 2011 to December 31, 2016 was targeted. Patients who were excluded from surgery due to trauma or tumor were excluded from the diagnosis. Minimal invasive surgery such as endoscopic surgery and keyhole surgery were excluded.

C5 palsy patients were searched for patients with a history of "C5 palsy", "shoulder weakness", and "arm weakness" on the EMR because the search was not easy.

Twenty-seven patients were detected during the period, and 6 of them were excluded after reviewing the comment on EMR.

RESULTS : The patients with C5 palsy on anterior (ACCF, ACDF) had 4 (2,2) and on posterior (laminectomy only, laminectomy & fusion, laminoplasty) had 17 (0, 12,5). The incidence of the anterior and posterior approaches was 0.23% and 2.67%, there was a significant difference in the p-value <0.001 between the two, respectively.

In the posterior approach, the frequencies of occurrence were 0%, 5.265%, and 1.50% in laminectomy only, laminectomy & fusion, and laminoplasty. There was a statistically significant difference between the laminectomy only group and the laminectomy & fusion group (p-value = 0.041).

CONCLUSION : According to the approach, the incidence of C5 palsy is higher in the posterior approach than in the anterior approach, which is already known in other literature and has shown similar results



in this paper.

Among all the surgical methods to be investigated, the highest incidence of C5 palsy was that in the laminectomy & fusion group. But there was not observed in the laminectomy only group which has same procedure except for screw fixation.

Recently, some articles mention the posterior shifting or root traction of neural components as the cause of C5 palsy. The results of this paper will be another basis for supporting the mechanism of these papers.

Although it is difficult to verify what is academically, it is expected that a more academic and well-grounded study will be made on the mechanisms inferred based on these papers.



다분절 전방 경추 유합술 시행 후 경추의 시상 정렬에 따른 환자 예후와의 관계

전 세 일, 한 상 현, 김 현 집, 장 태 안, 김 기 정, 현 승 재

분당 서울대학교병원

PURPOSE : The purpose of this study was to investigate the relationship between cervical sagittal alignment and patient-reported health-related quality-of-life (HRQOL) after 3-level or more multilevel anterior cervical discectomy and fusion (ACDF). Previous researchers reported that T1 slope minus C2-C7 lordosis (TS-CL) and cervical sagittal alignment affect HRQOL scores following multilevel posterior cervical fusion surgery. However, there has been no report of a relationship between cervical alignment and patient outcome after multilevel ACDF.

MATERIALS AND METHODS : A total of 33 patients underwent multilevel ACDF with cervical stenosis, HIVD, and OPLL between February 2006 and April 2017. The mean follow-up duration was 57.6 ± 33.2 months. Radiographic measurements included C0-C2 lordosis, C2-C7 lordosis, C2-C7 sagittal vertical axis (SVA), T1 slope, and TS-CL. The clinical outcomes were evaluated by Neck Disability Index (NDI) and Visual Analog Scale (VAS) scores

RESULTS : The C2-C7 SVA values were less than 10mm in 5 patients, 10-20 in 9 patients, 20-30 in 13 patients, 30-40 in 5 patients and more than 40 in 1 patient after surgery. The C2-C7 SVA was not significantly different before and after surgery and was not correlated with NDI scores. Significant correlations were found between C2-C7 lordosis and T1 slope ($r=0.581$, $P=0.004$), between C2-C7 lordosis and TS-CL ($r=-0.579$, $P=0.004$). However, C2-C7 lordosis, C2-C7 SVA and TS-CL had no significant correlation with NDI and VAS score after surgery. Whereas, postoperative TS-CL ($P=0.01$) and changes of T1 slope ($P=0.028$) and TS-CL ($P=0.01$) were significantly correlated with NDI changes.

CONCLUSION : Multilevel ACDF surgery under neutral supine position did not change the postoperative cervical alignment significantly. Thus, multilevel ACDF surgery under neutral supine position might not affect the cervical alignment and HRQOL significantly.

2년 이상의 추적관찰을 통한 단일 및 다부위 케이지 단독 전방 경추 융합술의 결과

이 정 길, 박 재 영, 김 상 덕, 문 봉 주

전남대학교병원 신경외과

PURPOSE : The aim of this study was to evaluate long-term follow-up radiologic/clinical results of patients who underwent anterior cervical discectomy and fusion (ACDF) with stand-alone cages (SAC) in a single institution.

MATERIALS AND METHODS : Total 59 patients who underwent ACDF with SAC for degenerative cervical disorder between January 2002 and February 2014 were evaluated retrospectively. A total of 89 segments were included in this study. Basic demographic information, radiographic [segmental subsidence rate, fusion rate, C2-7 global angle, and segmental angle changes]/clinical outcomes (by visual analog score (VAS)) and complications were evaluated to determine the long-term outcomes.

RESULTS : The majority were males (39 vs. 20) with average age of 51.9. Mean follow-up period was 57.0 months (24.2 ~ 129.8 months). The segmental subsidence rate was about 45% and fusion rate was 96.6%. Adjacent segmental disease was occurred in 3 (5%) patients, and no reoperation was performed at the index level. The kyphotic change of segmental angle and cervical sagittal angle were 2.3 and 0.7 degrees. There was no statistical significance between clinical and radiological outcomes. But, overall long-term clinical outcome by neck and arm VAS was satisfactory

CONCLUSION : Long-term outcomes of ACDF with SAC group were acceptable and satisfactory. ACDF with SAC can be an effective, reliable, and safe alternate for ACDF with plating.



경추 전방접근 후에 발생하는 경추 추간판 침강에 관여하는 위험인자 분석

이 정 재, 이 동 훈, 김 영 일, 조 철 범, 양 승 호, 성 재 훈, 이 상 원, 이 종 범, 김 일 섭, 흥 재 택
성빈센트병원

PURPOSE : Interbody spacer settling is a frequently observed occurrence after spinal fusion. Although a certain amount of subsidence can result from resorption of bony spacers or corrosion from metallic interbody implants. In anterior cervical spine fusion, cortical bone allografts and cancellous bone allograft was used for interbody spacer use.

MATERIALS AND METHODS : We retrospectively reviewed ACDF cases from January 2013 to December 2015 at one institution. All surgeries were performed by a fellowship-trained orthopedic spine surgeon. Approval of institutional review board was obtained prior to study initiation. There were 82 cases (35 females, 47 males) of ACDF with either cortical bone allograft(CG bio) or cancellous bone cages(ilic bone). Immediate post-operative and 3-month lateral cervical radiographs were evaluated for subsidence by measuring the middle disc height and segmental lordosis at each operative level. Risk factor analysis was performed.

RESULTS : Our results showed that the 6 patients had symptom recur after post. foraminotomy surgery. The radiculopathy recurrence period was between one week and one year after surgery. (mean duration 4.7 month) The disc height of recurrence group (3.76 mm) significantly narrower than non-recurrence group (5.16 mm) ($p = 0.013$). Patients who combined post decompression (etc. lamioplasty, laminectomy) showed lower incidence of recurrence ($p < 0.01$). However, Patients who complain symptom recur, showed significantly larger lordotic C2-7 angle than non-recurrence group ($P 0.03$), foraminal diameter was smaller in recurrence group (3.75 mm) than non-recurrence group (5.16 mm).($p 0.13$) There is no statistical difference of two groups in other risk factors such as age, sex, osteophyte and post-fixation.

CONCLUSION : Radiographic subsidence after ACDF occurred in 46.8 % patients as of 12 months after the single-level ACDF. The lack of correlation between bad clinical outcome and radiographic subsidence may be due to segmental kyphosis, preserved posterior height, and maintaining the global cervical angle.

경추 후관절골절의 치료

조 용 재

이화여자대학교 목동병원 신경외과

PURPOSE : Facet joints are major stabilizers of cervical motion allowing for effortless and pain-free multidimensional cervical spine movements without significant linear or rotational translation, thus minimizing any chance for spinal cord or nerve root impingement. Unilateral, nondisplaced subaxial facet fractures do not meet the conventional criteria for spinal instability under physiological loads. Limited evidence indicates that even with no or minimal displacement, 20%–80% of these fractures fail nonoperative management. The risk factors for instability in isolated nondisplaced subaxial facet fractures remain uncertain. In this retrospective study of prospectively collected data, the authors attempted to identify the predictors of failure in the management of isolated, nondisplaced subaxial facet fractures admitted to our institutes.

MATERIALS AND METHODS : Demographic, clinical, imaging, and follow-up data for 25 patients with unilateral nondisplaced subaxial facet fractures who were managed surgically ($n = 10$) or nonoperatively ($n = 15$) were statistically analyzed.

RESULTS : The mean age of the patients was 38 years, 19 were male, and 21 of the fractures were the result of either motor vehicle accidents or falls. The mean motor score on the American Spinal Injury Association scale was 99.2, and the mean Subaxial Injury Classification (SLIC) severity score was 3 (operated 3.5, nonoperated 2.3). Allen mechanistic classification included 22 compressive-extension Stage 1 and 2 distractive-extension Stage 1 fractures. Subaxial facet fractures involved C-7 in 17 patients (68%), C-6 in 7 (28%), and C-3 in 1 (4%). The anatomical plane of fracture through the lateral mass was sagittal in 12 patients, axial in 8, and coronal in 3 patients. Nondisplaced floating lateral mass injuries were noted in 2 patients. The mean instability score, considering 7 components of the discoligamentous complex on MRI, was 3.2 (operated 3.6, nonoperated 3.0). Ten (40%) of 25 patients in this investigation did not have successful management, 9 in the nonoperated and 1 in the operated group ($p = 0.018$). Unsuccessful management was significantly greater in younger patients ($p = 0.0008$), possibly indicating selection bias ($p = 0.07$, Wilcoxon ranksum test). Fracture plane, instability, and SLIC scores did not play



a significant role in treatment failure in this study.

CONCLUSION : In this study, surgery was superior to nonoperative management of isolated, nondisplaced, or minimally displaced subaxial cervical spine facet fractures.

Prodisc-C를 사용한 경추인공디스크치환술: 단일 기관에서 10년이상 추적 관찰한 임상적 및 영상의학적 전향적 연구 결과

허정우¹, 박준근², 정호중¹, 조현진¹, 김진성¹, 류경식¹

¹가톨릭대학교 서울성모병원, ²굿닥터튼튼병원

PURPOSE : Cervical artificial disc replacement (ADR) is indicated for the treatment of severe radiculopathy permitting neural decompression and maintenance of motion. Previous reports of short and mid-term results have shown that cervical ADR using Prodisc-C is safe and effective in symptomatic CDD between C3 and C7. The objective of this study is to evaluate long-term clinical and radiologic results of ADR using the Prodisc-C in patients with single-level cervical disc disease (CDD) in minimum 10-year follow-up.

MATERIALS AND METHODS : Data were collected through a prospective registry, with retrospective analysis performed on 79 consecutive patients treated with cervical ADR with the Prodisc-C device (DePuy Synthes, West Chester, PA, USA) in a single institution. All enrollees were evaluated pre- and post-operatively at regular intervals using both clinical and radiologic parameters.

Clinical outcome measures included visual analogue scale (VAS) for neck and arm pain and Oswestry disability index (ODI). Serial flexion-extension cervical radiographs and CT scans were performed to assess range of motion (ROM) of index segment, adjacent segment degenerations (ASD), implant-related complications (migration, subsidence, lucency) and heterotopic ossification (HO) using McAfee classification system.

RESULTS : Out of 79 patients enrolled, 79.7% (63/79) of patients continued regular outpatient visit at the 5-year follow-up period. However, after 10 years, only 22.9% (17/71) of patients remained with the study. Average follow-up was 10.7 years.

After 5-year follow-up, neck and arm pain improved 68.6% and 86.8%, respectively, and ODI had an improvement of 85.7%. However, after the last visit, neck pain improvement decreased to 29.7%, whereas arm pain and ODI remained at 74.6% and 68.9%, respectively. Neurologic success rate was 82.3% after final assessment.

There were no episodes of device failure except one case of subsidence. Mean ROM of the device decreased from 6.7° at 5-year to 5.4° at final assessment. Radiographic ASD developed in 58.8% of



patients (mild; 29.4%, moderate; 23.5%, severe; 5.8%, respectively) and 58.8% demonstrated HO at the final follow-up, however, only 17.6% were symptomatic requiring second surgery.

CONCLUSION : The Prodisc-C device for cervical ADR appears to be safe and effective for the treatment of CDD after long-term follow-up. Despite radiographic evidence of ASD and HO on final assessment, Prodisc-C ADR provided maintenance of segmental motion at the index level and good neurologic success rate.

Arthroplasty for cervical spondylotic myelopathy with 30 months follow-up data

이 종 주

연세대학교 세브란스병원

PURPOSE : Cervical artificial disc replacement (ADR) is a surgical treatment introduced to overcome the adjacent segment disease of anterior discectomy and fusion (ACDF) by motion preservation. According to literature up to the 5 years follow-up, ADR showed clinical and radiologic results equivalent to ACDF in 1 level cervical disc disease with radiculopathy. However, studies on patients with cervical myelopathy have been poorly studied. Therefore, in this study, we aimed to investigate the results of cervical ADR with cervical spondylotic myelopathy during 30 months follow-up.

MATERIALS AND METHODS : From January 2003 to December 2011, we retrospectively reviewed 40 patients who were diagnosed as cervical spondylotic radiculopathy and myelopathy and underwent surgical treatment. We compared the whole cervical spine and segmental range of motion of preoperative, postoperative, 2 year and 5 years after surgery. Clinically, VAS score (neck, arm), JOA score, nurick score was compared between before surgery and immediately after surgery, 1 year after surgery, and 5 years after surgery.

RESULTS : Of the total 40 patients, 27 (67.5%) were male and 13 (32.5%) were female. The mean age was 45.25 (range 32–63 years) years. The mean follow-up period was 32.58 (range 12–115 months) months. The preoperative and the latest postoperative range of motion were $12.10 \pm 1.00^\circ$, and $15.26 \pm 7.49^\circ$ respectively at index level ($p > 0.05$). In the clinical evaluation, postoperative VAS, JOA, and nurick score significantly improved immediately after surgery and at 1 year after surgery and maintained at 5 years after surgery.

CONCLUSION : ADR showed equivalent clinical and radiologic results not only in patients with radiculopathy but also in patients with cervical spondylotic myelopathy for a minimum of 5 years. According to the patient's status, ADR may be a possible surgical option in patients with myelopathy.

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Free Paper I

Degenerative Cervical Spine

좌장 : 가톨릭관동대 **진병호**, 가천대 **김우경**

Risk factor analysis for OPLL progression in multilevel cervical OPLL patients by 3-dimensional volumetric measurement

이 종 주

연세대학교 신촌세브란스병원

PURPOSE : Ossification of the posterior longitudinal ligament (OPLL) is a disease caused by abnormal growth and calcification of the posterior longitudinal ligament, which may result in neurologic deficit due to narrowing of the spinal canal and cord compression. Despite the fact that OPLL is a three-dimensional (D) disease, conventional studies have mainly focused on two-dimensional measurement through simple radiography, computed tomography (CT) scan and it is also difficult to know accurately the volume of OPLL progression. Therefore, in this study, we evaluated various risk factors for OPLL progression in multilevel cervical OPLL patients with more than 3 levels by calculating OPLL progression with 3D measurement using Mimics® program.

MATERIALS AND METHODS : A total of 83 patients were retrospectively examined for age, sex, body mass index, hypertension, diabetes, type of OPLL, surgical method, and preoperative cervical curvature, preoperative and postoperative cervical range of motion. Preoperative cervical CT and the most recent follow up cervical CT were converted to digital imaging and communication in medical (DICOM) data, and the OPLL volume was three-dimensionally measured using Mimics® program. OPLL volume progression were analyzed by univariate and multivariate analysis, respectively.

RESULTS : Finally, a total of 83 patients were analyzed. The average follow up period was 32.19 (\pm 23.56) months. The mean age of the patients was 54.92(\pm 8.21) years. Each independent variable was statistically significant with annual OPLL progression rate (%/year) in univariate analysis at age ($p < 0.05$) and surgical method ($p < 0.05$). On the basis of this, only the surgical method ($p < 0.05$) showed a meaningful result in the multivariate analysis using age and OP method as independent variables.

CONCLUSION : In this study, we could measure the more accurate OPLL volume change using 3D method and found that the surgical method is a risk factor of OPLL progression.

언덕 모양의 후종인대골화를 치료에 경추 전방 유합술이 언제 적절한가?

노성현, 조용은, 김근수, 진동규, 구성욱, 박정윤, 김경현

연세대학교 강남세브란스병원

PURPOSE : The choice of surgical option for ossification of the posterior longitudinal ligament (OPLL) was based on pathological extent and cervical alignment. Short-segment pathology was treated via the anterior approach and long-segment pathology via the posterior approach. In case of hill shape OPLL, ACDF and ACCF are possible to remove of OPLL. However, the comparison of ACDF with ACCF for OPLL with regard to proper indication, surgical results, and radiological outcomes has never been addressed so far. Thus, this study was designed to evaluate the appropriate indication and surgical outcomes between these techniques.

MATERIALS AND METHODS : Fifty selective patients with hill shape OPLL who underwent surgery by anterior approach from January 2011 to December 2016 were retrospectively investigated (25 for ACDF, 25 for ACCF). Clinical outcomes including the Japanese Orthopedic Association (JOA) scales, visual analogue scale (VAS), Neck Disability Index (NDI) were reviewed and radiologic results were investigated such as occupying ratio (OR), fusion rate, subsidence, space available of spinal cord, cervical alignment, dimension rate of OPLL, OPLL-to-disc distance (ODD) of cephalad and caudal, ODD/ posterior body heights (PBH) of cephalad and caudal, and increased signal intensity (ISI) on preoperative T2-weighted magnetic resonance images (T2W MRI) between two groups.

RESULTS : Clinical measurement of both groups showed significant increases after a mean 21.52 ± 13.8 month follow-up. Both groups showed significant increases in postoperative cervical alignment at last follow-up ($p < 0.05$). Preoperatively, ACDF group's mean OR was significantly lower than that of ACCF group ($41.04 \pm 10.5\%$ vs $49.32 \pm 7\%$, $P < 0.05$) and ACDF group's mean space available of spinal cord was significantly higher than that of ACCF group (6.56 ± 1.6 mm vs 5.7 ± 1.2 mm, $P < 0.05$). ACDF group's mean dimension rate of OPLL was significantly lower than that of ACCF group ($10.44 \pm 1.16\%$ vs $26.68 \pm 1.07\%$, $P < 0.05$). Subsidence occurred in two cases (8%) in the ACCF group. Fusion occurred in 24 cases (96%) in the ACDF group, 22 cases (88%) in the ACCF group. ODD of cephalad and caudal, ODD/PBH of cephalad and caudal of ACDF group were significantly lower than those of ACCF group ($P < 0.05$).



Intraoperatively, ACDF group's mean operation time and bleeding volume were significantly lower than those of ACCF group (150.8 ± 64.02 minutes vs 276.8 ± 73.92 minutes, 209.2 ± 210.87 cc vs 650.8 ± 351.6 cc, $P < 0.05$). Prevalence of increased signal intensity (ISI) on preoperative T2-weighted MRI were significantly lower in ACDF compared to ACCF.

CONCLUSION : Both ACDF and ACCF provide satisfactory clinical outcomes and radiologic outcomes for hill shape OPLL. ACDF compared to ACCF could be more appropriate surgical techniques when there was no signal change in preoperative MRI and OR was less than 50% or ODD/PBH was less than 0.5 or dimension rate of OPLL was less than 20%.

치상돌기 분리증 환자군과 비 치상돌기 분리증 환자군의 경추 1-2간 후방 고정술 후 후두부 통증, 가동 범위 및 임상적 결과에 대한 비교

강 지 인, 하 윤, 윤 도 흠, 김 금 년, 이 성, 신 동 아

연세대학교 신경외과학교실

PURPOSE : The purpose of this study was to compare the effect of atlantoaxial fixation on ROM, suboccipital pain and clinical outcomes in patients with os odontoideum (OO) versus those without an os odontoideum (non-OO).

MATERIALS AND METHODS : A total of 119 patients who underwent atlantoaxial fixation for instability were identified between January 1998 and January 2014. Inclusion criteria included age more than 21 years and diagnosis of OO and non-OO. There were twenty-two OO patients, and twenty non-OO patients, which included six rheumatoid, 11 degenerative and three trauma patients. Regular follow-ups were performed at 3, 12, 24, 36, 48, 56, and 72 months after surgery. Standing plain radiographs of the cervical spine were obtained (lateral, flexion, and extension), and pre- and post-operative cervical spine alignment was assessed for the following 5 parameters: the Oc-C1 Cobb angle, C1-2 Cobb angle, C2-3 Cobb angle, C2-7 Cobb angle, and C2-7 sagittal vertical axis (SVA). The change in cervical sagittal alignment was defined as the difference between the pre- and post-operative Cobb angles, ROM and C2-7 SVA. Outcome assessment of suboccipital pain was determined using a visual analog scale (VAS), and Japanese Orthopaedic Association (JOA) scores were obtained in all patients pre- and post-operatively.

RESULTS : The average patient age of the OO group was 43.68 ± 15.50 years and the non-OO group was 52.95 ± 14.82 years ($p=0.06$). There were 3 males and 19 females in the OO group and 9 males and 11 females in the non-OO group ($p<0.01$). An average follow up in the OO group was 24.23 ± 19.17 months (range 7-71 months) and the non-OO group was 24.7 ± 11.8 months (range 7-71 months) ($p=0.92$). The preoperative C1-2 angle in the OO group ($26.02 \pm 10.53^\circ$) was significantly higher than the non-OO group ($19.76 \pm 8.48^\circ$) ($p=0.04$). The preoperative C2-7 SVA in the OO group (19.36 ± 10.31 mm) was significantly higher than the non-OO group (7.5 ± 11.65 mm) ($p=0.00$). After C1-2 fixation, the OO group had significantly higher kyphotic change in the C1-2 angle ($\Delta C1-2$) [$3.2^\circ \pm 7.3^\circ$ (OO) vs. $-1.46^\circ \pm 7.21^\circ$ (non-OO)] ($p=0.04$), and higher decrease in postoperative C2-7 SVA



(Δ C2-7 SVA) [5.64 ± 11.56 mm (OO) vs. -0.51 ± 6.57 mm(non-OO)] ($p=0.04$). Both groups showed improvements in the health related quality of life (HRQOL) after surgery based on the VAS and JOA score ($p<0.001$).

CONCLUSION : After fixation, kyphotic angular change in atlantoaxial joint and decrease C2-7 SVA were marked in the OO group. Both the OO and non-OO groups improved in neurological function and outcome after surgery.

경추 수술시 척추 동맥 개방성 평가를 위한 ICG 조영술의 유용성

이 종 범, 이 정 재, 김 일 섭, 흥 재 택

가톨릭대학교 성빈센트병원

PURPOSE : Indocyanine green (ICG) videoangiography is a new technique that allows for real-time evaluation of blood flow in the aneurysm and vessels. Intra-operative indocyanine green (ICG) videoangiography is a useful addition to cerebrovascular neurosurgery.

We evaluate the usefulness and limitation of ICG videoangiography during the cervical posterior fixation to evaluate the patency of the vertebral artery in the cases with high risk of VA injury.

MATERIALS AND METHODS : Twenty-one patients (14 female, 7 male; mean age, 54.4 years) were evaluated. Near infrared ICG angiography was applied after the posterior screw fixation in the cases of high riding VA at the level of C2 vertebra, V3 segment anomaly and the situation of the VA injury was suspected during the surgical procedure.

RESULTS : ICG videoangiography is useful in different types of upper cervical posterior surgery. This technique is useful to evaluate the VA patency after screw instrumentation especially in the cases of the VA anomaly and high riding VA. And it is useful to identify the vessel patency after the inevitable VA management during the procedure. Overall, the procedure interrupted the surgical procedure for less than 5 minutes. One case of adverse skin reaction to the dye was encountered due to the dye leakage outside the vessel during the injection.

ICG videoangiography has some limitations such as its inability to be viewed outside of the observed plane of illumination with infrared light and inconsistent complete washout, making repeated viewing sometimes difficult in structures surrounded by thick and excessive tissue.

Quantitative evaluation of vessel flow is not possible with ICG videoangiography.

CONCLUSION : ICG angiography could be a simple intraoperative evaluating tool with which the patency of the extracranial vertebral artery can be assessed. Compared with digital subtraction angiography, ICG angiography requires less time, personnel, and equipment, is safer, and can resolve smaller vessels, but is limited by the surgeon's viewing angle and the depth of penetration of the infrared light. Even though it is necessary to expose the VA above the C1 arch or lateral to the C1 lateral mass to identify the ICG



flow in the cases of CVJ surgery, it can be a useful tool to verify the patency of the possibly damaged VA during the screw placement. Unlike ultrasound technology, this technique is a hands-off method that can inform the surgeon about the flow patency of the extracranial vertebral artery.

새로운 경추 척추 시상면 영상학적 인자로서의 K-line 기울기

오재근, 김현식

한림대 성심병원

PURPOSE : To assess the relationship between K-line tilt and classical cervical parameters in cervical sagittal alignment.

MATERIALS AND METHODS : We reviewed 50 patients over 60 years old with cervical spine lateral X-ray without previous cervical spine surgery and checked cervical spine parameters. Radiographic measurements included K-line tilt, C2-C7 lordosis, C2-C7 sagittal vertical axis (SVA), T1 slope, and T1 slope minus C2-C7 lordosis (T1S-CL). Pearson correlation coefficients were calculated between each cervical parameters.

RESULTS : Of 50 patients, there were 33 male patients. Mean age was 70.84 ± 7.52 . Mean K-line tilt was 11.28 ± 8.31 . K-line tilt was correlated with C2-C7 SVA ($r=0.813$, $P=0.000$) and T1S-CL ($r=0.315$, $P=0.026$) statistically. Approximately K-line tilt $> 20^\circ$ is C2-C7 SVA $> 40\text{mm}$.

CONCLUSION : This study showed that K-line tilt is an effective novel parameter as C2-C7 SVA and T1S-CL in cervical sagittal alignment.

후종인대 골화증을 동반한 경추성 척수증의 후방 하이브리드 수술법: 후향적 연구

신제임스키, 류 달 성, 윤 승 환

인하대학교병원 신경외과

PURPOSE : To recognize the outcomes of a posterior hybrid decompression for cervical spondylotic myelopathy (CSM) associated with ossification of posterior longitudinal ligament (OPLL).

MATERIALS AND METHODS : This study retrospectively reviewed 17 CSM patients with OPLL who had hybrid decompression by a single surgeon over a 7-year period with a minimum of 12 months of follow-up. The procedure contained reconstruction of cervical lamina using Centerpiece plates. Surgical outcomes were assessed by Japanese Orthopedic Association (JOA) score, outcomes, many radiological profiles such as cervical range of motion, Cobb's method for measuring cervical lordosis and spinal canal sagittal diameter, bone healing rates on both the hinge and open sides, and postoperative neck pain assessed by visual analog scale.

RESULTS : Postoperative JOA score improved significantly, with a mean recovery rate of 62.1%. Mean cervical lordotic angle had decreased 3.8 degrees by 1 year after surgery (C.I. 0.05). Preservation of cervical range of motion was mostly satisfactory postoperatively. Bone healing rates 6 months after surgery were 89% on the hinge side and 92.2% on the open side using postoperative CT scan. Satisfactory outcomes were demonstrated by a significantly increased spinal canal.

CONCLUSION : Hybrid decompression using Centerpiece plates leads to bone fusion and produce a comparatively prognosis for CSM patients with OPLL.

낮은 T1 경사면과 Stand-alone cage를 이용한 ACDF에서 subsidence의 관련성

이수현, 송근성, 손동욱, 김동하, 이준석

양산부산대학교병원

PURPOSE : Preoperative parameters including the T1 slope (T1S) and C2-7 sagittal vertical axis (SVA) have been recognized as predictors of kyphosis after laminoplasty, which is accompanied by posterior neck muscle damage. The importance of preoperative parameters has been under-estimated in anterior cervical discectomy and fusion (ACDF) because there is no posterior neck muscle damage. We aimed to determine whether postoperative subsidence and pseudarthrosis could be predicted according to specific parameters on preoperative plain radiographs.

MATERIALS AND METHODS : We retrospectively analyzed 41 consecutive patients (male:female, 22:19; mean age, 51.15 ± 9.25 years) who underwent ACDF with a stand-alone polyether-ether-ketone (PEEK) cage (> 1 year follow-up). Parameters including SVA, T1S, segmental angle and range of motion (ROM), C2-7 cervical angle and ROM, and segmental inter-spinous distance were measured on preoperative plain radiographs. Risk factors of subsidence and pseudarthrosis were determined using multivariate logistic regression.

RESULTS : Fifty-five segments (27 single-segment and 14 two-segment fusions) were included. The subsidence and pseudarthrosis rates based on the number of segments were 36.4% and 29.1%, respectively. Demographic data and fusion level were unrelated to subsidence. A greater T1S was associated with a lower risk of subsidence ($p=0.017$, odds ratio=0.206). A cutoff value of T1S $< 28^\circ$ significantly predicted subsidence (sensitivity: 70%, specificity: 68.6%). There were no preoperative predictors of pseudarthrosis except old age.

CONCLUSION : A lower T1S (T1S $< 28^\circ$) could be a risk factor of subsidence following ACDF. Surgeons need to be aware of this risk factor and should consider various supportive procedures to reduce the subsidence rates for such cases.

K-line 양성의 경추부 후종인대 골화증에서 후궁성형술 및 후궁성형-유합술의 결과 비교

김 일 섭, 이 상 원, 성 재 훈, 양 승 호, 조 철 범, 이 정 재, 이 종 범, 홍 재 택

가톨릭대학교 성빈센트병원 신경외과

PURPOSE : The K-line, which is a virtual line that connects the midpoints of the anteroposterior diameter of the spinal canal at C2 and C7 in a plain lateral radiogram, is a useful preoperative predictive indicator for sufficient decompression by laminoplasty for ossification of the posterior longitudinal ligament (OPLL). K-line is defined as (+) when the peak of OPLL does not exceed the K-line, and is defined as (-) when the peak of OPLL exceeds the K-line. For patients with K-line (+) OPLL, laminoplasty, which preserve cervical motion, and posterior decompression with fusion, which preserve cervical lordosis, and prevent OPLL progression are treatment options. The aim of the present study was to compare the clinical outcome of laminoplasty and laminoplasty with instrumented fusion for the patients with K-line (+) OPLL.

MATERIALS AND METHODS : A total 43 cases of K-line (+) OPLL patients who underwent laminoplasty (Lam Group, n=26) and laminoplasty with instrumented fusion (LIF Group, n=17) during last 10 years, minimum follow-up 6 months were included in the present study. We retrospectively compared preoperative and last follow-up Japanese Orthopedic Association (JOA) scores, neck pain of visual analogue scale (VAS), C2-7 lordosis, C2-7 sagittal vertical axis (SVA), T1 slope, and JOA recovery rate (RR). Also, OPLL progression number, operation time and total blood loss during operation were evaluated between two groups.

RESULTS : Patients' preoperative JOA scores, VAS neck pain, C2-7 lordosis, C2-7 SVA, T1 slope were no significant differences between the two groups. The mean follow-up was 26 ± 6 (range 6-110) months in Group Lam, and 17 ± 7 (range 6-94) months in Group LIF, and difference between the two groups was not significant ($p = 0.859$). At the final follow-up, JOA scores of Group Lam, and Group LIF were 14.8 ± 2.4 and 15.5 ± 1.3 , respectively, and there was no significant difference between two groups ($p=0.475$). Also JOA RR were not significantly difference (Group Lam $51 \pm 35\%$, Group LIF $66 \pm 32\%$, $p=0.297$). And the improvement of VAS neck pain in Group Lam, and in Group LIF were 3.16 ± 1.9 and 3.35 ± 1.9 , respectively, and there was no significant difference between two groups ($p=0.778$).

At the final follow-up, the C2-7 lordosis significantly decreased in Group Lam (10.7° to 4.1°) and kept unchanged in Group LIF (7.7° to 8.9°). The SVA in Group Lam significantly increased (31.6mm to 36.5mm) and kept unchanged in Group LIF (30.9mm to 29.1mm). Differences in preoperative C2-7 lordosis and SVA between two groups were not significant, but became significant at the final follow-up ($p < 0.001$, 0.007). T1 slope kept unchanged in Group Lam (22.5° to 19.6°), and in Group LIF (19° to 16.8°) ($p = 0.679$). The number of OPLL progression at the final follow up in Group Lam and in Group LIF were 7/26, and 3/17, respectively (26.9%, 17.6%, $p = 0.410$). Mean total blood loss was 333 ± 50 (range 75-590) ml in Group Lam and 570 ± 83 (range 140-1500) ml in Group LIF ($p = 0.013$). Mean operation duration was 176 ± 16 (range 90-260) min and 253 ± 20 (range 105-490) min in Group Lam and LIF, respectively ($p = 0.006$). Number of cases who experienced C5 palsy was zero in Group Lam and three (3/17, 17.6%) in Group LIF.

CONCLUSION : Although postoperative kyphotic change and sagittal imbalance were larger after the Lam than those after the LIF in K-line (+) OPLL, the improvements of neurologic function, axial neck pain and OPLL progression were not significantly different.

laminoplasty 이후 관상면에서의 척추 전만의 예측 인자 분석

이준석, 송근성, 손동욱, 김동하, 이수현

양산부산대학교병원

PURPOSE : Laminoplasty is an effective surgical method for treating cervical degenerative disease. However, postoperative complications such as kyphosis, restriction of neck motion, and instability are often reported. Despite sufficient preoperative lordosis, this procedure often aggravates the lordotic curve of the cervical spine and straightens cervical alignment. Hence, it is important to examine preoperative risk factors associated with postoperative kyphotic alignment changes. Our study aimed to investigate preoperative radiologic parameters associated with kyphotic deformity post laminoplasty.

MATERIALS AND METHODS : We retrospectively reviewed the medical records of 49 patients who underwent open door laminoplasty for cervical spondylotic myelopathy (CSM) or ossification of the posterior longitudinal ligament (OPLL) at our institution between January 2011 and December 2015. Inclusion criteria were as follows: 1) preoperative diagnosis of OPLL or CSM, (2) no previous history of cervical spinal surgery, cervical trauma, tumor, or infection, 3) minimum of one-year follow-up post laminoplasty with proper radiologic examinations performed in outpatient clinics, and 4) cases showing C7 and T1 vertebral body in the preoperative cervical sagittal plane. The radiologic parameters examined included C2-C7 Cobb angles, T1 slope, C2-C7 sagittal vertical axis (SVA), range of motion (ROM) from C2-C7, segmental instability, and T2 signal change observed on magnetic resonance imaging (MRI). Clinical factors examined included preoperative modified Japanese Orthopedic Association (JOA) scores, disease classification, duration of symptoms, and the range of operation levels.

RESULTS : Mean preoperative sagittal alignment was 13.01° lordotic; 6.94° lordotic postoperatively. Percentage of postoperative kyphosis was 80%. Patients were subdivided into two groups according to postoperative Cobb angle change; a control group (n=22) and kyphotic group (n=27). The kyphotic group consisted of patients with more than 5° kyphotic angle change postoperatively. There were no differences in age, sex, C2-C7 Cobb angle, T1 slope, C2-C7 SVA, ROM from C2-C7, segmental instability, or T2 signal change. Multiple regression analysis revealed T1 slope had a strong relationship with postoperative cervical kyphosis. Likewise, correlation analysis revealed there was a statistical significance between T1

slope and postoperative Cobb angle change (P value: 0.035), and that there was a statistically significant relationship between T1 slope and C2–C7 SVA (P value: 0.001). Patients with higher preoperative T1 slope demonstrated loss of lordotic curvature postoperatively.

CONCLUSION : Laminoplasty has a high probability of aggravating sagittal balance of the cervical spine. T1 slope is a good predictor of postoperative kyphotic changes of the cervical spine. Similarly, T1 slope is strongly correlated with C2–C7 SVA.

경추 1-2번간 후방고정술에 대한 생역학적 비교연구 : 유한요소 해석

전 동 현

신촌 세브란스병원 신경외과학교실

PURPOSE : To compare the biomechanical stability imparted to the C1 and C2 vertebrae by transarticular screw fixation, C1 lateral mass - C2 pedicle/pars/trans laminar screw fixation techniques in a finite element study

MATERIALS AND METHODS : From computed tomography images, a nonlinear intact three-dimensional C1-2 finite element model(FEM) had been developed and validated. Then four FEMs were reconstructed from different C1-2 fixation techniques. Range of motion and maximum von Mises stresses in the instruments for the four screw techniques were compared under various motion(flexion, extension, lateral bending, axial rotation)

RESULTS : The C1 lateral mass- C2 pedicle screw fixation technique showed the greatest decrease in ROM in unstable models with flexion / extension and lateral bending. Transarticular screw fixation and the C2 pars screw fixation technique showed less ROM reduction compared to the other fixation in flexion / extension. Translaminar screws showed the least decrease in ROM during axial rotation compared to other techniques. The maximum von Mises stress on the screw in each fixation technique occurred at different sites. In the case of transarticular fixation, the maximum stress was in the C1 / 2 joint region. In the C2 pedicle screw, C1 rod head, C2 pars screw and C2 translaminar screw were stressed at the C2 rod head. The maximal von Mises stress on the transarticular screw at the C1 / 2 joint site was the highest at flexion / extension, whereas the C1 lateral mass-C2 pedicle screw technique had the lowest stress on the screw at flexion/extension and lateral bending. The C1 lateral mass-C2 translaminar screw showed the highest stress in axial rotation and lateral bending compared to other techniques.

CONCLUSION : The C1 lateral mass - C2 pedicle screw fixation provided the highest stability among 4 different techniques. the the maximum stress site on the screw differs according to each screw type, the surgeon needs careful confirmation of the site at the postoperative follow up.

경추 척수증 환자의 수술 결정에서 운동성 MRI 의 유용성

이 종 범, 권 재 열, 흥 재 택, 김 일 섭, 이 정 재

가톨릭대학교 성빈센트병원

PURPOSE : The aim of our study was to decide to analyze significance of dynamic MRI for cervical myelopathy.

MATERIALS AND METHODS : Patients with cervical myelopathy (n=106) who underwent dynamic MRI were included in this study. We performed a retrospective analysis of surveillance data collected between Feb. 2014 and April 2017, 106 patients who had a spondylotic myelopathy at our institution. We measured diameter of the spinal canal and thickness of the ligamentum flavum (LF) at sagittal T2-weighted sequence. Evaluation of spinal stenosis at the neutral position, extension and flexion using grading system, Muhle's classification. And we made two kinds of groups, cervical spondylotic myelopathy (CSM) and ossification of longitudinal ligament (OPLL). Than the measurements of the cervical spine in flexion, neutrality and extension were compared between CMS and OPLL.

RESULTS : Total 84 patients were included. 22 of 106 patients were excluded. 2 patients diagnosed to tumor. 8 patients diagnosed to instability. 4 patients diagnosed to trauma. 8 patients were excluded due to absence of neutral image. Diameter of the spinal canal of the extension position was tended to become more narrowing than neutral position. Especially, diameters of spinal canal on C3-4, 4-5, 5-6 were more difference. The differences of diameter on C3-4, 4-5, 5-6 were 7.90 / 6.84, 7.23 / 5.88, 7.03 / 5.96 (neutral position /extension). And these values were about CSM group

CONCLUSION : Extension image of dynamic MRI could be more effective in CSM cases rather than OPLL cases.

상부 경추 고정술 시행후 하부 경추 배열 변화의 위험성 분석

이 종 범, 이 정 재, 김 일 섭, 흥 재 택

가톨릭대학교 성빈센트병원

PURPOSE : There have been few analysis about risk factors related to postoperative subaxial cervical kyphosis following craniovertebral junction (CVJ) fixation

The aims of this study were to evaluate the changes of cervical alignment and analyze the risk factors of postoperative kyphotic change of subaxial cervical spine after CVJ fixation.

MATERIALS AND METHODS : The authors retrospectively reviewed 115 patients in whom CVJ pathology was treated with upper cervical fixation. Angles of OC1, C12, OC2 and C27 were determined based on an upright lateral radiograph in flexion, neutral and extension positions. The range of motion (ROM) at OC1, C12, OC2 and C27 was determined. The association between OC1, C12, OC2 and C27 angle was also investigated. All patients were examined before and 1 year after the surgery.

The postoperative subaxial cervical kyphotic change group included the patients whose C27 angle change was greater than -10 degree. The reciprocal changes of the C27 angle and other parameters (age, sex, etiology, occipital fixation, semispinalis cervicis resection at C2 spinous process, additional C12 posterior wiring and subaxial laminoplasty) were investigated. Univariate and multivariate analyses were conducted to determine the risk factors for postoperative kyphotic change of subaxial cervical spine.

RESULTS : The mean angles of preoperative OC1, C12, OC2 and C27 angle in neutral position were -7.7 , 19.6 , 12.0 and 13.4 retrospectively. Those at final follow up were -7.3 , 18.1 , 10.8 and 13.3 retrospectively.

There were statistically significant correlation between C12 angle change, OC2 angle change and C27 angle change. The C27 angle change was greater than -10 degree in twenty-nine of the 115 patients (25.2%).

Risk factor analysis showed combined CVJ fixation with subaxial laminoplasty (OR=10.326, 95% confidence interval [CI]=1.593-66.943, P=0.014), occipital fixation (OR=5.062, 95% CI=1.742-14.708, P<0.01), and reduced range of motion (ROM) at C0-1 segment (OR=0.823, 95% CI=0.741-0.914, P<0.01) were related to the postoperative subaxial kyphosis.



Resection of C2 semispinalis cervicis muscle, rheumatoid arthritis, additional C12 posterior wiring were not the risk factor of subaxial kyphosis

CONCLUSION : We demonstrated that alignment of subaxial cervical spine changed significantly at the 1 year follow-up after CVJ posterior fixation. Subaxial cervical alignment has reciprocal interaction with upper cervical angle after CVJ fixation. Our study suggest that combined subaxial laminoplasty, occipital fixation and reduced ROM of C01 segment are associated with subaxial kyphotic change after upper cervical fixation.

2017. **9.16** (Sat.)



Luncheon Seminar II

좌장 : 고려대 김세훈, 인하대 윤승환

1. Current Multicenter Clinical Trials of E-Coli derived rhBMP-2 for Spine Fusion

연세대 **진동규**

2. Realizations of 3D printed Product in Spine Surgery – Merits and Concerns

순천향대 **임수빈**



Current Multicenter Clinical Trials of E-Coli derived rhBMP-2 for Spine Fusion

진 동 규
연세대



Realizations of 3D printed Product in Spine Surgery- Merits and Concerns

임 수 빈

순천향대

2017. 9. 16 (Sat.)



Emerging Technology

Predictive Analytics in Spine Surgery Outcomes

좌장 : 가톨릭대 김대현, 영남대 김상우

1. Introduction of Modified 'Frailty Index' from National Surgical Quality Improvement Program (NSQIP) Surgical Risk Calculator

순천향대 박형기

2. FRAILITY as a Crucial Predictor of Outcomes for Spine Surgery Candidates

단국대 김영진

3. Patient-Reported Pain vs Actual QOL & Function

경희대 이준호

4. PROMIS vs Conventional Parameters (ODI, NDI, SF-36..)

가톨릭대 홍재택

박 형 기

순천향대학교 서울병원



최근 주요 약력

- 2007 Peripheral nerve surgery at Ochsner hospital
- 2010 Cyberknife radiosurgery center at Stanford university hospital
- 2011 Department of neuroendoscopy at Allegheny general hospital

최근 주요 경력

- 현재. 순천향대학교 서울병원 교수 (2015- 현재)
- 대한척추신경외과학회 학술위원
- 대한말초신경학회 고시이사
- 대한노인신경외과학회 특별이사
- 대한척추종양연구회 운영위원

Introduction of modified frailty index from National Surgical Quality Improvement Program (NSQIP) surgical risk calculator

Hyunki Park

Department of Neurosurgery, Soonchunhyang University Seoul Hospital

Frailty is defined as a decrease in the physiological reserves as well as multisystem impairments that are separate from the normal process of aging. Frailty is one of the greatest challenges for healthcare professionals in societies faced with ageing populations. The concept of frailty denotes progressive physical and mental loss of function and vitality, with or without coexisting disease. It is associated with adverse health outcome, dependency, institutionalization and mortality. The Canadian Study of Health and Aging Frailty Index (CSHA-FI) includes easily identified patient characteristics derived from a history and physical examination. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP®) has helped hundreds of hospitals across the country measurably improve surgical patient outcomes. The CSHA-FI includes easily identified patient characteristics derived from a history and physical examination. Because the NSQIP database contains similar variables, frailty can be assessed using some of these CSHA-FI variables obtained from NSQIP data for various surgical populations. 16 variables in the NSQIP database were matched to 11 corresponding items used in the CSHAFI. These 11 variables were used to calculate the modified frailty index (mFI), a prevalidated risk assessment tool. The mFI was created by Tsiouris et al. Recently Ali et al. studied an mFI based on the CSHA-FI and the data available on NSQIP to predict the postoperative morbidity and mortality for patients undergoing spine surgery. It is a useful tool for risk stratification and serves as an objective measure to help describe potential risks of spine surgery to patients and their families. In this presentation, I will introduce the latest concepts and research on the modified frailty index.

김 영 진

Dankook University Hospital



Education and Training

- 1998–2002, Feb Residency training of Neurosurgery, Hanyang University Medical Center, Seoul, Korea
- 1997–1998, Feb Internship training, Hanyang University Medical Center, Seoul, Korea
- 2006–2008, Aug Hanyang University Postgraduate Research course, Seoul, Korea (Ph.D.)
- 1999–2000, Aug Hanyang University Postgraduate Research course, Seoul, Korea (M.S.)
- 1991–1997, Feb Hanyang University School of Medicine, Seoul, Korea (M.D.)

Appointments and Positions

- Mar.2015–Feb.2016 Visiting Scholar (UC DAVIS MEDICAL CENTER)
- Mar.2012–present Associate Professor, Department of Neurosurgery,
Dankook University School of Medicine, Cheonan, Korea
- Mar. 2006–Feb.2012 Assistant Professor, Department of Neurosurgery,
Dankook University School of Medicine, Cheonan, Korea
- May,2005–Feb,2006 Neurosurgery Fellowship (SPINE)
Hanyang University Medical Center, Seoul, Korea
- Mar.2002–Apr.2005 Korean Military Service (Army Neurosurgeon)

Membership

- Korean Neurological Society
- Korean Spinal Neurosurgery Society
- Korean Cervical Spine Research Society
- Asia Pacific Cervical Spine Society
- Korean Neurotraumatology Society

FRAILITY as a crucial predictor of outcomes for spine surgery candidates

김 영 진

단국대

Background : Surgery for patients with degenerative spine is associated with high complication rates and significant concerns present during risk stratification with older patients. The relationship between frailty and postoperative outcomes after degenerative spine surgery has been needed.

Contents of lecture : This lecture contains as followings– a) determination of prevalence of frailty in the degenerative spine population, b) description of characteristics associated with frailty, c) determination of the association between frailty and postoperative complications, mortality, length of stay, and discharge disposition.

Methods : To survey keywords on PubMed.gov and founded several best corresponding reports. Analysed these reports and summarized the role of frailty as a predictor of outcomes. A modified frailty (mFI) is also introduced and used as a tool of analysis.

이준호

경희의료원



최근 주요 약력

- 서울대병원 임상 강사
- 국군서울지구병원 청와대 의무실
- 강남우리들병원 진료원장, 국제환자센터장, 수가위원장
- 경희대병원 신경외과 부교수

최근 주요 경력

- 대한신경외과학회 정회원
- 대한척추신경외과학회 학술위원
- 대한최소침습학회 대외협력이사
- 대한경추연구회 학술위원
- 대한의학레이저학회 상임이사, 윤리위원장
- Member, International Tier I, North American Spine Society
- Member, AOSpine Asia Pacific, North America
- Committee member, Walter E. Dandy Society

The role of PROMIS (Patient-Reported Outcomes Measurement Information System)

이 준 호

경희대병원

Background : Patient-reported outcome measures have become important tools for assessing health status in a variety of patient populations. Many historically or commonly used patient-reported outcome measures in orthopaedics or neuro-spinal surgical fields are narrow in scope and are limited by the burden associated with their administration, making them useful only for specific populations. Meanwhile, patient-reported outcomes (PROs) provide vital information when assessing effectiveness of clinical care. The Patient-Reported Outcomes Measurement Information System (PROMIS) was developed to overcome these limitations.

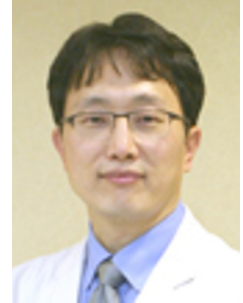
Methods : The PROMIS system was developed using item response theory, a physical function (PF) item bank consisting of 124 items, which allows for reliable and efficient estimation of underlying health traits using targeted item banks to assess PF in the upper and lower extremities.

Results : PROMIS has been validated in patient populations with orthopaedic disorders of the foot and ankle, upper extremity, and recently of the spine. It has demonstrated a marked improvement in measurement characteristics and reduced patient and administrative burden. Studies aiming to evaluate the psychometric properties of the PROMIS PF item bank specifically for patients presenting with spine-related complaints have well, adequately addressed outcomes of patients with spinal disorders as reliabilities were excellent, minimal ceiling/floor effect existed, and item bias was limited

Conclusions & Limits : PROMIS Physical Function measures are useful for assessing spinal surgeries outcomes and are superior to legacy measures in several key populations. Future effort should be focused on eliminating, rescaling, or modifying those items that had item bias.

홍재택

가톨릭의대 성빈센트병원



최근 주요 약력

- 2016 Best Paper Award, The Korean Society of Intraoperative Neurophysiological Monitoring
- 2015 Lami Academic Award, The Korean Spinal Neurosurgery Society
- 2015 Best Paper Award, The Korean Spinal Neurosurgery Society
- 2012 Lami Academic Award, The Korean Spinal Neurosurgery Society
- 2011 Best Paper Award, The Korean Spinal Neurosurgery Society

최근 주요 경력

- 2017–present Reviewer, Operative Neurosurgery
- 2017–present Editorial board, Annals of Neurological Surgery
- 2016–present Reviewer, The Spine Journal
- 2016–present Reviewer, Neurosurgery
- 2016–present Reviewer, European Neurology



PROMIS vs conventional parameters (ODI, NDI, SF-36..): would it outperform in the ERA OF 'PREDICTIVE' SPINE SURGERY?

Jae Taek Hong

Department of Neurosurgery St. Vincent's Hospital, Catholic University of Korea

Introduction

The Era of Outcomes Assessment

Outcomes in clinical practice provider, the patient, the public, and the payer are able to **assess the end results of care** and its effect upon the health of the patient and society.

Anderson & Weinstein, 1994

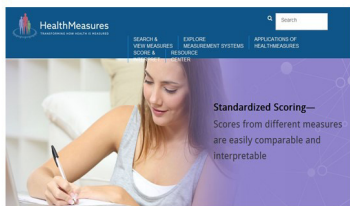
Contents

- PROMIS ?
- Simulation
- Multiple Parameters ?
- Benefits
- Supplements

Contents - PROMIS

• PROMIS - CAT ?

- P (Patient)
- R (Reported)
- O (Outcomes)
- M (Measurement)
- I (Information)
- S (System)
- CAT (Computer adaptive testing)



Standardized Scoring—
Scores from different measures
are easily comparable and
interpretable

Contents - PROMIS

- Patient – Reported Outcomes
 - Are They Living Up to Their Potential ?
- Growing chorus of support
- Still important practical questions

Collected
Visualized
Shared
Used to improve the quality of care

From Baumhauer JF. Patient – Reported Outcomes Are They Living Up to Their Potential ?
N Engl J Med . 2017;377(1):6-9



Contents - PROMIS

- Patient – Reported Outcomes
 - Are They Living Up to Their Potential ?

< Meaningful >

- ❖ Patients
- ❖ Institutions
- ❖ Surgeons

Time Point	Mean Score	N
Baseline	~40	107
3 Wk	~38	64
10 Wk	~45	75
20 Wk	~50	71
52 Wk	~58	13

Time Point	Mean Velocity (m/sec)	N
Baseline	~100	106
3 Wk	~95	64
10 Wk	~115	75
20 Wk	~120	71
52 Wk	~125	12

Physical Function Assessments after Knee-Ligament Reconstruction. Mean PROMIS physical function T scores (Panel A) and GAITRite velocity scores (Panel B) were obtained at baseline and over 1 year. Error bars indicate the standard error, and asterisks a significant difference from baseline (P<0.001). Modified from Papuga et al.⁷

From Baumhauer JF. Patient – Reported Outcomes Are They Living Up to Their Potential ? N Engl J Med .2017;377(1):6-9

Contents - PROMIS

- PROMIS - CAT ?
 - Health related Quality of life

PROMIS® Adult Self-Reported Health

Global Health

PROMIS Profile Domains

- Physical Health
 - Fatigue
 - Pain Intensity
 - Pain Interference
 - Physical Function
 - Sleep Disturbance
- PROMIS Additional Domains
 - Dyspnea
 - Gastrointestinal Symptoms
 - Pain Behavior
 - Pain Quality
 - Sexual Function
 - Sleep-related Impairment

Mental Health

- Anxiety
- Depression
- Alcohol
- Anger
- Cognitive Function
- Life Satisfaction
- Positive Affect
- Psychosocial Illness Impact
- Self-efficacy for Managing Chronic Conditions
- Smoking
- Substance Use

Social Health

- Ability to Participate in Social Roles & Activities
- Companionship
- Satisfaction with Social Roles & Activities
- Social Isolation
- Social Support

Contents - Simulation

- INTRO TO PROMIS
- OBTAIN & ADMINISTER MEASURES
- MEASURE DEVELOPMENT & RESEARCH

Interested in using PROMIS Computer Adaptive Tests (CATs)?
Try the PROMIS CAT Demo>>

Contents - Simulation

- INTRO TO PROMIS
- OBTAIN & ADMINISTER MEASURES
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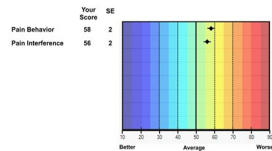
Interested in using PROMIS Computer Adaptive Tests (CATs)?
Try the PROMIS CAT Demo>>



Contents
- Simulation

Computerized Adaptive Test (CAT) Report

Date: 21-Aug-17
Your age: 45
Your gender: Male
Computerized Adaptive Tests: Pain Behavior, Pain Interference



Your score on the Pain Behavior CAT is 56. The average score is 50.
Your score indicates that your level of Pain Behavior is higher (worse) than:
- 72 percent of people in the general population
- 62 percent of people age 45-54
- 72 percent of males

Your score on the Pain Interference CAT is 56. The average score is 50.
Your score indicates that your level of Pain Interference is higher (worse) than:
- 66 percent of people in the general population
- 56 percent of people age 45-54
- 71 percent of males

Contents
- Parameters

- Outcomes Assessment
 - Collection and recording of information relative to health processes
- Outcomes Management
 - Using information in a way that enhances patient care



From Hansen DT – The Clinical Application of Outcomes Assessment, Stanford Connecticut, Appleton & Lange, 2000

Contents
- Parameters

• Outcomes Criteria

- Utility: Is it useful?
- Reliability: Is it dependable?
- Validity: Does it do what it is supposed to ?
- Sensitivity: Can it identify patients with a condition?
- Specificity: Can it identify those that do not have the condition?
- Responsiveness: Can it measure differences over time?

Contents
- Parameters

• Pain perception

- Visual Analogue Scales
 - ◊ Reliable and Valid (Jensen and Karoly, 1993)
 - ◊ Advantages over other measurement methods (Scott and Huskisson 1976, Price et al 1994)
- Quadruple VAS
 - ◊ Four specific factors (Von Korff et al, 1992)
 - Current pain level
 - Average or Typical pain level
 - Pain level at its BEST
 - Pain level at its WORST

QUADRUPLE VISUAL ANALOGUE SCALE

Name: _____ Number: _____ Date: _____

INSTRUCTIONS: Please circle the number that best describes the question being asked.
NOTE: If you have more than one complaint, please answer each question for each individual complaint and indicate which score is for which complaint.

EXAMPLE: HEADACHE NECK LOW BACK

0 1 2 3 4 5 6 7 8 9 10

1. What is your pain RIGHT NOW?
0 1 2 3 4 5 6 7 8 9 10
2. What is your TYPICAL or AVERAGE pain?
0 1 2 3 4 5 6 7 8 9 10
3. What is your pain AT ITS BEST (How close to "0" does your pain get at its best)?
0 1 2 3 4 5 6 7 8 9 10
What percentage of your awake hours is your pain at its best? _____ %
4. What is your pain AT ITS WORST (How close to "10" does your pain get at its worst)?
0 1 2 3 4 5 6 7 8 9 10
What percentage of your awake hours is your pain at its worst? _____ %

Reference: Tussone S, Grindy D, Wright B.D., Lincoff A.M. (1988). Rasch analysis of Visual Analogue Scales. *Scandinavian Journal of Rehabilitation Medicine* 20: 106-111.

Contents
- Parameters

• ODI
(Oswestry Disability Index)

Low back specific pain/disability scales

High correlation with general pain/function outcome measures

0 -20 : Minimal disability
21-40 : Moderate disability
41-60 : Severe disability
61-80 : Crippling back pain
81-100: Bed -bound

• NDI
(Neck Disability Index)

Multitude of neck specific pain/disability scales

High correlation with general pain/function outcome measures

0 - 4 : No disability
5 - 14 : Mild disability
15-24 : Moderate disability
25-34 : Severe disability
Above 34 : Complete

Point total / 50 x 100 = % disability

From Mark O. Papuga, PhD – Correlation of PROMIS Physical Function and Pain CAT Instruments with ODI and NDI in Spine Patients
Spine 2016 July 15; 41(14) : 1153-1159

Contents
- Parameters

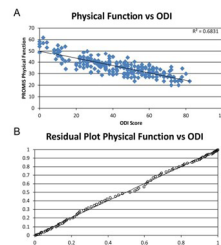


Figure 1. Linear regression analysis. Linear regression plots are shown illustrating the correlation of ODI with PROMIS physical function CAT for all patient visits (A). A significant correlation between ODI and PROMIS was found with a combined correlation value of 0.324 (p<0.0001). Residual plot demonstrates the appropriate use of a linear fit for the regression analysis, with a random and equal distribution about the predicted line (B).

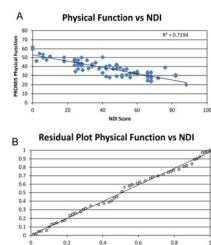


Figure 2. Linear regression analysis. Linear regression plots are shown illustrating the correlation of NDI with PROMIS physical function CAT for all patient visits (A). A significant correlation between NDI and PROMIS was found with a combined correlation value of 0.342 (p<0.0001). Residual plot demonstrates the appropriate use of a linear fit for the regression analysis, with a random and equal distribution about the predicted line (B).

From Mark O. Papuga, PhD – Correlation of PROMIS Physical Function and Pain CAT Instruments with ODI and NDI in Spine Patients
Spine 2016 July 15; 41(14) : 1153-1159



Contents
- Parameters

Conclusions
- in Spine Patients

Moderate to strong correlation with the ODI

Taking less time and requiring

- PROMIS CAT 35± 16 sec, 4.5± 1.8 questions
- ODI/NDI 188±85 sec, 10 questions

From Mark O. Papuga, PhD – Correlation of PROMIS Physical Function and Pain CAT instruments with ODI and NDI in Spine Patients Spine 2016 July 15; 41(14) : 1153-1159

Contents
- Parameters

- Short- Form (SF) – 36 Scales
 - Items : 10
 - Reliability : Exceed 0.80 (McHorney et al., 1994; Ware et al., 1993)
 - Scores range from 0 – 100 (Lower scores = more disability)
- Sections
 - Vitality
 - Physical functioning
 - Bodily pain
 - General health perceptions
 - Physical role functioning
 - Emotional role functioning
 - Social role functioning
 - Mental health

From Darrel S. Brodtko – PROMIS PF CAT Outperforms the ODI and SF-36 Physical Function Domain in Spine Patients Spine 2017; 42 : 921-929

Contents
- Parameters
(Distribution)

All four categories done

PROMIS PF CAT had far less unexplained variance

Ceiling effect and Floor effect improved
→ PROMIS PF-CAT is more sensitive for both high and low functioning populations of spine patients
→ Potentially a better instrument

Completion time
→ Half the SF-36 PFD
→ One-third of the ODI
→ Less patient and office burden

From Darrel S. Brodtko – PROMIS PF CAT Outperforms the ODI and SF-36 Physical Function Domain in Spine Patients Spine 2017; 42 : 921-929

Contents
- Parameters
(Reliability)

	Total Score	Count	Mean	Model Std. Error
PF CAT	448.2	117	3.8	0.16
Mean	448.2	117	3.8	0.16
Standard SD	115.0	117	1.26	0.06
Minimum	310.0	117	1.26	0.06
Maximum	586.0	117	1.26	0.06
ODI	188.0	117	1.62	0.07
Mean	188.0	117	1.62	0.07
Standard SD	85.0	117	0.66	0.03
Minimum	100.0	117	0.66	0.03
Maximum	273.0	117	0.66	0.03
SF-36	2352.0	117	20.1	0.88
Mean	2352.0	117	20.1	0.88
Standard SD	448.2	117	3.79	0.16
Minimum	494.4	117	3.79	0.16
Maximum	3003.0	117	3.79	0.16
ODI	188.0	117	1.62	0.07
Mean	188.0	117	1.62	0.07
Standard SD	85.0	117	0.66	0.03
Minimum	100.0	117	0.66	0.03
Maximum	273.0	117	0.66	0.03

The person reliability : PF CAT (r=0.87) SF-36 (r=0.87) ODI (r=0.87)
→ Patient functioning would occur in similar orderings in future studies.

The item reliability : PF CAT (r=0.99) SF-36 (r=1.00) ODI (r=1.00)
→ The order of item difficulty would be similar across populations.

From Darrel S. Brodtko – PROMIS PF CAT Outperforms the ODI and SF-36 Physical Function Domain in Spine Patients Spine 2017; 42 : 921-929

Contents
- Parameters

Conclusions
- in Spine Patients

Strong correlation with the ODI and SF-36 PED

Taking less time (PF CAT – 44 seconds, ODI – 169 seconds, SF-36 – 99 seconds)

The ceiling and floor effects were excellent

From Darrel S. Brodtko – PROMIS PF CAT Outperforms the ODI and SF-36 Physical Function Domain in Spine Patients Spine 2017; 42 : 921-929

Contents
- Parameters

- mJOA
 - Upper extremity function (5points)
 - Lower extremity function (7points)
 - Sensory function (3points)
 - Bladder function (3points)
- Score range from 0 – 18 (18 considered a normal)

Score	Definition
Minor dysfunction	
Upper extremities	
0	Unable to move hands
1	Unable to eat with a spoon, but able to move hands
2	Unable to button shirt, but able to eat with a spoon
3	Able to button shirt with great difficulty
4	Able to button shirt with slight difficulty
5	No dysfunction
Lower extremities	
0	Complete loss of motor and sensory function
1	Sensory preservation without ability to move legs
2	Able to move legs, but unable to walk
3	Able to walk on flat floor with a walking aid (cane or crutch)
4	Able to walk upstairs and/or downstairs with the aid of a handrail
5	Moderate to significant lack of stability, but able to walk up and/or downstairs without handrail
6	Mild lack of stability, but able to walk unaided with smooth recognition
7	No dysfunction
Sensory dysfunction	
Upper extremities	
0	Complete loss of hand sensation
1	Severe sensory loss or gain
2	Mild sensory loss
3	No sensory loss
Sphincter dysfunction	
0	Unable to micturate voluntarily
1	Marked difficulty in micturation
2	Mild to moderate difficulty in micturation
3	Normal micturation

mJOA : Modified Japanese Orthopedic Association

From Robert J. Owen M.D. - PROMIS Physical Function Correlation with NDI and mJOA in the Surgical Cervical Myelopathy Patient Population Spine 2017 accepted

Contents
- Parameters

Table 3. Strong correlation of both NDI and mJOA with PROMIS PF

	NDI + PROMIS PF		mJOA + PROMIS PF		NDI + mJOA	
	Baseline	Follow up	Baseline	Follow up	Baseline	Follow up
R	-0.69	-0.76	0.61	0.72	-0.51	-0.69
R squared	0.48	0.58	0.37	0.51	0.26	0.36
95% interval	(-0.82/0.38)	(-0.86/0.36)	(0.36/0.70)	(0.53/0.84)	(-0.72/0.26)	(-0.76/0.38)
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Legend: PROMIS PF = Patient Reported Outcome Measurement Information System Physical Function, NDI = Neck Disability Index, mJOA = Modified Japanese Orthopedic Association score

From Robert J. Owen M.D.- PROMIS Physical Function Correlation with NDI and mJOA in the Surgical Cervical Myelopathy Patient Population Spine 2017 accepted

Contents
- Parameters

Conclusions

- postoperative cervical myelopathy patient

- Strong negative correlation with NDI
- Strong positive correlation with mJOA
- Improve completion of outcome measures
- Reduce administrative burden

From Robert J. Owen M.D.- PROMIS Physical Function Correlation with NDI and mJOA in the Surgical Cervical Myelopathy Patient Population Spine 2017 accepted

2017. **9.16** (Sat.)



Free Paper II

Deformity

좌장 : 원광대 박종태, 건국대 최우진

한국인 시상면 불균형에서의 건강 관련 삶의 질

김 병 우¹, 문 봉 주², 류 달 성³, 이 정 길², 윤 승 환³, 오 재 근⁴, 이 동 엽¹,
안 풍 기¹, 하 윤⁵, 진 동 규⁵, 김 금 년⁵, 대한척추변형연구회⁶

¹참포도나무병원, ²전남대학교 의과대학 신경외과학교실, ³인하대학교 의과대학 신경외과학교실,
⁴한림대학교 의과대학 신경외과학교실, ⁵연세대학교 의과대학 신경외과학교실, ⁶대한척추신경외과학회

PURPOSE : Recently, the understanding of sagittal plane alignment has become critically important issue on the treatment of spinal disorders. A failure to recognize malalignment in this plane can lead to significant consequences for the patient not only in terms of pain and deformity, but also social interaction and decreased quality of life. Despite of the clinical impact of this plane, the determinants of sagittal imbalance have been assessed mainly in highly selected samples of surgery-related individuals. The clinical relevance of sagittal standing posture and its determinants are still unclear and inconclusive among adults from the general population, especially overall non-neutral sagittal postural patterns. The purposes of this study were to analyze the relation of sagittal imbalance with health-related quality of life and to estimate its association of sociodemographic, anthropometric and biophysiologic factors in Korean men and women.

MATERIALS AND METHODS : This is a population-based prospective cohort study carried out to develop risk prediction algorithms aimed at identifying people who are the most likely to develop impaired sagittal standing balance and decreased health-related quality of life and impaired physical functioning, in the coming years. A total of 229 adults who have non-neutral sagittal standing posture were separately recruited from the rural (n=103) and urban (n=126) community-based institutes during July-December 2016. Inclusion criteria were (1) Korean men and women ≥ 60 years and (2) C7 sagittal vertical axis (SVA) ≥ 5 cm on whole spine standing lateral radiograph. As the part of primary outcome measures of this study, 157 adults (male : female = 38 : 119) were initially assessed and 72 adults were dropped out for the following reasons : incompleteness of whole study-examinations, disagreement of genetic analysis and not meeting inclusion-exclusion criteria. On lateral standing radiograph, the following radiologic parameters were measured : thoracic kyphosis (TK), lumbar lordosis (LL), pelvic tilt (PT), pelvic incidence (PI), and C7 SVA. Pain severity, physical disability and psychosocial impairment were assessed thorough self-reported questionnaire such as visual analogue scale (VAS), Oswestry disability index (ODI), EuroQol 5 dimension (EQ-5D) and health-related quality of life using two main components of the Short Form

36 (SF-36). Data regarding age, sex, body mass index (BMI), medical history, smoking status, alcohol consumption, nutritional status, education, occupation and socioeconomic status were also obtained. Complete medical checkups for spinal disorders were conducted using the blood laboratory examinations, bone mineral density (BMD) and magnetic resonance imaging (MRI) of whole spine. Qualitative and quantitative evaluation of paraspinal muscle components were also conducted using Goutallier method and calculation of total cross sectional area (TCSA) on T2 weighted axial images of MRI.

RESULTS : All participants were divided into three groups according to the degree of PI minus LL mismatch ($PI-LL < 10$, $10 \leq PI-LL \leq 20$, $PI-LL > 20$), and the all measured parameters were compared among the groups. There were significant differences in physical component summary (PCS) of SF-36, ODI, VAS, TCSA of multifidus muscle (MF), Goutallier grade of MF and psoas muscle (PS) and T-score of total femur BMD ($P < 0.05$), and were no differences in age, BMI, mental component summary (MCS) of SF-36 and T-score of lumbar spine BMD. Especially, there were consistent differences in TCSA of MF among the groups (836.76 vs 789.90 vs 654.78, $P < 0.0001$). Participants with decreased size of MF showed greater mismatch of PI-LL (Pearson correlation coefficient -0.398 , $P < 0.0001$) and worsening of PCS ($P < 0.01$). Furthermore, Participants with greater mismatch of PI-LL demonstrated more decreased health-related quality of life on the all components of survey (PCS, MCS, ODI and VAS ; $P < 0.05$). Especially, PI-LL mismatch showed significant linearity with PCS (Pearson correlation coefficient -0.316 , $P < 0.0001$) and ODI (Pearson correlation coefficient 0.325 , $P < 0.0001$). Older age also showed strong correlation with decreased PCS, MCS and ODI ($P < 0.05$), but there were no linearity between the age and the mismatch of PI-LL. All of measured radiologic parameters (TK, LL, PT, PI and C7 SVA) showed no correlation with the age. In multiple regression analysis, older age ($B = -0.673$, $p = 0.012$), greater mismatch of PI-LL ($B = -0.174$, $p = 0.008$) and fatty degeneration of MF ($B = -3.149$, $P = 0.029$) were significantly associated with the worsening of physical impairment.

CONCLUSION : Sagittal standing posture was consistently associated with pain, physical impairment and quality of life in Korean men and women. The mismatch of PI-LL was strong predictive radiologic parameter and its greater mismatch could lead to poor health-related quality of life. Especially, the degeneration and decreased size of MF were strongly associated with the mismatch of PI-LL and poor physical performance. This study is the only first step to demonstrate the physiology and natural course of sagittal imbalance in Korean people. Further study should be required to understand the progression of sagittal imbalance and its risk factors.

성인 척추 변형 수술에서 Pedicel subtraction osteotomy와 Posterior column osteotomy중에서 어떤 것을 선택해야하는지 결정할 때에 수술중 방사선 사진의 유용성

한 상 현, 김 현 집, 장 태 안, 김 기 정, 현 승 재

분당서울대학교병원 신경외과 척추센터

PURPOSE : Posterior column osteotomy (PCO) and Pedicle subtraction osteotomy (PSO) are useful methods for the sagittal plane deformity correction in adult spinal deformities (ASD). However, there were few studies on the selection criteria of osteotomy method between multilevel PCOs and a single level PSO. The aim of the study was to find out which pre- or intra-operative radiographic parameter was a determinant factor for the choice between the osteotomy methods in ASD surgery.

MATERIALS AND METHODS : Between 2012 and 2017, forty-five consecutive patients undergoing corrective surgery for ASD in a single institute were enrolled. The patients were divided into two group (PCO and PSO group). Baseline characteristics and pre- and postoperative radiographic parameters including pelvic incidence (PI), lumbar lordosis (LL), PI minus LL (PI-LL) were compared between the groups. The LL (Stand) was measured in preoperative whole spine lateral standing radiograph, the LL (Extension) in preoperative lumbar spine lateral decubitus extension, and the LL (Intraop) in intraoperative lateral radiograph on the Jackson operating table.

RESULTS : Patients' baseline data were similar between the groups in terms of age at surgery, gender, and fusion levels. The number of prior fusion surgery at L4-5 or L5-S1 was smaller in PCO group than in PSO group (6 [13.3%] vs. 19 [47.5%], $P = 0.001$). The average of LL (Stand) ($-6.0 \pm 19.1^\circ$ vs. $3.7 \pm 24.6^\circ$), LL (Extension) ($-26.5 \pm 9.5^\circ$ vs. $-11.7 \pm 20.3^\circ$), LL(Intraop) ($-45.2 \pm 9.4^\circ$ vs. $-21.1 \pm 15.0^\circ$), PI-LL (Stand) ($48.6 \pm 19.6^\circ$ vs. $58.5 \pm 23.2^\circ$), PI-LL (Extension) ($29.8 \pm 12.0^\circ$ vs. $43.7 \pm 18.5^\circ$), PI-LL (Intraop) ($10.3 \pm 8.9^\circ$ vs. $34.3 \pm 12.1^\circ$), the number of patients having PI-LL (Extension) $> 30^\circ$ (18 [48.6%] vs. 29 [59.5%]) and the number of patients with PI-LL (Intraop) $> 30^\circ$ (0 vs. 33 [89.2%]) were significantly smaller in PCO group than in PSO group. Among the significantly different factors, the other factors except for prior fusion at L4-5 or L5-S1 had a significant correlation with each other. An area-under-curve (AUC) of predicted probability for selection of PSO rather than multilevel PCOs was 0.987 (95% [CI] 0.967 - 1.000, $P < 0.001$) and the AUC of PI-LL (Intraop) $> 30^\circ$ was 0.950 (95% [CI] 0.895 - 1.000, $P < 0.001$). It was closest to the value of the predicted probability among the factors, which means it can be



the representative value in deciding on a PSO instead of multilevel PCOs.

CONCLUSION : If intra-operative PI-LL was more than 30° in ASD surgery, PSO might be a more appropriate strategy than multilevel PCOs. The PI-LL (Intraop) $> 30^\circ$ can be a determinant parameter for selection of osteotomy method between multilevel PCOs and a single level PSO in ASD surgery.

K-와이어와 도관나사를 이용한 프리핸드 S2AI 나사 삽입법

최호용¹, 김현집², 장태안², 김기정², 현승재²

¹삼성창원병원, ²분당서울대학교병원

PURPOSE : The purpose of this study was to describe a novel technique of free hand S2AI screw insertion using a K-wire and cannulated screw, and to evaluate the accuracy of the technique.

MATERIALS AND METHODS : S2AI screw was inserted by free hand technique in sixteen consecutive patients without any fluoroscopic guidance. The gearshift was advanced to make a pilot hole passing through the sacroiliac joint and directing the anterior inferior iliac spine. A K-wire was placed through the pilot hole. After introducing a cannulated tapper along with the K-wire, a cannulated S2AI screw was installed over the K-wire.

RESULTS : Thirty-three S2AI screws were placed in sixteen consecutive patients. Thirty-two screws were cannulated screws, and one screw was a conventional non-cannulated screw. Thirty out of 32 (93.8%) cannulated screws were accurately positioned, whereas two cannulated screws and one non-cannulated screw violated lateral cortex of the ilium.

CONCLUSION : The technique using K-wire and cannulated screw can provide accurate placement of S2AI screw.

단부위 요추 후방 고정술후 발생하는 인접마디 변성과 척추골반각 변수와의 상관 관계에 대한 연구

Novan Krisno Adji¹, 류 달 성², 신제임스키²

¹Seobandi General Hospital-Jember University Faculty of Medicine, Jember, Indonesia, ²인하대병원 신경외과

PURPOSE : Adjacent Segment Degeneration (ASD) is one of the complication following Lumbar Fusion Surgery. Its incidence it varies and the background factors has not been described clearly. The spinopelvic parameters has been helping the surgeon to predict the outcome of spinal surgery, but for the short fusion the surgeon usually didn't care to much with this parameters. Does the Spinopelvic Parameters Abnormality after Short Segment Lumbar Fusion cause the ASD?

MATERIALS AND METHODS : This is a retrospective study, we assessed patients who undergone short segment Lumbar Fusion operation (one to three level) in our Hospital between January 2005 until December 2015 with one year minimum follow up. The variables for the study from the medical records are Pelvic Tilt (PT), Sacral Slope (SS), Lumbar Lordosis (LL), Pelvic Incidence (PI) all is measured before and after operation, age, gender, Osteoporosis state, discus change in MRI according Pfirrmann Grade. All of the variables will be categorized with the Schwabb Classification(normal PT<20o, normal PI-LL <10o), and analyze by Chi Square analysis.

RESULTS : From 117 patient we reviewed, 28 patient suffering ASD(23.85%), mean follow up 30.45 months, mean age 64.11 years old. No statistically significant difference, between the ASD and non ASD group in Gender, Age, Pelvic Tilt (PT) preoperation and postoperation also the PI-LL preoperation, Osteoporosis state and Pfirrmann Grade. But there is statistically significant difference in PI-LL postoperation with the P value 0.011.

CONCLUSION : It is important to achieve harmony PI-LL even in short segment fusion to reduce the incidence of ASD in the future.

성인척추변형수술에 금속봉(rod)강도와 인접 상위부후만증 발생의 상관 관계에 대한 연구: 코발트크롬과 타이타늄 금속봉의 비교연구

현 승 재, 김 현 집, 장 태 안, 김 기 정, 한 상 현

서울의대, 분당서울대학교병원 신경외과

PURPOSE : Cobalt chrome (CoCr) rods, which are advantageous due to their greater strength and resistance to fatigue relative to Ti rods, have been introduced. Previous studies have demonstrated a 25% increase in the fatigue life of contoured CoCr rods over both Ti and stainless steel rods, and that CoCr rods are resistant to the effects of notches created by French benders during rod contouring. However, little is known about the effect of rod stiffness as the risk factor for proximal junctional kyphosis (PJK) in adult spinal deformity (ASD) surgery. The purpose of the present study was to compare radiographic outcomes following the use of Ti versus CoCr rods in a matched cohort with ASD with posterior spinal fusion above 3 levels and a minimum 2-year follow-up.

MATERIALS AND METHODS : We retrospectively reviewed data from patients who had undergone ASD surgery involving more than three levels at two academic institutions between 2002 and 2015. Patients were matched for age, diagnosis, three-column osteotomy, levels fused, and T-score. Fifty patients with Ti rods were identified and appropriately matched to 50 consecutive patients with CoCr rods. Fusion to the sacrum was performed for both groups. Radiographic parameters including sagittal vertical axis (SVA), thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), TK+LL+PI, and PI minus LL were measured on the standing lateral radiographs before surgery, 1 month postoperatively and at ultimate follow-up. The level of upper instrumented vertebra (UIV) was investigated in both groups.

RESULTS : Patients of the groups were similar in terms of age, gender, diagnosis, number of three column osteotomy, levels fused, bone mineral density, preoperative TK, pre- and postoperative TK+LL+PI, SVA difference, LL change, pre- or postoperative PI minus LL and the location of UIV (upper- or lower thoracic). However, there were significant differences in fusion rate (CoCr: 45 [90%] vs Ti: 33 [66%], $P=0.004$), occurrence of rod breakage (CoCr: 0 vs Ti: 8 [16%], $P=0.006$), and junctional kyphosis (CoCr: 24 [46%] vs Ti: 9 [18%], $P=0.003$). Moreover, by subgroup analysis, there were more significant differences in the occurrence of PJK and rod breakage (PJK : 12 (60%) vs 9 (26.5%), $P=0.015$; the occurrence of rod breakage : 0 (0%) vs 11 (32.4%), $P=0.004$, CoCr multiple rod- (MRC) vs Ti two



rod construct (2RC) group, respectively). Furthermore, the time of PJK was less than 12 months after surgery in CoCr MRC group, but over 12 months in more than half of Ti 2RC group.

CONCLUSION : Our findings indicate that the use of CoCr rods is effective in ensuring stability of the posterior spinal construct and accomplishment of spinal fusion. However, increasing the rod stiffness by use of CoCr and MRC can prevent rod breakage, however, may adversely affect the occurrence and the time of PJK.

골반 후경에 따른 천장골 나사못(S2AI)의 삽입각도의 변화 분석 :컴퓨터 단층 촬영을 이용한 해부학적 연구

최 선 아, 최 운 용

연세대학교 신경외과학교실 강남세브란스병원 척추신경외과

PURPOSE : Since a new technique for sacropelvic fixation named as sacral-2 alar iliac (S2AI) screw fixation has been introduced, various modification and optimal trajectory have been reported so far.

However, no current study have focused on the change of trajectory according to pelvic retroversion which most of patients with adult spinal deformity showed as compensation for sagittal imbalance.

Thus, this study was designed to evaluate the relationship of optimal S2AI screw trajectory with lumbosacral parameters including pelvic tilt, sacral slope, and lumbar lordosis using preoperative CT scan.

MATERIALS AND METHODS : From June 2011 to July 2017, Fifty-five patients were enrolled who underwent posterior lumboiliac fixation with S2AI screw.

We retrospectively reviewed the clinic charts and radiographs for investigating clinical outcome such as VAS, SF-36, SRS-22 and complications. Radiographic parameters including pre-postoperative sacropelvic parameters such as pelvic incidence, pelvic tilt, sacral slope, lumbar lordosis, and sagittal vertical axis were measured. Also we evaluated the optimal S2AI trajectory based on preoperative CT scan and analyzed the relationship between optimal screw trajectory and various sacropelvic parameters.

RESULTS : Mean optimal S2AI screw sagittal angle was 23.2 on right side, 22.9 on left side, and mean transverse angle on axial view was 45.0 on right side, 45.9 on left side. Because lumbosacral parameters could be different according to position change, we evaluated all parameters measured when both supine and standing position. Supine position and intraoperative prone position showed similar values in sacropelvic parameters.

CONCLUSION : Optimal S2AI screw angles changes according to pevic retroversion. Sagittal angles of S2AI screw trajectory decreased according to pevic retroversion although transverse angles between pevic rotation did not changed significantly. This result could be useful for increasing the rate of accurate S2AI screw placement.

어떤 접근 방법이 인접 마디 변성의 발생을 낮추는데 유리할까? : 제 4,5 요추간 전방전위증에 대한 3가지 다른 요추 유합술에 대한 비교 분석

이 철 우, 윤 강 준

강남 베드로병원

PURPOSE : The purpose of this study was to compare the radiological and clinical outcomes obtained in patients with lumbar spondylolisthesis in L4-5 who have undergone either instrumented anterior lumbar interbody fusion (ALIF), instrumented lateral lumbar interbody fusion(LLIF) or instrumented posterior Lumbar interbody fusion (PLIF), especially with regard to the development of adjacent-segment degeneration (ASD).

MATERIALS AND METHODS : The medical records of patients who underwent ALIF, PLIF or LLIF for single level spondylolisthesis on L4-5 at single center from January 2011 to December 2012 were retrospectively reviewed. Patient inclusion criteria for the study were: 1) diagnosed as L4-5 single level spondylolisthesis; 2) minimal ASD preoperatively 3) a minimum follow-up duration of 12 months. Patient exclusion criteria were: 1) requiring more than two-level fusions; 2) Prior surgery in L4-5 level; 3) Preexistent ASD. Radiographic measurements including preoperative and postoperative foraminal and disc height, segmental and lumbar lordosis, percentage of vertebral slippage, reduction rate were reviewed. Incidence of ASD and clinical outcomes were evaluated and compared between 3 groups. Clinical outcome by VAS, ODI and modified MacNab criteria were measured preoperatively, postoperatively and compared.

RESULTS : 82 patients who underwent instrumented L4-5 fusion for their L4-5 spondylolisthesis were included in this study and divided according to the surgical approach(ALIF: 27, LLIF: 24, PLIF: 31). Average follow-up period was 35.42 ± 9.35 months. Adjacent-segment degeneration was found in 40.7%(11), 37.5%(9) and 64.5%(20) of the patients in the ALIF, LLIF and PLIF group. ALIF and LLIF group showed favorable results compared to PLIF group in less incidence of ASD. These superiority was evident between ALIF and PLIF ($p=0.037$) but not statistically significant between LLIF and PLIF ($p=0.091$). The ALIF and LLIF groups had significantly increased disc and foraminal height compared to the PLIF group. The ALIF group had significantly improved lordosis compared to both other PLIF, LLIF groups. Our study showed that all three approaches significantly reduce spondylolisthesis and revealed ALIF have better ability to reduce the spondylolisthesis with a significant difference between the



three interbody fusion approaches Clinical success rates (excellent, good by modified MacNab criteria) were 92.5, 91.6 and 87.0% in the ALIF, LLIF and PLIF groups. There were no statistically significant intergroup differences in clinical outcome by VAS, ODI.

CONCLUSION : 3 different fusion techniques can produce good outcomes in treating lumbar spondylolisthesis in L4-5, but ALIF and LLIF are more advantageous in preventing the development of ASD, which may resulted from different ability to restore the postoperative sagittal balance and less intra-operative injury to posterior structures.

척추변형수술에서 수술중 혈액회수기 사용의 임상적 효용성

최 호 용¹, 김 현 집², 장 태 안², 김 기 정², 현 승 재²

¹삼성창원병원, ²분당서울대학교병원

PURPOSE : To determine the efficacy of intra-operative cell salvage system (ICS) to decrease the need for allogeneic transfusions in patients undergoing major spinal deformity surgeries.

MATERIALS AND METHODS : A total of 113 consecutive patients undergoing long level posterior spinal segmental instrumented fusion (≥ 5 levels) for spinal deformity correction were enrolled. Data including the osteotomy status, the number of fused segments, estimated blood loss, intra-operative transfusion amount by ICS (Cell Saver®, Haemonetics®, MA, USA) or allogeneic blood, postoperative transfusion amount, and operative time were collected and analyzed.

RESULTS : The number of patients was 81 in ICS group and 32 in non-ICS group. There were no significant differences in demographic data and comorbidities between the groups. Autotransfusion by ICS was performed in 53 patients out of 81 in the ICS group (65.4%) and the amount of transfused blood by ICS was 226.7 mL in ICS group. The mean intra-operative allogeneic blood transfusion requirement was significantly lower in the ICS group than non-ICS group (2.0 vs. 2.9 units, $P = 0.033$). The regression coefficient of ICS use was -1.036 , which means the use of ICS may reduce about one unit amount of allogeneic transfusion.

CONCLUSION : ICS use could decrease the need for intra-operative allogeneic blood transfusion. Specifically, the use of ICS may reduce about one unit amount of allogeneic transfusion in major spinal deformity surgery.

수술중 수술 테이블 변형을 통한 퇴행성 요추 질환의 다분절 요추 유합술에서 요추 전만의 회복 효과

남한가위, 전 상 용

서울아산병원

PURPOSE : This study aims to investigate the efficacy of lordosis restoration by intraoperative table modification on multi-level posterior lumbar interbody fusion (PLIF) for degenerative lumbar spinal disease through comparing the radiological outcome

MATERIALS AND METHODS : A total 20 patients who underwent three or four level PLIF between December 2012 and March 2017 was included in this retrospective study. According to performing of intraoperative table modification, patients were categorized into table modification PLIF (TM-PLIF) group (8 patients, 26 interbody segments in total) and non-table modification PLIF (non TM-PLIF) group (12 patients, 39 interbody segments in total). We reviewed patient age, sex, follow-up period, types of degenerative disease, spinal anteroposterior bone mineral density and degree of osteoporosis. Using lateral radiographs of the lumbar spine, the lumbar lordotic angle were measured preoperatively, immediately after surgery and at CT follow-up visit and change of lordotic angle between preoperatively and immediately after surgery, preoperatively and at CT follow-up visit were also measured. Fusion area, fusion morphology of fusion segments and interbody fusion rate measured by postoperative 4-6 months 3-dimensional computed tomography were achieved.

RESULTS : In TM-PLIF group included 1 male and 7 females (total 8 patients), aged 48 to 73 years old, with a mean age of 65.3 years. The mean follow up period was 4.9 months (ranging from 4 to 6 months). The mean lumbar lordotic angle at preoperatively, immediately after surgery, at CT follow-up visit was 17°, 38.7°, 39° respectively. The mean change of lordotic angle between preoperatively and immediately after surgery, preoperatively and at CT follow-up visit was 21.8°, 22.0° respectively. In non TM-PLIF group included 3 males and 9 females, aged 57 to 77 years old, with a mean age of 66.9 years. The mean follow up period was 16.1 months (ranging from 6 to 25 months). The mean lumbar lordotic angle at preoperatively, immediately after surgery, at CT follow-up visit was 24°, 38.2°, 31.4° respectively. The mean change of lordotic angle between preoperatively and immediately after surgery, preoperatively and at CT follow-up visit was 14.2°, 7.4° respectively. The change of lordotic angle between preoperatively



and at CT follow-up visit was significant difference between two groups ($p < 0.05$).

CONCLUSION : The intraoperative table modification on multi-level PLIF for degenerative lumbar spinal disease was effective for restoration of lumbar lordosis in the operation field, provided in situ fusion success in all cases even over multiple fusion levels, and can be an alternative among operative method for restoration of lumbar lordosis of multilevel lumbar degenerative disease.

심한 시상면 불균형을 보이는 요추 편평등 변형 환자에서 이상적인 상위 기구 고정 척추 분절

최 만 규¹, 임 유 석², 조 대 진², 조 응 학², 김 성 민²

¹경희대병원, ²강동경희대병원

PURPOSE : Despite increasing numbers of patients with lumbar flatback deformity (LFD), it is unclear how to select the optimal upper instrumented vertebra (UIV) in correction surgery for these patients. Given that instrumentation obliterates motion and places biomechanical stress on adjacent segments, it is crucial to ascertain the ideal UIV to minimize risk of proximal junctional failure (PJF) or kyphosis (PJK). Although the T10 vertebra is often chosen to allow bridging of the thoracolumbar junction into the immobile thoracic vertebrae, there is a controversy as to which level is suitable for the UIV. The purpose of this study is to evaluate and compare the postoperative changes of radiographic sagittal parameters according to difference in UIV.

MATERIALS AND METHODS : A total of 69 patients who underwent fusion from the ilium to the thoracic or lumbar spine for LFD with sagittal imbalance were enrolled. The changes of sagittal parameters were evaluated in each UIV, the comparative analysis was also conducted in two groups (divided by UIV, Group A; T9, 10, B; T11, 12, L1, 2). Radiographic sagittal parameters, such as thoracic kyphosis (TK), thoracolumbar kyphosis (TLK), lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT), pelvic incidence/lumbar lordosis (PI-LL), T1 pelvic angle (T1PA), sagittal vertical axis (SVA), and proximal junctional angle (PJA) were analyzed at preoperative and last follow-up whole standing spine radiographs. Significant radiographic parameters of sagittal imbalance were defined as $TLK > 15^\circ$, $SVA > 50\text{mm}$, $PT > 20^\circ$, $T1PA > 15^\circ$, and $PJA > 15^\circ$.

RESULTS : The incidence of radiographic sagittal imbalance were the lowest in patients with the UIV selected as T9 and corrected sagittal parameters (mean values) were TLK; 8.7° , SVA; 20.3mm, PT; 12.6° , T1PA; 9.25° , and PJA; 12.8° . There was only one revision surgery, because of PJF. In contrast, the incidence of sagittal imbalance was the highest in patients with the UIV selected as T12 (TLK; 17.9° , SVA; 45.9mm, PT; 16.7° , T1PA; 13.4° , and PJA; 16.5°). In statistical analysis, as the UIV gradually increased to higher levels, the PT and T1PA values increased proportionally (both p-values=0.023, 0.005). Comparing two groups, there were significant differences in TLK, SVA, PT, T1PA, and PJA (all p-values

<0.05). In group B, the incidence of radiographic sagittal imbalance was higher than group A (TLK, T1PA, and PJA; all p values <0.05, all odds ratios > 5).

CONCLUSION : T9 as the UIV when compared with the patients with other UIV resulted not only lower incidence of PJF and PJK but also radiologically satisfactory outcomes in terms of sagittal balance. Hence, selection of the UIV at T9, or at least T10 level seems adequate in maintaining good sagittal balance and prevents PJF, PJK after corrective surgery involving long vertebral levels.

Modified Iliac Screw Fixation: 방법 및 임상 적용

손 세 일¹, 정 천 기², 김 치 현²

¹차의과학대학교 분당차병원, ²서울대학교

PURPOSE : A conventional iliac bolt and the S2 alar iliac screw fixation technique (S2AI) are commonly used sacropelvic fixation techniques. However, Conventional iliac bolt technique requires a lateral connector and commonly has prominent screw head problems. S2AI reportedly has a high instrument failure rate. We aim to introduce a modified iliac screw fixation technique and to investigate its clinical application in adult patients.

MATERIALS AND METHODS : The entrance site of the modified iliac screw fixation technique was 1cm medial and 1cm caudal from the posterosuperior iliac spine. From 2009 to 2015, 10 adult patients underwent sacropelvic fixation with the modified iliac screw fixation technique in our spine clinic. A minimum 12 month clinical and radiographic follow-up was adopted. The mean follow-up period was 30.7 months (12-74 months). Mean number of fixation levels was 7.7 segments (5-10 segments).

RESULTS : Postoperatively, the C7 plumb line (SVA) were significantly decreased ($P = 0.04$). Upon the last X-ray, SVA did not differ between postoperative and the last X-ray ($P = 0.1$). There was no breakage during our follow-up period. There was no prominent screw head. There were no cases requiring implant removal.

CONCLUSION : The modified iliac screw fixation technique does not cause prominence in the sacral region, and does not require lateral connector, both of which are necessary when using the classical iliac bolt technique. This technique also avoids the acute angle between the screw head and the shaft of the screw commonly seen in S2AI. The modified iliac screw fixation technique can be an effective alternative for sacropelvic fixation.

심한 척추 변형에서 후방 도달 척추 절제술의 임상결과 및 영상학적 결과

이 병 훈¹, 김 현 집¹, 김 용 종², 장 태 안¹, 김 기 정¹, 현 승 재¹

¹분당 서울대학교병원, ²콜롬비아대학병원

PURPOSE : The aim of this study was to investigate clinical and radiological outcomes of patients who underwent posterior vertebral column resection (PVCR) by a single neurosurgeon in a single institution.

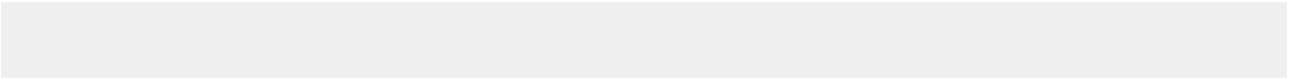
MATERIALS AND METHODS : Thirty-four consecutive patients with severe spinal deformities who underwent PVCR between 2010 and 2016 were enrolled. The radiographic measurements included a kyphotic angle of PVCR levels (VCR angle), sagittal vertical axis (SVA), thoracic kyphosis, lumbar lordosis (LL) and spinopelvic parameters. The data of surgical time, estimated blood loss, duration of hospital stay, complications, intraoperative neurophysiologic monitoring, and the Scoliosis Research Society (SRS)-22 questionnaire were collected using a retrospective review of medical records.

RESULTS : The VCR angle, LL, and SVA values were significantly corrected after surgery. The VCR- and LL angle were changed from the average of $38.4 \pm 32.1^\circ$ and $-22.1 \pm 39.1^\circ$ to $-1.7 \pm 29.4^\circ$ ($p < 0.001$) and $-46.3 \pm 23.8^\circ$ ($p = 0.001$), respectively. The SVA was significantly reduced from $103.6 \pm 88.5\text{mm}$ to $22.0 \pm 46.3\text{mm}$ ($p = 0.001$). The clinical results using SRS-22 survey improved from 2.6 ± 0.9 to 3.4 ± 0.8 ($p = 0.033$). There were no death and permanent neurological deficits after PVCR. However, complications occurred in 19 (55.9%) patients. Those patients experienced a total of 31 complications during- and after surgery. Sixteen reoperations were performed in twelve (35.3%) patients. The incidence of transient neurological deterioration was 5.9 % (2 out of 34 patients).

CONCLUSION : Severe spinal deformities can be effectively corrected by PVCR. However, the PVCR technique should be utilized limitedly because surgery-related serious complications are relatively common.



Poster





Poster

P-1

만성디스크성 연관통에 대한 동척신경 추간공 경막외 레이저 삭마술

주윤석

수원나누리병원

외과의의 경험에 따른 척추경제거술의 수술 및 영상의학적 결과

최호용¹, 김현집², 장태안², 김기정², 현승재²

¹삼성창원병원, ²분당서울대학교병원

PURPOSE : To evaluate and compare the surgical, radiographic, and clinical outcomes of pedicle subtraction osteotomy (PSO) according to surgeon's experience.

MATERIALS AND METHODS : Comparative analysis of 40 consecutive patients treated with lumbar PSOs was performed. According to time period, the former- and latter 20 patients were divided into group 1 and group 2, respectively. Patients' demographic data, operative-, radiographic/clinical outcomes, and complications were compared between the groups.

RESULTS : Baseline characteristics and preoperative radiographic parameters were not different between the groups. There observed significant reductions of operative time (569.6- vs. 392.0 minutes, $P = 0.000$), surgical bleeding (1777.5- vs. 949.5 mL, $P = 0.002$), and transfused volume of red blood cell (1232.6- vs. 864.1 mL, $P = 0.041$) in group 2. Postoperative sagittal vertical axis was significantly different between the groups (40.1- and -3.6 mm, group 1 and 2, respectively, $P = 0.008$), and the difference was sustained to the ultimate follow-up (59.4- vs. 13.2 mm, $P = 0.003$). There was a difference regarding the amount of curve correction by PSO, which was significantly greater in group 2 (25.7° vs. 35.8°, $P = 0.023$). Intra-operative complications (7 vs. 1, $P = 0.019$) were significantly lower in group 2. Total complications (20 vs. 10, $P = 0.070$), postoperative transient neurologic deficit (2 vs. 1) and revision surgery (4 vs. 3) were also lower in group 2, without statistical significance. The amount of the improvement of SRS-22 score was not different between the groups ($P = 0.395$).

CONCLUSION : PSO may be performed in patients with fixed sagittal imbalance with an acceptable rate of complications after about 20 cases. With acquisition of surgical experiences, surgeons could perform PSO more effectively and safely.

급성 경추부 통증을 주소로 내원한 환자: 급성 경장근 석회성 건염과 경추부 날개인대의 석회화를 동시에 가진 47세 여자 환자

김기훈, 성한유, 정훈재, 이동엽

서울부민병원

PURPOSE : Acute cervical calcific tendinitis of the longus colli muscle is rare disease caused by calcium hydroxyapatite deposition in the longus colli muscle. This disease commonly observed with headache and swallowing difficulty. And it is easy to misdiagnosed symptoms such as meningitis or retropharyngeal abscess.

MATERIALS AND METHODS : A 47-years old woman presented acute neck pain, headache, and swallowing difficulty. And she was complained sleep disturbance due to severe pain. The physical examination reveals the limitation of neck motion, but neurologic examination were normal. The cervical spine X-ray showed the prevertebral soft tissue swelling and loss of the normal cervical curvature. And CT scan showed acute calcific tendinitis of the longus colli muscle at C2 level and calcification of the cervical alar ligament simultaneously. The haematological analysis showed mild increase of erythrocyte sedimentation rate(ESR=31mm/hr) and C-reactive protein (CRP=2.08mg/dL). We was treated with NSAIDs, low doses of corticosteroids.

RESULTS : The symptoms began to resolve within 48 hours form the treatment. At 1 month after treatment, the calcium deposit and all symptoms had resolved. At that time, CT scan showed the decreased calcification of the longus colli muscle at C2 level, but calcification of the cervical alar ligament was still no change.

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수술 후 발생한 신경근 탈출을 동반한 pseudomeningocele: 3례 증례보고

김성호, 박진학, 권재은, 이창주, 박선영, 정을수, 지용철

보강병원

PURPOSE : Pseudomeningocele is an abnormal extradural cerebrospinal fluid (CSF) collection from a dura–arachnoid defect. Post–laminectomy pseudomeningocele is formed when CSF extravasates from a breach in the dura–arachnoid layer. This rare complication mostly results from an incidental dural tear during laminectomy and most of the patients tolerate the presence of the cyst well. However, accompanied with nerve root entrapment from dura–arachnoid defect, the symptoms vary from no symptom, back pain, radiculopathy to cauda equina syndrome (CES). We report 3 cases with severe radicular symptoms and CES after laminectomy.

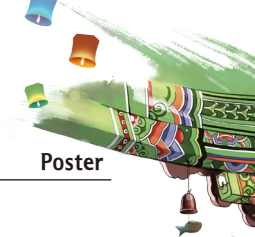
MATERIALS AND METHODS :

Case 1.

A 76–year–old male presented with lower back pain and sciatica on the left L5 dermatome for 2 years. The symptoms had aggravated just 3 days before. His lumbosacral spinal mobility was limited because of severe back pain and straight leg raising test was positive on the left side about 60 degree. Neurologic examination revealed that muscle strength of the extremity was completely normal and deep tendon reflex was normoactive. MRI showed left sided upward disc herniation with moderate degree of bulging disc, severely thickened ligamentum flavum on the L4–5. Because of intractable pain, microdiscectomy was performed. On the twenty seventh day after operation, he visited emergency department with intractable left sciatica on the L5 dermatome. Neurologic examination revealed no definite abnormality except for severe pain. MRI showed no disc herniation and no definite neural compression. Exploration was done. There was 0.7 cm sized longitudinal dura laceration. Some of the rootlet was entrapped through the defect which was not found at the first operation. As there was not enough space for closing the defect, posterior lumbar interbody fusion operation was performed, and the dural defect was closed. Three years after the operation, his complaint improved completely.

Case 2.

A 59–year–old male presented with lower back pain, severe sciatica on the right L4, 5 dermatome, and



weakness of right ankle dorsiflexion and great toe dorsiflexion for several days.

His lumbosacral spinal mobility was limited because of back pain, and straight leg raising test was negative. Neurologic examination revealed that muscle strength of right foot extensor was grade 1, walking on the right heel gait was not possible. Deep tendon reflex was normoactive. MRI showed spinal stenosis on the L3-4, L4-5 and decompressive laminectomy was performed.

RESULTS : On the twelfth days after operation, he visited emergency department with severe right sciatica and urinary incontinence and decreased anal sphincter tone, symptom of CEI. MRI showed no neural compression on L3-4, and small amount of epidural hematoma was found on the L4-5. Exploration was done. There was 0.3 cm sized dura laceration at dorso-lateral side of thecal sac on L3-4 and some of rootlet was entrapped through the defect which was not found at the first operation. Some of the rootlet was entrapped at facet joint. The dural defect was closed. The amount of epidural hematoma on L4-5 was small and considered not enough to compress thecal sac. Six months after the operation, his complaints improved considerably, but there still was anal sphincter tone decreased with urinary incontinence.

Case 3.

A 75-year-old male presented with lower back pain and both calf pain for a year. His lumbosacral spinal mobility was normal and straight leg raising test was negative. Neurologic examination revealed that the muscle strength of left ankle, knee, hip and right hip was grade 4, deep tendon reflexes were normoactive. MRI showed spinal stenosis on the L2-3, L3-4, L4-5 and decompressive laminectomy was done. On the fifth day after operation, he complaint severe left sciatica with weakness of muscle strength of the left ankle about grade 1 and symptom of CEI. MRI showed no definite neural compression. Exploration was done. There was 0.3 cm sized dura laceration at left lateral side of the thecal sac on the L2-3 and some of rootlets was entrapped through the defect which was not found at the first operation. Some of rootlets was entrapped at the facet joint. The defect was tightly closed. Two months after the operation, his complaints improved considerably, but the muscle weakness still remained.

CONCLUSION : We hereby report 3 cases of post-laminectomy pseudomeningocele with nerve root entrapment. For all 3 cases, there was no durotomy during the first operation. We can construe the reason for the dura laceration as blunt surgical instruments, use of anti-adhesiolysis agent and incidental durotomy by rough deed. Considering the poor consequences of pseudomeningocele, appropriate surgical intervention should be decided and carried out once the diagnosis is made.

퇴행성 요추 질환에 대한 L5-S1 PLIF 후 수술에 영향을 주는 요인들

김성호, 박진학, 권재은, 이창주, 박선영, 정을수, 지용철

보강병원

PURPOSE : Posterior lumbar interbody fusion (PLIF) is widely considered an effective surgical method for patients with degenerative lumbar disease such as stenosis, degenerative spondylolisthesis (DS), isthmic spondylolisthesis (IS). The purpose of this study is to investigate factors affecting the results of L5-S1 PLIF for degenerative lumbar disease including the status of screw insertion.

MATERIALS AND METHODS : A retrospective trial was performed on 163 patients who received PLIF surgery between January, 2010 and June, 2015. Among them, 109 patients were included who were followed up at least 2 years. There were 46 males and 63 females, with an average age of 61 (37~83y). The mean follow-up period was 26.7 months. The parameters included were the presence or absence of diabetes mellitus (DM), osteoporosis, spondylolisthesis. Spondylolisthesis group was subclassified as DS, IS and without-spondylolisthesis. The convergence angle of screw and the convergence angle difference between L5 and S1 were checked on CT. Clinical results were measured by The Short Form (36) health survey (SF-36), Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) and radiological findings were measured by Bridwell classification and the presence of adjacent segment disease (ASD) along with 2 year-follow-up period.

RESULTS : There were twenty-two patients (20.2%) with DM and there is no statistically significant difference between the patients with DM and without DM for clinical and radiological findings. There were 27 in osteoporosis group, 37 in osteopenia group and 45 in normal osteosis group. There was no statistically significant difference among 3 groups for clinical and radiological results. Regarding spondylolisthesis there were 9 in DS, 43 in IS and 57 in group without spondylolisthesis. The group without spondylolisthesis had better clinical results than with DS and IS group in VAS($p=0.014$), ODI($p=0.006$). The average convergence angle of screws is 9.0° on the right L5 screws, 8.6° on the left L5 screws, 6.2° on the right S1 screws and 5.9° on the left S1 screws.

There was no statistically significant difference in the average angles of screw convergence, and difference between screw convergence angles of L5 and S1 for clinical results and radiological findings.

There were seven cases of ASD (6.4%) and 13 cases of screw loosening or breakage (11.9%).

CONCLUSION : There are many reported factors which affect surgical results of PLIF. However, in our study, the only statistically significant factor was the presence of spondylolisthesis. Our study is limited because of small number of cases. We may need more number of cases and prospective study.

손상된 요추 신경근 주변의 외상성 경막 누출 부위를 인공경막을 이용하여 감싸는 방법으로 처치한 증례 보고

윤 상 훈

국군수도병원

PURPOSE : This technical note describes repair by rolling artificial dura (lyodura®) around root sleeve as an alternatives after failed a primary closure of durotomy by traumatic lumbar spinal fracture.

MATERIALS AND METHODS : An 24-year-old soldier underwent a laminectomy and posterior fixation from L3 to L5 with spinal canal decompression. A traumatic dural tear was noticed at dorsal dura and left L4 root sleeve. The injured dura was explored, and the dura had torn from left side L4 root shoulder to axilla and the side under the axilla of root.

RESULTS : Microsurgical closure with suture is the primary modality in durotomy repair. But difficulty arose when the dura was torn and peeled off around L4 root axilla. Suturing worsens the durotomy. Also, the primary dural closure was performed from root shoulder to axilla area as possible and rolled artificial dura around the area peeled off by the manner similar to rolling cuff.

CONCLUSION : We describe the application of putting around artificial dura above tear and peeling site around root sleeve. No persistent cerebrospinal fluid leak was noticed. Postoperatively, patients have no limitations and are therefore prevented from being exposed to additional risks associated with bed rest.

희귀한 천골, 두개골 및 늑골을 침범한 다발성 골결핵: 증례보고

윤상훈

국군수도병원

PURPOSE : Multifocal skeletal involvement of tuberculosis with calvarial involvement is a rare presentation. It usually mimics skeletal malignancy and multiple metastasis of bone.

MATERIALS AND METHODS : A 22-year-old man presented with right pelvic pain and recurrent unknown origin fever. ^{99m}Tc -MDP bone scan and magnetic resonance image (MRI) of sacrum demonstrated multiple active bone lesions including right sacrum, ribs, and calvaria. Chest X-ray showed no active lung lesion, and chest CT demonstrated infiltrative enhancing lesions in the 3rd rib and lymph node enlargement in the bilateral lung field. ^{18}F -FDG PET/CT performed to search for hidden malignancy revealed multiple osteolytic lesions with intense FDG uptake, supporting metastasis. Initial diagnosis by clinical and radiological information was a malignancy such as Ewing's sarcoma.

RESULTS : Tissue obtained from the sacrum and 3rd rib lesion showed no malignant cells but was positive for *Mycobacterium tuberculosis*. Antituberculosis medication was administrated.

CONCLUSION : After 2 weeks of antituberculosis medication, fever and vital signs were normalized and laboratory findings revealing infectious condition were normalized.

수술 중 C-arm 사용 시 의료진의 방사선 피폭량

박 세 훈

중앙대학교병원

PURPOSE : Recently, Minimal invasive surgery has been popularized as new surgical techniques for spine surgery are studied frequently. Minimal invasive spine surgery need more use of c-arm during surgery than open spine surgery. Since the position of the people in the operation field is different from that of the C-arm, it is considered that there is a difference in the amount of exposure. The purpose of this study was to investigate the radiation dose according to position of the medical staff and C-arm position in operating room during minimal invasive surgery.

MATERIALS AND METHODS : In this study, a radiation dose meter of RaySafe X2 model was used for measuring radiation exposure ($\mu\text{Sv/s}$), and radiation doses were measured during the operation after the medical staff wear the radiation dosimeter in the surgical clothing. The medical staff consisted of the operator, first assistant, anesthesiologist, and scrub nurse depending on the position with the C-arm. The 35 patients participated in the study. During the operation, the radiation dose was measured several times by the medical staff during the AP view and lateral view of the C-arm. Kruskal Wallis test and Mann-Whitney test was used to identify statistically significant differences.

RESULTS : The average radiation exposure in the AP view was the operator (0.680), the first assistant (0.211), anesthesiologist (0.047), the nurse (0.017), and the Lat view was the operator (2.331), first assistant (0.161), anesthesiologist (0.097), and scrub nurse (0.061). The radiation exposure was statistically significantly higher in the operator compared to the others (P value < 0.001).

According to the position (AP/Lat) of the C-arm, the radiation dose received by the surgeon (0.680/2.331), nurse (0.211/0.161), and anesthesiologist (0.047/0.097) excluding the first assistant was statistically significant.

CONCLUSION : The amount of radiation exposure by C-arm during surgery was the highest in the operator, especially in the lat view. It is necessary to actively study and protect the radiation exposure of the operator during minimal invasive spine surgery.

헤파린 기반의 하이드로겔과 지방유래 줄기세포를 사용한 좌골신경손상의 신경재생

이혜란, 신동아, 하윤, 이혜영

연세대학교

PURPOSE : Heparin-based hydrogel was reported to be excellent for adhesion and functions of human adipose-derived stem cells (hASCs). In this study, we applied the micropatches of heparin-based hydrogel as a carrier of hASCs for the peripheral nerve regeneration in a rat model.

MATERIALS AND METHODS : micropatterned heparin-based hydrogels were formed and hASCs were seeded on the hydrogel micropattern. After retrieving the hASC-attached micropatches, they were applied to the damaged peripheral nerve by epineural soaking after 1 week of injury. As control groups, PBS or hASCs only was applied to the damaged peripheral nerve. Behavior test and evoked potential test was performed for investigation of functional recovery.

RESULTS : Behavior test and evoked potential test showed the significantly enhanced functional recovery of the damaged peripheral nerve by using hASC-attached micropatches compared to the only cell delivery. In histological analysis, by delivering hASCs using the hydrogel micropatches, adhesion of hASCs on the peripheral nerve was confirmed after 4 weeks of cell delivery as well as the enhanced regeneration of axon and dorsal root ganglion compared to the control groups. Immunostaining of calcitonin gene-related peptide (CGRP) and macrophage showed minimal inflammation by using the heparin-based hydrogel micropatches.

CONCLUSION : hASC delivery assisted by micropatches of heparin-based hydrogel could facilitate the regeneration of damaged peripheral nerve by improving the settlement and viability of hASCs on the defect site, thus probably by the extended paracrine effects of hASCs.

저분자화합물 조합을 이용한 악성 신경교모종세포의 양성 신경교세포 전환

김 용 보, 하 윤, 오 진 수

연세대학교 의과대학 신경외과교실

PURPOSE : Glioblastoma(GBM) is the most common tumor of central nervous system and the median life expectancy of GBM patients is very low. In previous studies, it was reported that GBM is from transformation of glial progenitor cells and is positive for specific makers of glial progenitor cell. Therefore, we supposed that we can convert GBM into glial cells by controlling genes associated with glial progenitor cells which GBM includes.

MATERIALS AND METHODS : In this study, we used rat C6 glioma and induced it to differentiate glial cells by using small molecules. In order to confirm whether C6 glioma was converted into glial cells, Immunofluorescence staining was performed. Also, Cell proliferation rate was compared in control and experimental groups.

RESULTS : Differentiated C6 glioma cells were transformed into specific form of glial cell and was positive for glial cell makers such as GFAP, CNP, RIP. In addition, we confirmed that it was able to inhibit proliferation of C6 glioma cell in which small molecules were added. By microarray, we were able to see changed gene expression pattern in differentiated C6 glioma cells

CONCLUSION : We demonstrated that C6 glioma cell can be converted into glial cell by using small molecules. Therefore, we suppose that anticancer drug based on this strategy can be developed. This work was supported by the Korea Health technology R&D Project, Ministry of Health & Welfare, Republic of Korea (HI15C0916) and Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2016R1D1A1A02937027).

유도신경줄기세포에서 일시적인 Ngn2 발현에 의한 척수손상모델에서 신경분화와 신경돌기 성장 향상

오진수, 하윤, 김용보

연세대학교 의과대학 신경외과교실

PURPOSE : The direct reprogramming technology makes it possible for us to generate the autologous neural stem cells (termed “induced neural stem cells, iNSCs) within few weeks. Nevertheless, the neural differentiation efficiency and axonal outgrowing of NSCs transplanted into injured spinal cord still extremely limit because the transplanted neural stem cells (NSCs) be exposed to poor environment more and more in vitro.

MATERIALS AND METHODS : We thought that the cell clumping and proliferation in acute stage after transplantation lead to prevent the axonal outgrowth and neural differentiation in vivo. Thus we designed the strategy to avoid the cell mass formation and proliferation in acute stage though the transplantation of iNSCs after transient induction of Ngn2

RESULTS : We investigated the neural differentiation and cell proliferation of iNSCs after the transient expression of Ngn2 in vitro and vivo. We confirmed the neural differentiation efficiency of iNSCs by immunofluorescence staining and electrophysiology. The transient induction of Ngn2 leads to induce the neural differentiation of iNSCs within 3~4 days in vitro. Especially, we confirmed that the transient induction of Ngn2 not only prevent the cell clumping and proliferation, but also induce the neural differentiation and extensive axonal outgrowing in spinal cord injury model.

CONCLUSION : We suggest that the sufficient neural induction of neural stem cells prior to cell transplantation may be need for the safe and efficient stem cell therapy in spinal cord injury. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2015R1D1A1A02059821 and 2016R1D1A1A02937027)

신경 손상 모델에서 유도 신경 줄기세포를 기반으로 한 유전자 치료와 발프로산의 병합 치료 효과

백 다 예

연세대학교 의과대학 의과학과 신경외과학교실

PURPOSE : Recently, neural stem cell which is directly converted from human epidermal cell takes advantages in several ways. To make a synergic effect on neurologic disease, gene therapy was combined. Valproic acid (VPA) is known as a HDAC (histone deacetylase) family member, so VPA was added to improve gene expression level in iNSC. Also therapeutic gene was added to neuron-specific enolase (NSE) promoter. NSE promoter can be specifically expressed in neuron.

MATERIALS AND METHODS : After confirm the neural differentiation potential using several small molecules, plasmid containing neuron-specific enolase (NSE) promoter was transfected and cultured under normoxia or hypoxia conditions. VPA was treated in cultured iNSC. After promoter activity was measured using luciferase, gene was replaced to VEGF.

RESULTS : Induced neural stem cell (iNSC) from human epidermal cells was differentiated into neuron. Luciferase assay revealed that neuron-specific promoter showed strong gene expression in iNSC. Moreover, iNSC transfected pNSE showed higher gene expression under hypoxia conditions mimic neurologic disease in vitro. In addition VPA enhanced gene expression. Replaced VEGF gene also showed high gene expression level under hypoxia conditions and with neuron-specific promoter and VPA in vitro and in vivo.

CONCLUSION : iNSC has a great potential in cell therapy to treat neural degeneration disease. According to gene expression level, neuronal promoter showed strong activity in iNSC. Moreover, NSE promoter enhanced gene expression under hypoxia conditions. Also VPA made synergic effect on improving gene expression. It indicates that applied cell and gene therapy with VPA represent a promising combined treatment in neural disease.

악성 척수 종양에서 마지막 수단으로서의 척수절제술

최 선 아, 이 성, 강 지 인

세브란스병원 신경외과

PURPOSE : Spinal cord glioblastoma is a rare and hard-to-cure disease. Cordectomy is considered as a most definite and a final surgical intervention to avoid repetitive surgery and to halt the progression of disease at the same time in intra-axial malignant spinal cord tumors. Because of its functional and anatomical destructive characteristics, preoperative considerations are required including patient's general condition, functional status, and the possible risks and results from surgery. We present a recent case of cordectomy for secondary spinal glioblastoma.

MATERIALS AND METHODS : A 40-year old male patient with a secondary spinal glioblastoma—which was anaplastic astrocytoma at first— was undergone cordectomy. This decision was made based upon repeated surgeries and his newly-developed complete paraplegia status. The range of cordectomy was determined according to the MRI findings and the intraoperative pathologies.

RESULTS : A successful cordectomy was done without any additional complications, but the leptomeningeal seeding is suspicious pathologically. Adjuvant chemotherapy and radiation therapy would be needed for further disease control.

CONCLUSION : Cordectomy could be considered as a treatment option when it comes to spreading spinal cord disease with complete paraplegia status. In case of malignant tumor, it could be a curable way or a palliative/cytoreductive therapy followed by adjuvant chemotherapy or radiation therapy, producing the extension of patient's life expectancy and a better prognosis.

경추1/2번 추궁 아탈구

조 용 재

이화여자대학교 목동병원 신경외과

PURPOSE : Atlantoaxial subluxation is not common and potentially compromise to the normal occipital-cervical anatomy that makes atlantoaxial instability and cervical myelopathy, which may cause permanent neurologic deficits or sagittal deformity if not treated in a timely and appropriate manner. In addition to atlantoaxial subluxation, we experienced that the lamina of atlas impacted under the lamina of axis. The objective of this review is to provide our surgical experience and comprehensive review of the literature to identify this atlantoaxial lamina locking.

MATERIALS AND METHODS : A 72-year-old male was transferred to emergency room of our hospital. He complained of progressive weakness of four extremities after fallen down injury with neck extension at home. The weakness was more affected in legs than arms and hands. The patient had an electric sensation in the whole body. Radiologic study showed atlantoaxial instability and atlantoaxial Lamina Locking, which made myelopathic cervical cord compression and signal change on the MRI. In the operative finding, we identified that C1 lamina locked under C2 lamina and spinous process. Manual reduction did not restore to normal C1-2 lamina position. After laminectomy of C1 and C2, atlantoaxial subluxation managed to be reduced.

RESULTS : We performed decompressive C1 total laminectomy and C2 upper subtotal laminectomy. We confirmed decent dural pulsation after decompression. Tingling sense and quadriplegia improved slowly after the operation.

CONCLUSION : This case shows rare feature of atlantoaxial Lamina Locking. Lamina Locking has not been introduced in spite of the locked facet, this is first description of locked lamina, specially atlantoaxial joint.

타입 2 척추 시상면불균형에 대한 수술경험

조 용 재

이화여자대학교 목동병원 신경외과

PURPOSE : Spinal sagittal imbalance is not common and potentially compromise to the normal sagittal alignment that makes ambulatory difficulty and cosmetic problem, which may cause permanent sagittal deformity if not treated in a timely and appropriate manner. We experienced that type II sagittal imbalance. The objective of this review is to provide our surgical experience and a comprehensive review of the literature to identify this type II sagittal imbalance.

MATERIALS AND METHODS : A 67-year-old male was transferred to our hospital. He complained of progressive kyphotic change and walking difficulties. The patient had chronic back pain. Radiologic study showed severe kyphotic deformity, which made thoracic kyphosis : 44.7° , lumbar lordosis : -18.6° , pelvic incidence : 41.5° , sacral slope : 6.8° , pelvic tilt : 26.3° . In the operation, we performed L4-5-S1 posterior lumbar interbody fusion and pedicle screw fixation from T4 to Ilium.

RESULTS : At postoperative 1 year, C7 plumb line : neutral, sacral slope : 16.6° , pelvic tilt : 25.3° , lumbar lordosis : -34.6° were obtained. She walked upright.

CONCLUSION : This case shows rare feature of Type II sagittal imbalance. We obtained surgical experiences.

경추 후궁절제술 이후 신전시 발생하는 경척수병증 진단시 dynamic MRI 의 유용성

추윤희, 박수동, 전익찬, 김상우

영남대학교의료원 신경외과

PURPOSE : We introduce a case of extension myelopathy with postlaminectomy membrane, diagnosed by dynamic MRI findings; the Cerebrospinal fluid space having narrowed when the patient bend his neck backward.

MATERIALS AND METHODS : A 43-years-old man had Anterior Cervical Discectomy Fusion and Decompressive Cervical laminectomy to release the pressure on cervical cord caused by Ossification of Posterior Longitudinal Ligament. Although he had the operation and did rehabilitation, symptoms were not improved. He still complained for gait disturbance and both arm numbness which aggravated when lying down or bend his neck. We checked the dynamic MRI images showing buckled cord by (adhesive) soft tissue and less high signal signify CSF around cervical spinal cord. We diagnose myelopathy with postlaminectomy membrane with dynamic MRI in this case. We excoriated adhesioned tissue around laminectomy site, then fixed screws and applied dome-formed cross-link to prevent being re-adhesiveness.

RESULTS : A few days after the operation, he had less problem with both arm numbness when lying down. He was quite content with deep sleep in supine position. Further more, compare to before operation, he got better to walk.

CONCLUSION : Dynamic MRI could be very valuable tool to diagnose extension myelopathy, especially with postlaminectomy membrane. Practically we diagnosed myelopathy using dynamic MRI in the patient who suffer from gait disturbance and both arm numbness after laminectomy surgery. After the operation excoriating adhesioned tissue around laminectomy site based on the dynamic MRI findings, patients got better to walk and sleep with lying on his back. This case proved that dynamic MRI can do the key role to diagnose myelopathy with postlaminectomy membrane.

전방접근에 의한 경추간판 제거술 및 유합술 시행 후에 황색 인대 좌굴에 기인해 재발생한 경척수병증

박수동, 전익찬, 김상우

영남대학교의료원 신경외과

PURPOSE : Anterior cervical discectomy and fusion (ACDF) is one of the most commonly performed surgical procedures of the cervical spine. We present a patient with C4–C6 cervical stenosis with myelopathy who manifested a recurrence of symptoms even after the ACDF due to ligamentum flavum buckling.

MATERIALS AND METHODS : The 65-year-old male patient complained of tingling sensations in both upper limbs and progressive hand grip weakness for several years accompanied by gait disturbances. Pre-operative neurological examinations showed typical findings of the cervical spondylotic myelopathy (CSM) which include quadriparesis, positive Hoffman's sign and increased deep tendon reflexes. Magnetic resonance imaging (MRI) revealed cervical stenosis and degenerative retrolisthesis with reversed lordotic cervical curvature at C4–C6. Images at C4–C5 levels also showed significant canal compromise, disc protrusion, and hyperintense spinal cord signal in T2-weighted images. The patient, then, underwent microscopic C4–C6 discectomy and fusion with inserting stand-alone intervertebral cages (ZERO-P VA™). A post-operative examination revealed a brief improvement of symptoms, but pre-operative conditions recurred after several days. The ensuing MRI study demonstrated reduced retrolisthesis, over-corrected lordotic curvature, the posterior disc height remaining unchanged compared to that prior to the surgery and restenosis because of buckling of the ligamentum flavum into the spinal canal at the level of discectomy. Therefore, the patient underwent C4–C6 decompressive laminectomies. The buckled ligamentum was excised and screw fixation was performed.

RESULTS : Post-operatively, he was satisfied with the surgical treatment as the gait disturbances and hand grip weakness improved and was discharged without any neurologic deficit.

CONCLUSION : In this case, an insufficient insertion depth of the intervertebral cage, a failure to increase posterior disc height, gaining of lordotic curvature and reduction of retrolisthesis contributed to the restenosis due to ligamentum flavum buckling. Therefore, surgeons performing ACDF should consider these factors to prevent inadvertent restenosis from ligamentum flavum buckling.