MSS-SRS INTERNATIONAL SPINE CONGRESS 2011

THEME
Challenges & Controversies in Spine Surgery

8th – 10th DECEMBER 2011
Shangri-La Hotel, Kuala Lumpur Malaysia
Post-trauma recovery can be bristling with pain, but there is a fast and effective way to improve your patients’ outcomes.

**OxyNorm** (oxycodeone) capsules provide comparable analgesic efficacy to morphine in the post-operative setting. Oxycodeone has also been shown to have a better safety profile than morphine and tramadol. Although structurally related to morphine, oxycodeone has a higher oral bioavailability than morphine and other strong opioids. Structural differences may also mean oxycodeone is subject to less first-pass metabolism than morphine.

Indicated for moderate to severe post-operative and breakthrough pain, **OxyNorm** capsules are an important and convenient choice to help smooth out post-trauma pain.


**ADDUCED PRODUCT INFORMATION**

**COMPOSITION** Oxycodeone hydrochloride M18. 1. **INDICATIONS:** The management of opioid responsive, moderate to severe pain. 2. **CONTRAINDICATIONS:** Hypersensitivity to opioids, acute respiratory depression, delirium; cardiac arrhythmias; acute asthmatic or other obstructive pulmonary disease; paralytic ileus; suspected surgical abdomen; severe renal impairment (creatinine clearance < 10 ml/min); delayed gastric emptying; acute alcoholism; brain tumors; increased intracranial or intracerebral pressure; nausea; acute CNS depression; convulsive disorders; delirium tremors; hypercortisolemia; concurrent administration of monoamine oxidase inhibitors or within 2 weeks of discontinuation of their use. Not recommended for pre-operative use. 3. **PRECAUTIONS:** Hypersensitivity, raised intracranial pressure, hypertension, hypovolaemia, biliary tract disease, pancreatitis, inflammatory bowel disorders; mental depression; bronchial hyperactivity; adrenocortical insufficiency; psychosis; chronic pulmonary disease; peritonitis; peritoneal surgery; chronic non-malignant pain; prior substance abuse; tolerance and physical dependence; elderly, elderly debilitated patients; drinking; operating dangerous machinery; pregnancy. 4. **INTERACTIONS:** Anticoagulant agents; antihypertensive agents; CNS depressants (including sedatives, hypnotics, general anaesthetic, phenothiazines, other tranquillizers, alcohol, other opioids and neuroleptic drugs); coumarine derivatives; nortriptyline. MAOIs especially non-selective (e.g., Tranylcypromine, rasubene, alpha adrenergic blockers, alpha adrenergic antagonists) (e.g., aminophylline, bupropion), drugs that involve the cytochrome P450 system viz. CYP2C9, CYP2D6 (Refer to Product Information). 5. **ADVERSE REACTIONS:** Gastrointestinal disorders (nausea, vomiting, constipation, dry mouth, anorexia, gastritis, hiccup, dyspepsia, abdominal pain, diarrhea). CNS disturbances (headache, confusion). 6. **PRECAUTIONS:** OxyNorm capsules should be taken 4-6 hourly intervals. The dosage is dependent on severity of pain and the patient’s previous analgesic requirements. Refer to Product Information for further information on conversion factors to convert daily dose of opioid to daily dose of OxyNorm capsules. Children under 18 years Not recommended. **PRESENTATION:** OxyNorm capsules 5 mg (green/white), 10 mg (white/white), 20 mg (pink/white) in blister pack of 28 capsules (two blister strips of 14 capsules). Full prescribing information available upon request.
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International Organising Committee
Scoliosis Research Society

INTERNATIONAL CO-CHAIRMEN
B Stephens Richards
Hilali M H Noordeen

WORLDWIDE CONFERENCE CHAIR
Ahmet Alanay

Local Organising Committee

CHAIRMAN
Dato’ Mohamad Abdul Razak

SECRETARY
Abdul Halim Yusof

TREASURER
Heng Hing, Lim

BUSINESS MANAGER
Abdul Malik Mohamed Hussein

SCIENTIFIC CHAIRMAN
Mun Keong, Kwan

PUBLICITY AND PROMOTION
Harwant Singh
Nurul Azwa b Mohd Noor
Marwar Sofiyan

SOCIAL EVENTS
K Parameshwaran
Chee Seang, Chong

TECHNICAL / AUDIO-VISUAL
Lim Beng, Saw
International Faculty

USA
B Stephens Richards
Kamal N Ibrahim
Sigurd H Berven
Robert W Gaines

UNITED KINGDOM
Hilali M H Noordeen

TURKEY
Ahmet Alanay

CANADA
Brian K, Kwon

EGYPT
Hazem Elsebaie

GERMANY
Nils Hansen-Algenstaedt

HONG KONG
Keith Dip Kei, Luk

INDIA
Arvind Jayaswal

KOREA
Jae Yoon, Chung

SINGAPORE
Hee Kit, Wong

TAIWAN
Po Quang, Chen

Local Faculty

Abdul Halim Yusof
Abdul Malik Mohamed Hussein
Deepak Ajit Singh

Heng Hing, Lim
Chung Chek, Wong
Message

Dear Colleagues,

It is my greatest pleasure to welcome the Scoliosis Research Society to Malaysia. It is also a very great honour for the Malaysia Spine Society as we have the opportunity to meet the international experts of spine deformity surgery in Malaysia. This is an important step in the development of spine surgery for our Society specifically, and for Malaysian orthopaedic surgery in general.

Our inaugural meeting has been themed “Challenges and Controversies in Spine Surgery”. We feel this is very timely, as knowledge and techniques in spine surgery have expanded and surgeons will require the platform to evaluate these developments in meetings such as these. To this end, we have invited speakers and experts from all corners of the world to come and share with us, present to us and teach us what is new, not forgetting that we have to also evaluate the outcomes of established practice.

Once again, on behalf of the Malaysia Spine Society, I welcome each and everyone of you to Malaysia for a stimulating scientific programme, and an equally exciting social programme.

PROF DATO’ MOHAMAD ABDUL RAZAK
Organising Chairman &
President, Malaysia Spine Society
Dear Colleagues,

On behalf of the Scoliosis Research Society, I welcome everyone to the Malaysia Spine Society’s 2011 International Spine Congress to be held on 8th to 10th December 2011.

The SRS sponsors three world-wide conferences each year, and this year, we are honored to be in Shangri-La Hotel, Kuala Lumpur, Malaysia, for one of them. Having the opportunity to work side-by-side with the Malaysia Spine Society, should result in an educational and exciting event. There will be numerous up-to-date lectures and case presentations on the challenges and controversies in spine surgery.

DR B STEPHENS RICHARDS
International Co-Chairman & President, Scoliosis Research Society
Message

Dear Colleagues,

On behalf of the Scoliosis Research Society (SRS), may I invite you and your colleagues to the joint meeting of the SRS and the Malaysia Spine Society (MSS) in Kuala Lumpur.

Malaysia is an ideal venue to have this meeting, both in terms of its natural beauty, and for the clinicians, committed to providing the best care for spinal disorders. As a member of the SRS, it is an opportunity for the Society to continue demonstrating its commitment to the practice of spinal surgery, and for the large membership in this region to participate in this commitment.

As Adjunct Professor of Spinal Surgery at the National University of Malaysia in Kuala Lumpur (UKM), I can vouch for the venue and the outstanding instructional courses and programme. I warmly welcome you and hope you participate in what I know will be an exciting and enjoyable venture!

DR HILALI M H NOORDEEN
International Co-Chairman
Scoliosis Research Society
## Programme Summary

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Cervical Spine – Cervical Spondylotic Myelopathy (CSM) | SYMPOSIUM 11  
Sagittal Plane Deformities |
| 0900 – 0930 | | | |
| 0930 – 1000 | Tea Break | | |
| 1000 – 1030 | | | |
| 1030 – 1100 | SYMPOSIUM 1  
Challenges In Surgical Management Of Adolescent Idiopathic Scoliosis (AIS) | SYMPOSIUM 6  
Osteoporosis | SYMPOSIUM 12  
Lumbar Spine – Spondylolisthesis |
| 1100 – 1130 | | SYMPOSIUM 7  
Trauma | FREE PAPER 1  
Scoliosis |
| 1130 – 1200 | SYMPOSIUM 2  
Early Onset Scoliosis (EOS) | | FREE PAPER 2  
Miscellaneous |
| 1200 – 1230 | | | SYMPOSIUM 13  
Complications In Spinal Surgery: How To Prevent And Manage? |
| 1230 – 1300 | Lunch Satellite Symposium  
[K2M] | Lunch Satellite Symposium  
[DePuy / Medtronic] | Closing Ceremony / Lunch |
| 1300 – 1330 | | | |
| 1330 – 1400 | | | |
| 1400 – 1430 | SYMPOSIUM 3  
Adult Degenerative Scoliosis | | |
| 1430 – 1500 | | | Friday Prayers |
| 1500 – 1530 | CASE DISCUSSIONS | SYMPOSIUM 8  
Tumour | |
| 1530 – 1600 | | SYMPOSIUM 9  
MISS | |
| 1600 – 1630 | Tea Break | | |
| 1630 – 1700 | SYMPOSIUM 4  
Complications In Scoliosis Surgery: Dealing With Disasters | SYMPOSIUM 10  
Infections | |
| 1700 – 1730 | | | |
| 1730 – 1800 | Tea Break | | |
| 1930 – 2300 | 2000 – 2200  
Faculty Dinner  
(by invitation only) | Congress Dinner | |

*Faculty Dinner (by invitation only)*
### Daily Programme

#### 7th December 2011, Wednesday

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<td>1430 – 1700</td>
<td><strong>PRE-Congress Workshop</strong>&lt;br&gt; Xia 3 SUK – Direct Vertebral Rotation (DVR) System&lt;br&gt;• Quick, Simple, Modular&lt;br&gt;• 3 Dimensional Approach to Correcting Deformity&lt;br&gt;• Segmental &amp; En Bloc Derotation Maneuvers&lt;br&gt;<em>Kim Soon, Oh / Chung Chek, Wong / Uei Chyi, Chuah</em></td>
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#### 8th December 2011, Thursday

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<td>0800 – 0830</td>
<td><strong>Plenary 1</strong>&lt;br&gt;Surgical management of Adolescent Idiopathic Scoliosis: Past, present and future&lt;br&gt;<em>B Stephens Richards</em></td>
<td>Sabah Room</td>
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<td>0830 – 0930</td>
<td><strong>Opening Ceremony</strong>&lt;br&gt;Guests and Delegates to be seated&lt;br&gt;Welcome Address by Prof Dato’ Mohamad Abdul Razak, Organising Chairman and President, Malaysia Spine Society&lt;br&gt;Speech by Dr B Stephens Richards, President, Scoliosis Research Society&lt;br&gt;Speech by YB Datuk Seri Mohamed Khaled bin Nordin, Minister of Higher Education Malaysia, followed by opening of the conference&lt;br&gt;End of ceremony / Refreshments / Press Conference</td>
<td>Sabah Room</td>
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<td>0930 – 1000</td>
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<tr>
<td>1000 – 1130</td>
<td><strong>Symposium 1</strong>&lt;br&gt;Challenges In Surgical Management Of Adolescent Idiopathic Scoliosis (AIS)&lt;br&gt;<em>Chairpersons: Abdul Malik Mohamed Hussein / Dato’ Faizir Mohamad</em>&lt;br&gt;1. Selective thoracic fusion in Lenke 1. How to choose the level of fusion? <em>Hee Kit, Wong</em>&lt;br&gt;2. How to balance a proximal thoracic curve to achieve a balanced shoulder and neck? <em>Ahmet Alanay</em></td>
<td>Sabah Room</td>
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3. Lenke type V or VI curves – Should we stop using ASF and only use PSF now? [page 23]  
   B Stephens Richards

4. Sagittal and axial correction strategies in AIS [page 24]  
   Hilali M H Noordeen

5. Short segment bone-on-bone instrumentation for Adolescent Idiopathic Scoliosis: 45 cases with mean follow-up of 6 years [page 25]  
   Robert W Gaines

6. Management strategies in correction of severe rigid scoliosis: Cobbs > 90° [page 26-27]  
   Arvind Jayaswal

1130 – 1230 SYMPOSIUM 2  
   Early Onset Scoliosis (EOS)  
   CHAIRPERSONS: HENG HING, LIM / OZLAN IZMAN KAMIL
   1. Bracing in Early Onset Scoliosis [page 28]  
      B Stephens Richards
   2. Congenital scoliosis – Challenges and surgical options [page 29]  
      Ahmet Alanay
   3. Growing rod system [page 30]  
      Keith Dip Kei, Luk
   4. Choosing between growing rods and VEPTR [page 31]  
      Hilali M H Noordeen

1230 – 1400 Lunch Satellite Symposium  
   Vertebral rotation with range system (K2M)  
   Kamal N Ibrahim

1400 – 1500 SYMPOSIUM 3  
   Adult Degenerative Scoliosis  
   CHAIRPERSONS: DEEPAK AJIT SINGH / CHERN LONG, SHUE
   1. How to prevent complications associated with surgery in adult degenerative scoliosis? [page 32]  
      Po Quang, Chen
   2. Sacro-pelvic fixation [page 33]  
      Kamal N Ibrahim
   3. Osteoporosis – Options in preventing implant failure [page 34]  
      Ahmet Alanay
      Sigurd H Berven
Daily Programme
8th December 2011, Thursday [cont’d]

1500 – 1600 CASE DISCUSSIONS
Sabah Room
CHAIRPERSONS: CHUNG CHEK, WONG / ZAMZURI ZAKARIA
1. How to select the fusion level in AIS? [page 36-37]  
   B Stephens Richards
2. Correction strategies and decision-making in early-onset scoliosis [page 38]  
   Hilali M H Noordeen
3. Surgical decision-making in adult degenerative scoliosis [page 39]  
   Kamal N Ibrahim

1600 – 1630 Tea Break

1630 – 1730 SYMPOSIUM 4
Sabah Room
Complications In Scoliosis Surgery: Dealing With Disasters
CHAIRPERSONS: MAZWAR SOFIAN / CHEE HUAN, PAN
1. Misplaced pedicle screws [page 40]  
   • Incidence, recognition, prevention and management  
   Hilali M H Noordeen
2. Postoperative spinal imbalance [page 41]  
   • Incidence, recognition, prevention and management  
   Sigurd H Berven
3. Pedicle screws migration in growing rods [page 42]  
   • Incidence, recognition, prevention and management  
   Hazem Elsebaie

2000 – 2200 Faculty Dinner (by invitation only)
Malaysian Petroleum Club, Petronas Twin Towers, Kuala Lumpur  
(Bus will leave Lower Lobby, Shangri-La Hotel at 1930 hrs)
PLENARY 2

Chairperson: Dato’ Zamyn Zuki Mohd Zaki

Spinal cord injury – Recent updates [page 43]
Brian K, Kwon

SYMPOSIUM 5

Cervical Spine – Cervical Spondylotic Myelopathy (CSM)

Chairpersons: Kim Soon, Oh / Hishamuddin Salam

1. Natural history of CSM: When should we operate? [page 44]
   Brian K, Kwon

2. Adjacent segment degeneration in anterior cervical fusion
   – Minimal 10 years follow-up [page 45]
   Jae Yoon, Chung

3. Cervical myelopathy [page 46-47]
   Keith Dip Kei, Luk

4. What is the best surgical approach for multi-segmented cervical
   spondylotic myelopathy? [page 48]
   Brian K, Kwon

SYMPOSIUM 6

Osteoporosis

Chairpersons: Yew Siong, Siow / Jamal Azmi Mohd

1. The roles of cement augmentation in osteoporosis fracture [page 49]
   Deepak Ajit Singh

2. Vertebroplasty vs kyphoplasty. Which is better? [page 50]
   Sigurd H Berven

3. The use of cement screws in osteoporotic bone [page 51]
   Ahmet Alanay

4. Surgical difficulties in osteoporotic compression fracture [page 52]
   Po Quang, Chen

SYMPOSIUM 7

Trauma

Chairpersons: Azmi Baharuddin / Mohammad Zaki Mohd Amin

1. Thoracolumbar fracture. Do we need to fix? [page 53]
   Po Quang, Chen

2. Proximal half corpectomy and one motion segment fixation of Denis
   type B burst fractures of lumbar spine [page 54]
   Jae Yoon, Chung

3. Role of Minimally Invasive Surgery (MIS) in thoracolumbar trauma
   [page 55-56]
   Arvind Jayaswal

4. Successful short-segment instrumentation and fusion for thoracolumbar
   spine fractures: A consecutive 4\(\frac{1}{2}\)-year series [page 57]
   Robert W Gaines
1200 – 1330  
**Lunch Satellite Symposium**  
**Deformity correction with Viper 3D (DePuy)**  
*Kamal N Ibrahim*  
Demonstration *(Medtronic)*  
*Ahmet Alanay*

1330 – 1430  
**Friday Prayers**

1430 – 1530  
**SYMPOSIUM 8**  
*Tumour*  
**CHAIRPERSONS: ABDUL HALIM YUSOF / NOR AZLIN ZAINAL ABIDIN**  
1. Posterior column reconstructions in total spondylectomy  
   *Jae Yoon, Chung*  
2. Surgical treatment of aggressive sacral tumors  
   *Keith Dip Kei, Luk*  
3. Spinal metastasis: When should we operate?  
   *Abdul Malik Mohamed Hussein*  
4. Palliative spine surgery in spinal metastasis using MISS techniques  
   *Nils Hansen-Algenstaedt*

1530 – 1630  
**SYMPOSIUM 9**  
*MISs*  
**CHAIRPERSONS: SABARUL ALFIAN MOKHTAR / AHMAD TAJUDDIN ABDULLAH**  
1. MISS in deformities  
   *Nils Hansen-Algenstaedt*  
2. Percutaneous endoscopic surgery – Fact and hype  
   *Heng Hing, Lim*  
3. The role of endoscopic decompression in lumbar spinal stenosis  
   *Abdul Halim Yusof*  
4. Radiation exposure to surgeons: New concerns in the age of minimally invasive spine surgery  
   *Hee Kit, Wong*

1630 – 1730  
**SYMPOSIUM 10**  
*Infections*  
**CHAIRPERSONS: AHMAD SABRI OMAR / MOHD IMRAN YUSOF**  
1. Infections in idiopathic scoliosis  
   *B Stephens Richards*  
2. Single surgery for spondylodiscitis with epidural abscess. The level dictates the approach  
   *Hazem Elsebaie*  
3. The use of endoscopic surgery in the treatment of spinal infections  
   *Chung Chek, Wong*  
4. Management of tuberculous spondylitis: Current thinking  
   *Arvind Jayaswal*

1730 – 1800  
**Tea Break**
### Congress Dinner

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<td>2005</td>
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<td>Citation on Dato’ Dr K S Sivananthan for the Outstanding Leadership in Spine by Dr Abdul Malik Mohamed Hussein</td>
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<td>Address by Dato’ Dr K S Sivananthan on “Development of Spine Surgery in Malaysia”</td>
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Daily Programme
10th December 2011 (Saturday)

0800 – 0830  PLENARY 3  Sabah Room
CHAIRPERSON: DATO’ K S SIVANANTHAN
Recent advancements in Minimally Invasive Spine Surgery (MISS)  [page 74]
*Nils Hansen-Algenstaedt*

0830 – 0930  SYMPOSIUM 11  Sabah Room
**Sagittal Plane Deformities**
CHAIRPERSONS: YUE SENG, CHOOI / CHEE YEW, CHEOK
1. Analysis of sagittal imbalance and its clinical importance  [page 75]
   *Sigurd H Berven*
2. Management of sagittal imbalance in ankylosing spondylitis  [page 76]
   *Po Quang, Chen*
3. Management of proximal junctional kyphosis in spinal deformity  [page 77]
   *Sigurd H Berven*
4. Neural arch saving technique of shortening osteotomy for sagittal correction  [page 78]
   *Jae Yoon, Chung*

0930 – 1000  Tea break

1000 – 1100  SYMPOSIUM 12  Sabah Room
**Lumbar Spine – Spondylolisthesis**
CHAIRPERSONS: CHEE SEANG, CHEONG / AHMAD NOR SHARID
1. Lysis repair in spondyloysis and listhesis  [page 79]
   *Hilali M H Noordeen*
2. Pathomechanism of degenerative spondylolisthesis – When and how to fuse?  [page 80-81]
   *Keith Dip Kei, Luk*
3. Surgical complications associated with high grade spondylolisthesis. How do we avoid them?  [page 82]
   *Kamal N Ibrahim*
4. Long-term results for operative reconstruction of high-grade spondylolisthesis and spondyloptosis  [page 83]
   *Robert W Gaines*

1100 – 1200  FREE PAPER 1  Sabah Room
**Scoliosis**
CHAIRPERSONS: CHEE HUAN, PAN / ABDUL HADI HUWIN
FP 1  Can we have both satisfying coronal and sagittal correction in Lenke 1 Adolescent Idiopathic Scoliosis curves?  [page 84]
   *Jean-Luc Clement*

FREE PAPER 2  Sarawak Room
**Miscellaneous**
CHAIRPERSONS: ZAIRUL ANUAR KAMARUL BAHRIAN / ZULKIFLI ATAN
FP 8  Neglected nonunited Odontoid type II fracture with myelopathy: Treatment with four different fixation techniques  [page 91]
   *Torphong Bunmarprasert*
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<td>Harwant Singh</td>
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<td>Alpaslan Senkoylu</td>
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<td>Priyesh Dhoke</td>
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<td>The effect of chronicity of symptoms on pain outcome measures in the surgical treatment of spinal stenosis</td>
<td>Myint Thaung</td>
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**Daily Programme**

**10th December 2011 (Saturday)** [cont’d]

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**1200 – 1300**  
**SYMPOSIUM 13**  
*Complications In Spinal Surgery: How To Prevent And Manage?*  
**CHAIRPERSONS:** DATO’ R RAMANATHAN / K PARAMESHWARAN

1. **CSF leaks in spine surgery**  
   *Incidence, recognition, prevention and management*  
   **Brian K, Kwon**

2. **Post operative haematoma?**  
   *Incidence, recognition, prevention and management*  
   **Hee Kit, Wong**

3. **Intraoperative bleeding?**  
   *Prevention and management*  
   **Kamal N Ibrahim**

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**1300 – 1330**  
**Closing Ceremony / Lunch**
Conference Information

Conference Venue
Shangri-La Hotel Kuala Lumpur
11 Jalan Sultan Ismail
50250 Kuala Lumpur
Tel: (603) 20268488
Fax: (603) 20321245

Registration
The operating times are:
- 7th December 2011, Wednesday 1600 to 1900 hrs
- 8th December 2011, Thursday 0700 to 1800 hrs
- 9th December 2011, Friday 0730 to 1700 hrs

Identity Badges
Delegates are kindly requested to wear identity badges during all sessions and functions.

Entitlements
Registered delegates will be entitled to the following:
- Conference Bag and Materials
- Scientific Sessions
- Coffee/Tea and Lunch
- Congress Dinner
- Admission to the Trade Exhibition

Opening Ceremony (8th December 2011, Thursday • 0830 to 0930 hrs)
The guest of honour at the Opening Ceremony is YB Datuk Seri Mohamed Khaled bin Nordin, Minister of Higher Education Malaysia.

Congress Dinner (9th December 2011, Friday • 1930 to 2300 hrs)
This will be held at the Ballroom of the Shangri-La Hotel, Kuala Lumpur. Delegates are welcomed to bring their spouses and guests at an additional cost of RM150 per person. Please enquire at the Registration Counter.
Dress code: Smart casual.

Disclaimer
 Whilst every attempt will be made to ensure that all aspects of the Conference as mentioned in this publication will take place as scheduled, the Organising Committee reserves the right to make changes should the need arise.
Floor Plan & Trade Exhibition

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MSS-SRS International Spine Congress 2011
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SURGICAL MANAGEMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS: PAST, PRESENT, AND FUTURE

B Stephens Richards
Texas Scottish Rite Hospital, Dallas, Texas, United States

PAST
Risser cast immobilization, cut-out for fusion
Harrington Rod
Introduction of sublaminar wires
Anterior instrumentation for thoracolumbar/lumbar curves
Segmental posterior fixation using multiple hooks

PRESENT
Introduction of pedicle screws
Thoracoscopic fusion
Intraoperative neuromonitoring
Blood management techniques
Bone graft alternatives
Vertebral column resection

FUTURE
Minimally invasive posterior spinal fusions?
Genetic manipulation
SELECTIVE THORACIC FUSION IN LENKE 1. HOW TO CHOOSE THE LEVEL OF FUSION?

Hee Kit, Wong

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University Orthopaedics, Hand and Reconstructive Microsurgery Cluster (UOHC)
University Spine Centre, National University Health System (NUHS), Singapore

Lenke type 1 curves are single thoracic curves where the main thoracic curve is the major curve, and the proximal thoracic and thoracolumbar/lumbar curves are minor non-structural curves. The classification is further divided into 3 subtypes (lumbar modifier A, B, C) depending on the displacement of the apex of the minor non-structural lumbar curve from the central sacral vertical line; and a further 3 subtypes (hypo-, normal, hyper-) depending on the thoracic sagittal profile. By nature of its definition, surgical treatment mandates fusion of this main thoracic curve alone. However, the proximal and distal levels of fusion are not adequately dictated by this classification, and in the case of Lenke 1C curves, fusion could be taken distally into the entire lumbar compensatory curve. In reality, true ‘selective’ fusion of the thoracic spine applies only to Lenke 1C curves. Nevertheless, this presentation will cover the choice of fusion levels for all Lenke 1 subtypes. Decision on the proximal fusion level could depend on the shoulder level; the greater the shoulder is tilted towards the side of the curve, the greater the tendency to go further cephalad into the proximal thoracic curve. The proximal fusion level can stop at the upper end vertebra if the shoulder is tilted away from the main thoracic curve. In general, the distal fusion level is the stable vertebra or the lower end vertebra of the main thoracic curve if it is of neutral rotation. Care must be taken not to end the fusion close to or at the apical vertebral of the lumbar minor curve for Lenke 1B or C subtypes to avoid truncal imbalance after surgery. Achieving spinal balance for ‘selective’ fusion of Lenke 1C curve will depend on the relative magnitudes of the thoracic and lumbar curves, moderated correction of the main curve, and the appropriate level of distal termination of fusion of the main curve. These principles largely apply to posterior spinal fusion. The fusion levels for anterior trans-thoracic fusion are from upper to lower end-vertebrae. As the anterior approach does not allow adequate access to the minor proximal thoracic and lumbar curves, it is generally suitable only for Lenke 1A and 1B curve types.
The shoulder balance is an important parameter to decide whether or not to instrument the PT curve. The decision is easy in case of a King-Moe type V (proximal thoracic curve + T1 tilt more than 5°) curve or Lenke type 2 (Double thoracic curve each of which does not decrease to less than 25° in bending x-rays) curve as left shoulder is usually elevated and the PT curve is structural in these deformities and extension of fusion to PT curve is mandatory. The difficulty is the judgement of postoperative behavior of PT curve and left shoulder in other types of Lenke curves and especially for type 1 and 3 curves. Several attempts were made to determine criteria to recognize the PT curves which fits to non-structural category but may deteriorate or may end up with Left Shoulder Elevation (LSE) when left unfused. Those criteria usually worked well when patients were treated by using the hybrid and hook systems. However, with the popularization of all pedicle screw constructs, surgeons were able to get higher correction rates both in coronal and transverse planes of adolescent deformities. More correction has resulted with more shoulder balance problems. In a recent presentation at SRS annual meeting, O’Brien et al has reported an incidence of 39% for LSE after treatment of Lenke type 1 curves. Lenke type-1 curves were MT curves with non-structural PT curves and LSE was not expected after fusing only MT curves. Higher correction rates caused higher incidence of LSE. Therefore Lenke classification and other criteria were not sufficient to determine the structurality of the PT curve for a considerable number of patients and we can not rely on this classification for each patients with non-structural PT curves. In our hands, the best method to demonstrate the flexibility of the curves and prediction of left shoulder behavior and changes in balance was by using traction x-rays under general anesthesia (TRUGA). In a recent study we have demonstrated that by using the TRUGA to predict the shoulder balance in patients with non-structural curves was 14%. We have also observed that none of the patients with (-) shoulder balance demonstrated by TRUGA had LSE after the surgery. However, in 14% of patients who were determined to have LSE after surgery, LSE could not be prevented despite ending the instrumentation at T2 and all precautions. Other ways to prevent shoulder imbalance were to get an intraoperative prone x-ray and evaluate the shoulder balance and to make necessary adjustments such as compression and distraction to balance the shoulders.
LENKE TYPE V OR VI CURVES – SHOULD WE STOP USING ASF AND ONLY USE PSF NOW?

B Stephens Richards
Texas Scottish Rite Hospital, Dallas, Texas, United States

PROBLEMS WITH ASF

- Postoperative pain, large scar (Kim, Spine 2009)
- Sympathectomy on the ipsilateral side, perhaps permanently
- Weakness in hip flexor
- Higher potential for pseudarthrosis and/or correction loss with single rod (Ouellet, Spine 2002; Zhang Spine 2006)
- Reports of vascular injury (Lavigne, Eur Spine J 2009)
- Potential of kyphosis through instrumented segment with single rod (Ouellet, Spine 2002; Zhang, Spine 2006)
- Unable to address thoracic component, should it require extension proximally during surgery
  - Risk of thoracic curve problem if TL/L:T ratio <1.25 with stiff thoracic component or triradiate cartilage open (Li, Spine 2009; Sanders, Spine 2003)
- Impact on pulmonary function
  - Takedown of the diaphragm during exposure
- Persistence of LIV tilt
  - What does this mean for the future?
- More operative time and longer hospitalization (Erickson, SRS 2009; Geck, Spine 2009)
- We accepted all of these potential problems because we didn’t have a better tool until this past decade... the power of posterior screw constructs

POSTERIOR INSTRUMENTATION/FUSION (Shufflebarger, Spine 2004; Erickson, SRS 2009)

BENEFITS

- Equal or better correction (Erickson, SRS 2009; Geck, Spine 2009; Yu, Zhong Yi Xue Za Ahi 2009; Zhan, Chin J Surg 2009)
  - Less loss of correction over time
  - Similar LIV to anterior surgery
  - Most commonly the LEV, though PSF more likely to extend distal to LEV (Erickson, Yu, Zhan)
- Improvement in disc wedging following surgery (Yu, Chin Med Sc J 2010)
- Higher fusion rates (Shufflebarger, Spine 2004)
- Less surgical time (Erickson, Geck, Zhan)
- No difference in postoperative gait parameters (Mahaudens, Eur Spine J 2010)
- Easier, more familiar techniques
- Can extend proximally, if needed
- Shorter operative time
- Patient doesn’t see the scar in the mirror
- No hip flexor weakness
- No sympathectomy
AIS (Adolescent idiopathic scoliosis) is a three dimensional deformity resulting in coronal imbalance with curvature of spine in addition to thoracic hypo-kyphosis (lordoscoliosis) and vertebral axial rotation. The spinous processes are rotated inwards into the concavity of the curve resulting in a rib-hump deformity. Severe rotation esp. at the apex of curve produces “Razorback” deformity. Three dimensional “Da Vinci” representations help one in understanding the curve better.

Corrective strategies used include application of cantilever forces that produces translation of spine coupled with segmental derotation. Rigid anchorage of vertebral elements to pedicle screws facilitates application of large corrective forces to correct the spine. Use of compressive and distractive forces at relevant segments facilitates coronal and sagittal correction.

Use of modern “End of Construct” (EoC) pedicle screws that withstands enormous pull-out strengths are inserted into upper & lower instrumented vertebrae and locked / rigidly tightened before segmental derotation is performed at every level in cranio-caudal sequence (i.e. thoracic first followed by lumbar).

The indications to perform anterior release are shrinking with evolution of modern / sophisticated instrumentation systems and single stage posterior spinal fusion with all pedicle screws segmental spinal instrumentation appears to be evolving as a gold standard in surgical management of AIS. However presence of rigid deformity with severe lordoscoliosis may cause reduced chest AP diameter with large intra-thoracic airway obstruction. Spinal osteotomies with extensive convex anterior / concave posterior releases with facetectomies may be necessary to restore normal spinal balance and are discussed.

Surgeons vs. Parents vs. Patients’ perception of a successful outcome may vary and important issues surrounding these should be discussed during consenting and counselled appropriately. Use of validated outcome measures (SRS-22 questionnaire) is mandatory while reporting surgical results.
SHORT SEGMENT BONE-ON-BONE INSTRUMENTATION FOR ADOLESCENT IDIOPATHIC SCOLIOSIS: 45 CASES WITH MEAN FOLLOW-UP OF 6 YEARS

Robert W Gaines
Columbia Orthopaedic Group, Columbia, Missouri, USA

STUDY DESIGN
Prospective case series.

OBJECTIVE
To evaluate the clinical and radiologic outcomes of short segment anterior scoliosis surgery with bone-on-bone apposition using a dual screw, dual rod system.

SUMMARY OF BACKGROUND DATA
Posterior segmental fixation for correction of AIS involves instrumentation of all the vertebrae included in the major curve. Our short segment anterior technique produces similar results by fusion of fewer levels.

METHODS
Forty-five patients operated between 1996 and 2004. Twenty-eight thoracic (Lenke 1) and 17 thoracolumbar (Lenke 5). The mean age was 19 years, 87% were females, and the mean follow-up was 72 months (range 28–121 months). We operated on curves less than 85° with “total discectomy,” bone-on-bone apposition, and dual-screw, dual-rod fixation.

RESULTS
A mean of five vertebrae (four discs) were instrumented, with a mean operative time of 360 minutes, blood loss of 877 mL and a hospital stay of 9.1 day. Lenke 1: The main preop thoracic curve was 52.5°, final postop curve 27.9°, by fusing five vertebrae, four discs. A spontaneous improvement of 47.5% of the lumbar compensatory curve was seen. The lower tilt angle corrected from 20.9° to 11°. Lenke 5: The preoperative thoracolumbar major curve corrected from 50.5° to 18.3° (final) with fusion of four vertebrae, three discs. A spontaneous improvement of 37.4% occurred in the thoracic compensatory curve. The preop tilt angle improved from 27.7° to 8.3°. The sagittal and coronal balance was restored in all the patients. There were no neurologic, vascular, pulmonary, or implant-related complications. Union occurred within 3 months. All the patients returned to an unrestricted lifestyle within 4 months.

CONCLUSION
We report good results after surgical correction using our short segment bone-on-bone technique. Improvements were noted and maintained, over a 6-year period.
In developing and underdeveloped countries there is still a large chunk of scoliosis that present late – about 30-40% in our practice. Long standing curves become rigid (little or no flexibility), have increased cobbs angle (>90°) and are grossly rotated at the apex. These are not only cosmetically grotesque but are also difficult to correct. The management of these severe and rigid curves are often a challenge for the surgeon. Various strategies for management of these severe curves have been reported via a two stage anterior & posterior correction, anterior releases with halo distraction followed by posterior correction, & more recently correction based on a single stage posterior alone vertebral column resection (PVCR)

The key to good surgical correction, is a good & extensive release of contracted anterior & posterior soft tissues as well as bony resection (osteotomies if required) along with judicious use of instrumentation. Thus a combined anterior & posterior approach – either in one or two stages, is what is preferred by us.

The presentation includes the study carried out at our institute.

OUR STUDY
Twenty eight patients with severe rigid scoliosis (>90° Cobb's) were managed with a two staged procedure involving Anterior release in Stage I and Posterior osteotomies in Stage II (asymmetric Pedicle subtraction osteotomy and/or Ponte’s Osteotomies) with all pedicle screw instrumentation and fusion. The average age was 14.4 yr and there were 8 males & 20 females with 6 having congenital scoliosis, 20 neglected Idiopathic scoliosis and 2 syndromic children. Average follow-up was 20 months (10-38). All the surgeries were carried out under spinal cord monitoring. All patients received tranexemic acid intra-operatively (Loading: 10-20mg/kg; Infusion 1-2mg/kg/hr.). All patients were assessed for pre and post-operative Cobb's angle (coronal and sagital) and other radiological parameters, mean operative time, average blood loss, functional scoring with SRS 30 questionnaire and complications.

RESULTS
The pre-op Cobb’s was 117.3° (101°-124°), which improved to 71.5° (64-88°) after anterior release and the final post-op Cobb’s was 26.6° (22°-32°), with a total of 77.3% correction. The average pre-op Cobbs (sagital) of 50.1° improved to 30.7° [39%] postoperatively. The average blood Loss was 1.8lt (1.2-2.8lt) for the posterior procedure and 580ml (400-980 ml) for anterior release. The mean operative time for anterior release was 223 min (165-315 min) and posterior surgery was 314 min (280-420 min). The mean apical RVA sag (vertebral rotation) of 56° improved to 28° postoperatively (p<0.05). There was significant improvement in Apical Vertebral Translation (AVT), trunk balance and rib hump correction after surgery. One patient had transient monoparesis which recovered spontaneously after 3 weeks; one patient had local skin necrosis. 2 patients required post-op ventilator support for 3 days. There was a significant improvement in self-image/appearance (mean 4.4) with a high satisfaction rate (mean 4.6) according to SRS-30 questionnaire.
CONCLUSION
Anterior release as a first stage procedure helps in partially correcting the deformity and reduces the need for a more extensive osteotomy from the back during the second stage of correction. Risks and morbidity in correction of these deformities are potentially there, but with a cautious approach and judicious application of the principles of osteotomy and spinal cord monitoring, the risks can be minimized to get a gratifying and a functionally beneficial correction for these severely deformed patients.
BRACING IN EARLY ONSET SCOLIOSIS
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INFANTILE ONSET IDIOPATHIC SCOLIOSIS (0-3 YRS.)
Resolving : RVAD < 20°; Phase I
Progressive : RVAD >20°; Phase II

LONG-TERM OBSERVATION AND MANAGEMENT OF RESOLVING INFANTILE IDIOPATHIC SCOLIOSIS
[JBJS (Br) – 2002, Diedrich, et al]
• Retrospective review of 73 subjects
• 58% had resolving curves [n=42]
  – All single pattern curves
• “…the RVAD is an essential radiological sign in distinguishing between resolving and progressive curves.”
  – >20° had 90% sensitivity, 85% specificity
  – Phase II rib head was a definitive sign of progressive scoliosis

GROWTH AS A CORRECTIVE FORCE IN THE EARLY TREATMENT OF PROGRESSIVE INFANTILE SCOLIOSIS
[Mehta, JBJS (Br) 2005]
• “…scoliosis can be reversed by harnessing the vigorous growth of the infant to early treatment by serial corrective plaster jackets”
• Plaster jackets worn 8-16 week intervals
• Casting d/c’d when:
  • Rib cage symmetry achieved (RVAD)
  • Derotation of apical vertebra
  • Complete or close to complete curve resolution
  • TLSO worn part-time, but consistently. Can d/c after 6 months if correction maintained.
• 94 children needed no further treatment – scoliosis corrected
• Mean age of 1+7 (6 - 48 months)
• Mean Cobb of 32° (range 11° to 65°)
• 77% treated by age 2; 39% Phase II
• 42 children with reduced, but not fully resolved deformity
• Mean age 2+6 (11 to 48 months)
• Mean Cobb of 52° (23° to 92°)
• 35% treated by age 2; 79% Phase II
• One of the most important factors for success was to begin treatment prior to the age of 2 years.

THE MORE TYPICAL TREATMENT SCENARIO FOR EARLY ONSET SCOLIOSIS
• Opportunity for orthotic treatment not afforded until a child is older (>2 years), and often with a much larger curve
• Begin cycle of orthosis / Risser cast and/or Halo Traction / Orthosis to “buy time” to allow growth prior to a more definitive (surgical) solution
CONGENITAL SCOLIOSIS – CHALLENGES AND SURGICAL OPTIONS
Ahmet Alanay
Istanbul Spine Center, Florence Nightingale Hospital, Istanbul Bilim University, Faculty of Medicine, Istanbul, Turkey

Congenital scoliosis is an imbalance of longitudinal growth of spinal column due to vertebral anomalies. Curves are usually progressive and rigid and may become severe in the early childhood. Treatment pose difficulties and brace treatment usually cannot control the curves. Stopping the deformity before it gets severe is the basic principle in early diagnosed kids. Several surgical options exist to achieve this aim. Posterior in situ fusion is the gold standard to stop the progression of the curves. However, current trend for patients with growing spine is to control the curves while allowing the spinal column to grow. The oldest method to allow the growth while controlling the curve is the convex hemiepiphysiodesis method. In this procedure, the overgrowing part of the spinal column (convex side) is fused anteriorly and posteriorly with expectation of growth through the opposite (concave) side. Instrumented convex hemiepiphysiodesis and periodic distraction at the concave side to speed up the growth and correction are current modifications of the technique. Growth stimulation techniques such as thoracic expansion and growing rods are also successful techniques to control and stimulate growth in selected congenital scoliosis patients.

Instrumented deformity correction and fusion can be done safely and effectively in patients who have completed the growth spurt or in growing patients with failure of the previously mentioned growth sparing techniques. Instrumentation and correction can even be done safely in patients with spinal dysraphism as our understanding of this pathology has increased by the help of current imaging tools and with the start of the use of neurological monitoring.

With the advent in surgical techniques and use of neuromonitorization, we are now able to perform sophisticated and technically challenging surgeries for the treatment of severe neglected cases which otherwise cannot be corrected with the standard instrumentation and correction techniques. Posterior vertebral column resection have been the popular technique recently to handle such severe cases.
The growing rod system is one of the non-fusion strategies in the management of early onset spinal deformities. It can be considered as an internal brace of the spine which should not only permit and guide spinal growth but also be able to maintain spinal length and correction of spinal deformities as the child grows. The former is a passive process whereas the latter is an active process. It is indicated in the immature spine that has significant remaining growth potential and with documented or predicted deformity progression, including congenital scoliosis and early onset idiopathic scoliosis. At the completion of growth it is expected that the instrumented segment will require a definitive fusion.

The concept of growing rod is not new but recent development of such instrumentations has expanded the applications even to correction of rigid deformities in the more mature patients taking advantage of the viscoelastic property of the spine. To avoid spontaneous ankylosis from subperiosteal dissection typically the instrumentation is implanted subcutaneously or intramuscularly with anchoring points made at the horizontal vertebrae cranial and caudal to the segment to be corrected particulary when a double-rod system is used. This often would involve a much longer segment of the spine beyond the primary deformity. If the primary aim is to obtain the most correction of a coronal deformity while involving the shortest segment the author prefers to use a single rod distraction system on the concave side. One should be mindful of the sagittal alignment to avoid a ‘flat back’.

One of the main disadvantages of the growing rod system is the need for repeated, though minor, distraction surgeries at 6-12 monthly intervals under general anesthesia. This also leads to increased risk of wound and soft tissue complications. Recently a new device has been developed that enables non-invasive actuation of an internal motor using an external magnet. It also permits more frequent smaller rod lengthening that better matches the physiological growth rate of the individual spine.
Early-onset scoliosis is challenging as ideal solution to address spinal growth, scoliosis correction and pulmonary function is not yet available. Severe curvature either due to rapidly progressive deformity or underlying syndrome results in TIS (thoracic insufficiency state).

STRATEGIES DEVELOPED TO ADDRESS THE ABOVE CAN BE BROADLY DIVIDED INTO:-

• Spine – Spine based implants (Growth rods)
• Spine – Rib based implants (VEPTR)

VEPTR is acronym for Vertebral Expandable Prosthetic Titanium Rib. It has been approved by US-FDA as humanitarian device exemption (HDE) implant for treating TIS. Dynamic MRI studies have shown improvement in pulmonary function with their use in-addition to modest curve correction in very young children. Multiple revision surgeries coupled with implant related wound problems are common. Conversion to Spine – Spine based implant is the end result of treatment: i.e. VEPTR graduation.

GROWING RODS ACT AS INTERNAL BRACE THAT GUIDES THE SCOLIOSIS CORRECTION WITH GROWTH. THEY HAVE EVOLVED WITH TIME HISTORICALLY FROM:-

• Luque-Trolley rods with sublaminar wires
• Hybrid constructs with hooks (top end), screws (bottom end) and domino connectors in the middle
• Magnetic growth rods (MGR).

Children with growth rods undergo lengthening at 6 monthly intervals. Definitive spinal fusion / removal of growth rods is the end result of treatment: i.e. Growth rod graduation.

More recently use of magnetic growth rods (MGR) has eliminated the need for repeated lengthening under anaesthetic wherein similar distraction can be achieved in an out-patient setting using an electronic remote controlled (ERC) device. The magnetic coil that has been in-built and embedded within the rod elongates thus simulating conventional distraction. Recent data has revealed improvement of pulmonary function with use of MGR in a selective group of young children.

The issues pertaining to complications with use of VEPTR & growth rods are discussed. Suffice to say that every case has to be thoroughly evaluated and treatment decisions individualised. This lecture provides guidance in make those key decisions.
Adult degenerative scoliosis (ADS) is supposed to come from degenerative change of the residual scoliosis or de novo changes in the aging patients. The patient usually presented with low back pain and sciatica of varying intensity, segmental slip, lumbar spinal kypho-scoliosis deformity and neurologic deficits. Many of them had neurogenic claudication, which interfered with daily life. Back pain is usually more severe if kyphosis is obvious in the lumbar region or having rotatory lateral subluxation of the apical segments. Therefore, operation is more difficult and has higher complications. The purposes of operation include pain relief, decompression of the narrow canal, correction of deformity and spinal stabilization. The extent and methods to achieve these purposes may vary case by case.

The pre-operative consideration includes correlation of symptoms/signs with imaging manifestations, such as severity and numbers of stenosis, spondylolisthesis or retro-listhesis, evaluation of the curvature in three dimensions and patient's general conditions and co-morbidities, in order to decide the level and number of bony decompression and instrumentation. Usually, when rotatory subluxation was noted, instability is very possible. Also, when Cobb angle is greater then 20° or kyphosis is present, implant should be laid over the upper segments, say to the lower thoracic spine. Because of the degenerative changes, the foramen could be narrow and impingement may occur, if correction is attempted. Therefore, thorough decompression to expose the exiting roots may be necessary. Motion preservation implant can be added to the top levels to avoid future junctional degenerative changes, stenosis or kyphosis. Fusion to the sacrum also increases the rate of pseudarthrosis. It can be achieved by iliac fixation or anterior cage insertion and bone grafting. But the necessity should be evaluated before operation. Nutritional evaluation and supply is also important for wound healing and avoiding infection.
SACRO-PELVIC FIXATION
Kamal N Ibrahim
Loyola University Chicago, United States

WHY PELVIC FIXATION
• Fixation to sacrum has high incidence of implant failure and pseudoarthrosis

INDICATION
• Long construct (e.g. deformity correction and fixation)
• High grade L5-S1 spondylolisthesis

BIOMECHANICS
• Four points fixation
• Iliac fixation to extend beyond the coronal plane
• The relation of lumbar lordosis and the pelvic incidence

SACRAL FIXATION
• Trajectory
• Extend of fixation
  – Bicortical
  – Tricortical
  – S1 end plate trajectory
• Intra-sacral (Jackson)
• Dunn-McCarthy, S shape rod over the Ala

ILIAC FIXATION
• Galveston
• Iliac screws fixation
  – One screw in the ilium
  – Two screw with triangulation (plate)
• Sacro-iliac screw fixation (S2 into the ilium)
• Iliac screw and sacro-iliac screw

CASE PRESENTATIONS
OSTEOPOROSIS – OPTIONS IN PREVENTING IMPLANT FAILURE
Ahmet Alanay

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One of the main complications of surgery on patients with osteoporosis is the failure of fixation. Preventive measures for fixation failures can be undertaken in three phases. Preventive measures should be started preoperatively and diagnosis of osteoporosis and increasing the bone density by using bisphosphonates and bone forming agents while postponing surgeries may be helpful. Intraoperatively, maximizing and enhancing anchor points while decreasing the demand on fixation for deformity correction are the basic preventive measures. Several surgical tactics include using double threaded screws, to increase depth of penetration of the screws, to increase the insertion angle, using the straight forward technique and undertapping the screw hole. Supplementation of the screws by hooks or sublamnar wires may also help. Cement augmentation of the screws on the other hand has been shown to increase the pull-out strength nearly 20 times more. One of the intraoperative aims should be to decrease the demand on fixation in deformity patients by doing extensive releases and maintaining or restoring the sagittal alignment as good as possible. Postoperative preventive measures include, external immobilization, restricting range of motion and starting isometric exercises and activity as soon as possible. Postoperative use of biphosphanates on the other hand is still controversial.
INTRODUCTION

There is significant variability in the management of deformity of the spine. Algorithms for decision-making begin with the decision to pursue operative versus non-operative approaches to deformity. Within the realm of operative options, surgical approaches may include decompression alone, limited fusion, or fusion of the entire deformity. An informed choice is based upon valid outcomes on the results of operative and non-operative care. Variability in approaches to care is driven by factors including clinical presentation and symptoms of the patient, comorbidities, patient preference, and surgeon recommendations. The purpose of this presentation is to provide information on what determines when to operate on the adult with spinal deformity, and when less surgery may be a better approach.

SURGICAL OPTIONS IN ADULT DEFORMITY

The spectrum of surgical options for adult deformity include strategies that may involve a limited approach to target select symptoms, or a more global approach to address deformity and specific symptoms.

a. Decompression only
   Indications:
   - Radicular pain > axial pain
   - Convex-sided pain
   - Limited global imbalance
   - Central and Lateral recess stenosis
   - Stable motion segment
   Important Considerations/Limitations:
   - Foraminal stenosis
   - Concave-sided pain
   - Progressive deformity - post-laminectomy deformity

b. Decompression with limited fusion
   Indications:
   - Segmental instability
   - Need for resection of facet or > 50% pars
   - Axial pain
   Important Considerations:
   - Global alignment of the spine
   - Adjacent segment alignment/degeneration
   - End vertebra of the curve

c. Decompression with deformity correction
   Indications:
   - Global sagittal or coronal imbalance
   - Segmental and regional kyphosis
   - Rib on pelvis deformity
   Important Considerations:
   - Magnitude of surgery
   - Potential for complications

d. Indirect decompression
   Indications:
   - Stenosis due to segmental collapse
   - Foraminal and up/down stenosis
   - Redundancy of the interlaminar ligament
   Important Considerations:
   - Rotational subluxation
   - Parallel distraction rather than extension
HOW TO SELECT THE FUSION LEVEL IN AIS?

B Stephens Richards
Texas Scottish Rite Hospital, Dallas, Texas, United States

Goal: Preserve distal motion segments but achieve satisfactory correction and balance

WHY IS THIS IMPORTANT
a. Region where stiff meets flexible
b. The need to achieve a globally balanced spine
c. The need to prevent further progression

WHAT INFLUENCES THE DECISION?
1. Type of curve
2. Clinical appearance
3. Approach and instrumentation

GENERAL PRINCIPLES
1. Identify the curve type
   Flexibility
   Lenke Classification

2. Identify Center Sacral Line
   End vertebra
   Stable vertebra
   Neutral vertebra (Suk – Lenke 1 curves)

   Stable vertebra
   1. Initially fusions were carried down to SV with Harrington
   2. Subsequently, over the past 20 years with segmental fixation systems, fusions frequently end at SV-1 (single thoracic curves)

   Neutral vertebra – Suk 2003

3. Using posterior implants, the lower instrumentation level (LIV) can end one level above the stable vertebra in single curves (Lenke 1A-R)

4. Use of LEV as a reference point when describing LIV will allow for consistent information when reporting on LIV selection for specific curve types.

5. Using posterior implants, include the upper thoracic spine if the left shoulder is elevated or if the upper thoracic curve does not bend < 25°

6. Do not stop the posterior instrumentation at a kyphotic area
THORACIC CURVES WITH FLEXIBLE LUMBAR CURVE (LENKE 1B, 1C)
SELECTIVE THORACIC FUSIONS
Must consider fusion to the TL stable vertebra; LIV=LEV

When selective thoracic fusion is planned:

1. Amount of correction achieved should not exceed spontaneous correction achieved in non-instrumented adjacent curves*.

2. Beware of kyphotic TL junction (junctional kyphosis).

3. Recent study reports that leveling LIV (extensive correction of STF) results in satisfactory balance at 2 years.

WILL THE UNINSTRUMENTED LUMBAR CURVE HOLD UP OVER TIME?
20-year followup: YES, it will hold up. [Richards, Larson, et al 2011]

DOUBLE MAJOR CURVES - LENKE 3C, 6C
Usually, LIV is L3 or L4, or most proximal lumbar vertebra touched by CSVL.

Ideally, LIV should be horizontal, central, and neutral AND disc below should be horizontal. Residual disc wedging seen more commonly when fusion stops at L3.

Significance of residual adjacent disc wedging uncertain.

Avoid excessive residual LIV-tilt and disc wedging

Significance of residual adjacent disc wedging is not yet known.
CORRECTION STRATEGIES & DECISION-MAKING IN EARLY-ONSET SCOLIOSIS

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Early-onset scoliosis is characterised by presentation of spinal deformity in children <5 years and may be a part of a generalised syndrome with multi-organ involvement. Co-existent congenital heart diseases, musculo-skeletal conditions (hip dysplasia / foot & ankle deformities etc), inguinal hernia etc should be comprehensively evaluated. MRI of whole spine is mandatory to rule out intra-spinal anomalies and appropriate multi-disciplinary input must be sought in optimising the child prior to any corrective spinal surgery. Close liaison with neurosurgical colleagues in detethering the tethered cord, excision of diastematomyelic spur or decompression of syrinx would be necessary before spinal deformity correction. The aim of surgery is to obtain curve correction and maintain trunk / spinal length with growth.

Evaluation of plain x-rays for evidence of curve progression (defined as worsening of cobb angle by ≥7° in six months), Rib-vertebral angle difference (RVAD) of ≥20° and phase 2 transition of ribs with poor response to bracing would be surgical candidates. There is increasing awareness on long-term respiratory function, thoracic volume and space available for lungs (SAL) in-addition to just improvement in coronal & sagittal balance. VEPTR is an excellent option in addressing such children with thoracic insufficiency syndrome.

The author’s preference would be to use magnetic growth rods (single or dual) that are inserted submuscularly and anchored to pedicle screws distally and hybrid construct proximally by two incision technique. The patient selection criteria, technical tips and correction strategies are covered in detail in the lecture. The lengthenings are performed every 3 monthly in out-patient / office setting using external remote controlled (ERC) device eliminating the need for hospital admissions, repeated anaesthetic / return to OR. Preliminary results also are promising for improvement in FVC & respiratory function following magnetic growth rods and unpublished data is presented.

The pros and cons of single vs. double rods and long-term follow-up data / results are reviewed. Other valuable practical tips of rod insertion / anchorage and avoiding implant related complications are shared.
SURGICAL DECISION-MAKING IN ADULT DEGENERATIVE SCOLIOSIS

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ETIOLOGY OF ADULT SCOLIOSIS
- Idiopathic (progression after maturity)
- Degenerative
- Idiopathic with degenerative changes
- Others

CHARACTERISTICS
- Pain
- Neurological deficit (stenosis)
- HRQL: health related quality of life, compromised
- Progression
- Cosmesis

CLASSIFICATION: LOWE/SRS
- Follows the same naming as Lenke types
- Add type VII: primary sagittal deformity
- Modifiers:
  - Sagittal
  - Lumbar degenerative
  - Global balance
- Myelography CT, MRI to determine the extent of the stenosis, integrity of different discs and facet joints

FUSION LEVELS
- Decompressed level
- Transitional segments
- Painful joints
- Unstable segments
- Levels which are part of the coronal and sagittal imbalance

EXTENDING TO THE PELVIS
- Spondylolisthesis at L5-S1
- Previous laminectomy L5-S1
- Decompression at L5-S1
- Foraminal stenosis L5-S1
- Oblique take-off L5-S1

EXECUTION
- Coronal and sagittal balance
- 360 degrees fusion
- All posterior
- Lateral access and posterior
- Anterior and posterior

CONCLUSION
- Adolescent onset Adult idiopathic Scoliosis most common
- Curve progression
- Post Maturity or late onset
- HRQL worse in early onset patients
- Back Pain greater than untreated Adults
- Fusion levels are modified from AIS to take in account the added characteristics of adult scoliosis
MISPLACED PECIDLE SCREWS

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Spinal instrumentation has obviated the need for post-op external immobilisation and bed rest providing immediate stability. Secure three column fixation with rigid fixation of instrumented area without sacrificing of additional motion segments has made pedicle screw fixation very attractive. Pedicle screws are very versatile and can be used in instances where lamina, facets or spinous process are missing either due to previous surgery or congenital absence.

Pedicle screws fixation / use are now the state of the art in treating not only spinal deformity but also in wide variety of traumatic / neoplastic and degenerative cases too. They can be used in any area of spine (cervical / thoracic and lumbosacral). The screw – rod construct gives greater modularity / autonomy and flexibility for a surgeon to apply compression, distraction and translation forces / manoeuvres and obtain desired correction.

Pedicle screw insertion is not without its risks and complications could be devastating. This lecture provides a broad preview of pedicle anatomy / bony landmarks and trajectory guidance in inserting pedicle screws at all levels using free-hand technique relying very minimally on fluoroscopy / O-arm intra-operatively. In complex deformity cases, review of CT scans with 3D reconstruction is mandatory to plan screw trajectories and study dysplastic pedicles. Studying pedicle morphology and strict adherence to landmarks is of paramount importance in obtaining secure purchase.

Breach / cut-out of pedicle screw can occur either in superior / inferior or medial / lateral direction. A medial wall breach has the highest incidence of injury to spinal cord / thecal sac and should be avoided at all costs. An inferior or lateral breach may injure / irritate an exiting nerve root causing neuropathic pain. Needless to say pull-out strength is significantly compromised by a poorly positioned screw. End of Construct (EoC) pedicle screw that have wider thread diameter / small core diameter and higher pitch have significantly higher pull-out strength. Cement augmentation may improve pull-out strength esp. in osteoporotic bone.
INTRODUCTION AND DEFINITION OF THE PATHOLOGY
Post-operative spinal deformity encompasses a spectrum of spinal disorders that include initial fixation of the spine in a position of malalignment, decompensation of the spine in the sagittal or coronal plane after surgery, and adjacent segment kyphosis. Post-operative deformity is an important complication, and a major reason for revision spine surgery. Revision rates in spine surgery have been reported variably, and rates are dependent upon the primary pathology treated, patient factors, methods of treatment, and choice of levels for arthrodesis. Post-operative deformity and adjacent segment pathology is associated with significant disability, and is one of the most frequent reasons for revision surgery. The purpose of this presentation is to discuss the etiologies of post-operative spinal deformity, and to provide guidance for both avoiding and managing deformities after spine surgery.

FUSION OF THE SPINE IN MALALIGNMENT
Initial fusion of the spine in a malaligned posture is a common cause of post-operative deformity. Malalignment of the spine at the time of initial surgery may be the result of inadequate correction of deformity, asymmetric correction of deformity, or failure to recognize deformity in pre-operative surgical planning or intraoperatively. Importantly, malalignment of the spine may occur after fusion for degenerative pathology as well as after fusion for deformity.

OPTIMAL SPINAL ALIGNMENT INCLUDES THE FOLLOWING PARAMETERS:
1. SVA within 4 cm of sacral promontory in sagittal plane
2. CSL within 4cm of C7 in coronal plane
3. Pelvic Tilt <25 degrees
4. Pelvic incidence = Lumbar Lordosis +/- 10 degrees

Avoiding fusion of the spine in Malalignment
Preoperative planning
Intraoperative Assessment and Radiography
Post-operative Recognition

Treatment of Post-operative Malalignment of the spine
Early recognition and correction
Late recognition and osteotomies for deformity correction
PEDICLE SCREWS MIGRATION IN GROWING RODS

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The change of position of the distal pedicle screws with growing rods in relation to vertebral bodies was described as “Pedicle Screws Migration”; pedicle screws are subjected to serial distractive forces pushing them down with every distraction, in addition there is continuous growth of the vertebral bodies during the treatment period; these the two factors can affect the change of position of the pedicle screws in relation to the vertebrae during the use of growing rods. To the authors’ knowledge this finding has never been studied, confirmed or quantified.

This is a retrospective review of the radiographs and operative notes of 23 consecutive cases of early onset scoliosis treated with single growing rods with proximal hooks and distal screws constructs. Age at index surgery was 4y 2m to 8y 9m, the number of distractions was 4 to 11 per patient. Measurements were done on post index and latest follow up true lateral radiographs with optimal initial position of the screws in the pedicle, we calculated the distance between the upper end plate and the pedicle screw (distance superior to the screw SS) and the distance between the screw and lower end plate (distance inferior to the screw IS) and we had this ratio as a percentage: SS/IS X 100. Any increase in this percentage with time denoted a more caudal position of the pedicle screw; however a change in the percentage of less than 10 percent was considered insignificant as we are looking only for clear obvious changes.

Seven cases were excluded because of inadequate radiographs

WITHIN THE DISTAL CONSTRUCT, MEASUREMENTS OF THE UPPER PEDICLE SCREW SHOWED THAT:
Six cases had a change of less than 10% and were considered insignificant.

Ten cases had change more than 10%: five had between 10 and 50% change, three between 50 and 100% and two more than 100% change.

The changes in the lower screws were always less than the upper one.

None of the patients had adverse clinical outcome related to this change.

Change of screw position with time is a frequent occurrence in the distal pedicle screws with single growing rods; despite being significant in some cases, it does not seem to have any adverse clinical effects. With growing rods some degree of distal pedicle screw migration in this pediatric age group may not be considered as a complication of treatment.
The objective of this lecture will be to provide physicians with an overview of the neurobiologic challenges of spinal cord injury, the current status of investigation for novel therapies that have been translated to human clinical trials, and the preclinical, scientific basis for each of these therapies.

A wealth of recent scientific and clinical research activity has revealed numerous insights into the neurobiology of SCI, and has generated an abundance of potential therapies. An increasing number of such therapies are being translated into human SCI trials. Clinicians who attend to SCI patients are increasingly asked about potential treatments and clinical trials.

A number of treatments have bridged the “translational gap” and are currently either in the midst of human SCI trials, or are about to begin such clinical evaluation. These include minocycline, Cethrin, anti-Nogo antibodies, systemic hypothermia, riluzole, magnesium chloride in polyethylene glycol, and human embryonic stem cell derived oligodendrocyte progenitors (ie. Geron). A systematic review of the preclinical literature on these specific therapies reveals promising results in a variety of different SCI injury models.

The SCI community is encouraged by the progression of novel therapies from “bench to bedside” and the initiation of clinical trials for a number of different treatments. The task of clinical evaluation, however, is substantial, and many years will be required before the actual efficacy of the treatments currently in evaluation will be determined.
NATURAL HISTORY OF CSM: WHEN SHOULD WE OPERATE?
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BACKGROUND
Cervical Spondylotic Myelopathy (CSM) is a clinical syndrome resulting from spinal cord compression due to degenerative change. It is the most common cause of acquired paresis, sensory loss and urinary incontinence in middle aged and elderly populations. Causes of compression include herniated discs, osteophytes, ligamentum flavum and facet hypertrophy, and OPLL. At least 75% of subjects older than 50 years exhibit spondylotic changes on imaging but symptoms don’t necessarily correlate.

PRESENTATION
Onset is typically insidious with a progressive stepwise decline in 70% of patients. Diagnosis can often be delayed due to the vagueness of complaints. Gait changes are the earliest, most common finding. Atrophy, weakness, clumsiness, dysesthesias, spasticity and altered reflexes are other signs. Plain radiography, CT and CT myelography play a role, but MRI is the gold-standard imaging modality. There is documented evidence that some patients may improve over time.

NATURAL HISTORY AND LIMITATIONS OF THE LITERATURE
Many natural history studies are based on “history prior to surgical intervention”. The very mild are overlooked and the most severe are offered surgery early, and are therefore excluded. Most literature is conflicting or unable to show a statistically significant difference between non-operative and operative management in altering the natural history of CSM. One prospective, commonly-cited paper (n = 62, with 8-13 months follow-up) concludes that when medical and surgical treatments are compared, surgically treated patients appear to have better subjective outcomes, despite having greater functional disability before treatment.

CONCLUSIONS
Patients with minimal symptoms without hard clinical evidence of gait disturbance or pathologic reflexes, or mild stable findings are suitable for non-operative management with close follow-up. Patients demonstrating myelopathy and spinal cord compression, or who have failed non-operative modalities are candidates for operative intervention.
ADJACENT SEGMENT DEGENERATION IN ANTERIOR CERVICAL FUSION – MINIMAL 10 YEARS FOLLOW-UP

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PURPOSE
We attempted to evaluate the effectiveness of anterior fusion of cervical spine by analyzing retrospectively about the frequency of radiologic and symptomatic degenerative changes at adjacent segment after anterior fusion and the risk factors of adjacent segment degeneration.

MATERIAL AND METHODS
This study is a retrospective analysis of 79 patients who underwent anterior fusion of cervical spine between 1984 and 2001, with follow up periods of minimum 10 years. An average age at the time of surgery was 46.7 years (20~68 years) and the mean follow up period was 15.8 years (10.1~25.2 years). The causes of fusion were disc herniation (37 cases), trauma (29 cases) and spondylosis (13 cases). The fused segments were 57 cases by single-level and 22 cases by multi-level. We evaluated the occurrence of the new symptoms and its onset related to the problems of adjacent segment. To evaluate degenerative changes in adjacent segment radiologically, we classified Grade 0 as normal, and Grade V as the narrowing of disc space was below 50% of normal disc height. And we also evaluated the distance from plate to end plate of upper and lower vertebral body, relationship between this distance and degenerative change, the frequency of symptomatic adjacent segment degeneration and the rate of revision surgery.

RESULTS
Severe degenerative changes over Grade III were found in 47 cases (59%), among them, 32 cases (56%) underwent single-level fusion and 15 cases (68%) had multi-level fusion. Also, severe degenerative changes were found in 14 cases (48%) in trauma, 20 cases (54%) in disc herniation and 12 cases (92%) in spondylosis. Severe degenerative changes of adjacent segment after anterior fusion of cervical spine were statistically significantly higher in patients who underwent multi-level fusion and had spondylosis. Degenerative changes of adjacent segment after fusion were found in 67 cases (85%) with radiological evaluation. But only 27 cases (34%) of whole patients had new symptoms related to the problems of adjacent segment, the symptoms appeared at an average time of 14 years 5 months after surgery. Only 3 cases (3.7%) needed revision surgery.

CONCLUSION
Degenerative changes of adjacent segment after anterior fusion of cervical spine commonly occurred in patients who had multi-level fusion and spondylosis according to our long term follow up study, and there were no significant relationship between degenerative changes in radiologic evaluations and onset of new symptoms from adjacent segment. Although anterior fusion of cervical spine has high rate of degenerative changes of adjacent segment radiologically at long term follow up study over 10 years, it is probably an effective treatment with low rate of revision surgery.
COMMON CAUSES OF CERVICAL MYELOPATHY
1. Congenital spinal stenosis (<12mm)
2. Cervical spondylosis (CSM)
3. Ossification of posterior longitudinal ligament (OPLL)
4. Cervical kyphosis
5. Impaired spinal cord blood supply

NATURAL HISTORY OF CERVICAL SPONDYLOTIC MYELOPATHY
• 75% episodic progression
• 20% steady progression
• 5% rapid deterioration

CERVICAL SPONDYLOTIC MYELOPATHY
1. Weakness and muscle wasting
2. Loss of hand dexterity
3. Numbness and paraesthesia
4. Spasticity
5. Loss of balance

CLARK 1956
CERVICAL SPONDYLOTIC MYELOPATHY
1. 10-seconds test
2. Finger escape sign
3. Hoffmann reflex

Prognosticating factor
• transverse area of cord < 30 mm²

Contributing factors
• chronicity of disease
• age at surgery
• multiplicity of involvement

INDICATIONS FOR SURGERY
1. Progressive neurologic deficit
2. Impaired ADL (JOA score)
3. Compatible imaging findings

INDICATIONS FOR POSTERIOR SURGERY
1. Central canal stenosis
2. No pre-existing instability
3. Normal sagittal curvature
4. Multiple level disease (>3 levels)
   i. CSM
   ii. continuous, mixed OPLL
   iii. developmental stenosis
   iv. dynamic stenosis
CHOICES OF POSTERIOR DECOMPRESSION
1. Laminectomy
2. Expansive laminoplasty
   i. Z-plasty (Hattori)
   ii. Open door (Hirabayashi, Itoh)
   iii. Double door (Kurokawa)

INDICATIONS FOR ANTERIOR SURGERY
• Pre-existing cervical kyphosis
• Pre-existing instability
• Segmental compression (<3 levels)

EARLIEST SYMPTOM OF RECOVERY
• Relieve of “tightness” over body
• Improve finger dexterity
WHAT IS THE BEST SURGICAL APPROACH FOR MULTI-SEGMENTED CERVICAL SPONDYLOTIC MYELOPATHY?

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Cervical spondylotic myelopathy (CSM) can present considerable decision-making challenges for the surgeon. Without doubt, surgery can arrest neurologic deterioration and can in many cases improve function. Deciding upon the best approach can be very difficult, however. It is recognized that while both anterior and posterior approaches have demonstrated good results in surgical management of CSM, there is no universally acknowledged superior method of treating CSM.

In this lecture, we will review the factors and considerations that influence surgical decision-making in multi-segmented CSM. These include: 1) Pathological factors such as sagittal alignment, number of levels involved and shape of compressive lesion. 2) Complications associated with approach and surgical goals, 3) Patient factors including age, obesity and cardiorespiratory reserve, and 4) Surgeon factors, including training and institutional policies.

In general posterior approaches are favoured for multi-segmented cases where significant anterior column reconstruction would be required if approached from the front. A discussion around the pros and cons of laminectomy & fusion versus laminoplasty is warranted. In certain contexts, anterior decompression and reconstruction may require posterior fixation for sufficient stabilization. Surgical management is as individual as the patient, their disease process, and the surgeon’s experience. Although there is no panacea approach, individualised management appropriate to unique circumstances are possible.
THE ROLES OF CEMENT AUGMENTATION IN OSTEOPOROSIS FRACTURE
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Vertebral compression fractures (VCF) have a 5 year survival rate that’s lower than patients with hip fractures. There is increased mortality from pulmonary causes as each vertebral fracture in the thoracic region causes a 9% decrease in forced vital capacity. Mortality is increased between 25 to 30 % compared to age-matched controls.

The kyphosis in thoracic or lumbar regions decreases vital capacity in the lungs – accentuates restrictive lung disease. There are also gastrointestinal difficulties with bloating, early satiety – all leading to malnutrition.

Pain relief after percutaneous vertebroplasty has been reported by 85 to 90 % of patients with vertebral compression fractures. This leads to early mobilization for most patients which in turn, results in reduced complications from being physically impaired and depressed.

Polymethylmethacrylate (PMMA) was first used for this purpose in 1984. Since then, the technique has evolved, the equipment has become better and safer, and also the cement itself has been improved for patient safety (higher viscosity). Hence, cement augmentation of vertebral compression fractures has become an important tool in the fight to reduce morbidity and mortality from this disease.
INTRODUCTION
Vertebral augmentation encompasses techniques for adding cement to vertebral bodies with the intention of treating or preventing vertebral fracture. Vertebroplasty and kyphoplasty are the most common techniques for vertebral augmentation. The role of vertebral augmentation in the management of vertebral fractures remains incompletely defined, and evidence for efficacy of vertebral augmentation has been mixed.

INDICATIONS FOR VERTEBRAL AUGMENTATION
1. Fractures
   a. Primary Osteoporosis
   b. Secondary Osteoporosis
2. Tumors of the Spine
3. Augmentation of vertebral fixation
4. Peripheral skeletal applications

EVIDENCE FOR VERTEBRAL AUGMENTATION
   a. 300 patients with pathologic fracture due to osteoporosis or tumor
   b. 2 year follow-up
   c. Kyphoplasty led to:
      i. Better quality of life
      ii. Quicker return of back function & mobility
      iii. Faster back pain relief
      iv. Less narcotic analgesic use
   a. Open-label post-market study of vertebroplasty vs non-operative care
   b. 202 patients with acute fractures
   c. Vertebroplasty patients with better outcome than non-op care

EVIDENCE AGAINST VERTEBRAL AUGMENTATION
   a. Multicenter, randomized, double-blind placebo-controlled trial and assessed outcomes at 1 week, 1,3, and 6 months.
   b. Both groups reported similar reductions in overall pain and night pain at each follow-up assessment. Similar improvements in physical function and overall quality of life
   a. Multicenter trial of 131 patients who also either received vertebroplasty or a simulated procedure without cement. Outcomes were reported at three, 14, 30 and 90 days.
   b. No significant difference in outcomes at one month
   c. Higher crossover from non-operative group to vertebroplasty

COMPLICATIONS
Symptomatic and asymptomatic cement extravasation more common with vertebroplasty than kyphoplasty
Failure of pedicle screws by loosening and pulling-out is a major problem in patients with osteoporotic spine. The mechanism is usually loosening by toggling and then pulling-out of the screw. There are several preventive measures including use of double threaded screws, increasing depth of penetration of the screws and medialization of the insertion angle, using the straight-forward technique and under-tapping the screw hole. However, despite all these efforts screw failure has still been a problem. Several bench-top biomechanical studies and cadaver studies have shown up to 20 times more strength against pull-out forces when the pedicle screws were augmented by cement. Indication for cement augmentation is patients with BMD less than -2.5. Cement augmentation can also be done in patients having T scores between -1.0 and -2.5 if the surgeon observes a low torque strength while inserting the screw. Cement augmentation can be done by using either a fenestrated screw or by first injecting the cement and then inserting the regular pedicle screws. Augmentation of cement can be performed by vertebroplasty technique. Although there is one study showing amount of injected cement and pull-out do not correlate we prefer to inject 4cc, for lumbar and 3 cc for thoracic spine. In one study we have shown that, aspiration of the content of the vertebrae body through the working cannula before injecting the cement may help decrease cement emboli. In a recent study we have evaluated the safety and efficacy of cement augmentation in patients with osteoporosis including 1454 screws. We have not observed any loosening, migration or pull-out after a 2 years of f/up. However, there was cement extravasation in 27 patients with no neurological compromise. We have also observed cement emboli into the lungs in 8 (6%) of the patients. Four had respiratory problems. Cement augmentation of the screws is an effective method to prevent fixation failure in osteoporotic patients.
SURGICAL DIFFICULTIES IN OSTEOPOROTIC COMPRESSION FRACTURE

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In the aging society, the incidence of osteoporotic compression fracture is commonly seen in the orthopedic clinics. Most of them suffered from pain and lack the ability to carry out daily activities or even needs the help by others. Thanks to the introduction of many newer drugs and better care, many of them can have good recovery without the need to receive invasive treatment, no matter how large or small it may be.

However, in the collapsed spine, many of them sustained severe back pain. The most popular procedures are vertebroplasty and/or kyphoplasty. The procedure needs to expand the collapsed space and fill the space with bone cement (PMMA). Pain usually can be markedly relieved immediately. But there were some potential complications and persistent back pain afterwards. In the follow-up, some surgeons argue the resorption of bone stock and the increasing collapse of the adjacent bodies.

If vertebral collapse is severe enough, and the history is too long, expansion by the aforementioned procedures may be difficult. In some occasion, if patient presented with neurologic deficits or kyphotic deformity or had breakage of the posterior vertebral rim, cement injection into the body may impose complications of leakage. In the Avascular necrosis (Kummel's disease), cement injection may also not be proper. In these situation, I prefer vertebral augmentation by bone grafting into the expanded body followed by inserting the expandable metal pillars through pedicle tracts. If necessary, further augmentation by pedicle screws in the adjacent bodies is applied. This is practical, if spine had kyphosis deformity. This method can also be applied, if cementing procedure was failed. So far, we have used this procedure for nearly 100 cases with longest follow-up to 4 years. The results were promising.
Thoraco-lumbar fracture is common in our society. The causes of injury in the region were the results of motorcycle accident, falling from height or direct injury to this area. For all types of injury, the principles of management depend on the mechanism of injury, the severity of bony or soft tissue damages and the presence of neurological deficits. Furthermore, the general conditions of the patients and the presence of other organ involvement should be considered in order to decide the sequence of management. Once stabilization by implant fixation is considered, further decision is whether we should approach from anterior or from posterior, or the combined procedures.

Instrumentation to fix the unstable spinal segments is usually necessary. The purposes are:
1. to achieve rigid fixation of the unstable segments;
2. to correct the deformed segments after proper decompression of the cord or roots. In recent years, pedicle screws were extensively used for these purposes, most of the fractures in the thoracolumbar region can be handled by posterior approach alone. Anterior approach to decompress the fractures are usually in the case of burst fracture. In this instance, anterior fixation can be achieved by using fibular bone graft or vertebral spacer with spinal plate. However, some surgeons prefer non-operative reduction technique for cases without neurological deficits in burst fracture or minor fracture. Only postural correction and cast fixation is needed in the early period of trauma. One extreme case is in ankylosing spondylitis patients, spinal trauma was quite unstable and could not healed if without implant fixation.
This paper evaluates the effectiveness and outcome of proximal half corpectomy and one motion segment fixation of Denis type B burst fractures of lumbar spine.

The purpose of this study was to evaluate the effectiveness and outcome of proximal half corpectomy and one motion segment fixation of Denis type B burst fractures of lumbar spine. To preserve lumbar motion by conserving as many motion segments as possible, we tried anterior decompression limited only to the crushed proximal part of the vertebral body in Denis type B burst fractures of the lumbar spine. In the present study, we report the clinical and radiological results of proximal half corpectomy and fusion of one motion segment in lumbar burst fractures. 43 patients were operated from December 1989 to November 1996 and who were followed up for at least two years. The results in these patients were compared with those obtained from 48 patients treated by total corpectomy with two motion segment fusion over the same period. 27 were men and 16 were women, and ages ranged between 17 and 68 years (Av. 34 years). The time of operation was within one month in 41 cases. Solid bony union was obtained in 43 cases within 3 months and 39 cases (93%) complained of no back pain at the last follow up. The average length of bone graft was 3.0cm in the half corpectomy group and 6.3cm in the total corpectomy group. Hardware breakage or graft collapse was not observed in patients who underwent proximal half corpectomy, but was observed in 5 patients who underwent total corpectomy. Proximal half corpectomy and fusion of one motion segment in Denis type B burst fractures is believed to be an effective surgical method that can minimize the extent of fusion, increase stability, preserve motion segments and reduce the incidence of complications.
ROLE OF MINIMALLY INVASIVE SURGERY (MIS) IN THORACOLUMBAR TRAUMA

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With advent of better minimally invasive instrumentation for Spinal stabilization, viz the multilevel percutaneous pedicular screw rod system, MIS application in spinal trauma is gaining popularity. Thus aligning and stabilization of a freshly fractured spinal column with percutaneous screws is not very difficult. The real challenge is in decompression of the canal through the MIS route.

Anterior or anterolateral thoracoscopic aided decompression of the thoracic and thoracolumbar canal can be achieved with good results. Thoracoscopic anterior fixation while decompression may be done simultaneously. Indirect decompression with ligamentotaxis in fresh compression & burst fractures using distraction with help of percutaneous pedicle screw rod fixation is an effective procedure. MIS-TLIF type approach through tubular expanding retractor can be used to do a posterolateral decompression of the roof and front of cord especially in paradiscal region. In the presentation the various MIS options are discussed and our experience of 26 cases is discussed.

OUR STUDY

Retrospective analysis of 18 males and 8 females average age 35.5 yrs (range 18-45yr) with thoracolumbar fractures. The average duration between surgery and injury was 9.5 days (2-14 days). Fractures were categorized based on AO classification. Two compression fracture (A 1), 16 burst fractures (4 stable & 6 unstable) (A 3), 6 fracture dislocation (C1) and two chance injuries (B 2). Patients were classified in four groups depending on the surgical treatment undergone.

Group I (n=12) Post percutaneous pedicle screw fixation & indirect decompression using ligamentotaxis.

Group II (n=6) Percutaneous pedicle screw fixation and posterolateral decompression through tubular retractor system.

Group III (n=5) Percutaneous pedicle screw fixation & anterior thoracoscopic aided decompression.

Group IV (n=3) Anterior thoracoscopic decompression & anterior instrumentation.

Twelve patients had no neurological deficit on presentation while ten had incomplete deficit (four each with ASIA C & D, two with ASIA B) and four with complete neurologic deficit (ASIA A).

RESULTS

Average blood loss was 431.25ml (100-1050ml) and the operative time varied from 120 - 345 min (av- 239 min). The blood loss and duration of surgery was least in Group I and increased successively in Group II, III, IV. The average hospital stay was 6.37days (3-18 days). The pre-operative kyphosis of 19.37° (range 12-28°) improved to 1.85° (-5 to 8°); [p value<0.05]. None of the patient required blood transfusion.
All the patients with incomplete neurologic deficit and two patients with complete cord injury improved in postoperative period by at least one grade. Two other patients with ASIA A did not improve neurologically. There was no deterioration in neurology in any of the case.

The mean VAS of 6.63 improved to 2.8 at the end of two weeks. Similarly average ODI of 80 improved to 46.5 at the end of 18 mths. The mean SCIM score of 38.57 improved to 83.43 (p=0.018) indicating good functional outcome. None of the patients had perforation of pedicle walls.

One patient in Group II with ASIA A had Grade III bed sore while one of the patients in Group IV had chest related complication and prolonged.

**CONCLUSION**

The minimally invasive techniques are based on rationale of decreasing approach-related morbidity. Adequate decompression may be achieved in selected patients with spinal trauma without compromising on the rigid fixation using MIS technique. Though the MIS procedures demand a learning curve, with experience, reasonably good functional outcome may be achieved in patients with traumatic cord injury.
SUCCESSFUL SHORT-SEGMENT INSTRUMENTATION AND FUSION FOR THORACOLUMBAR SPINE FRACTURES: A CONSECUTIVE 4½-YEAR SERIES

Gaines, Robert W; Parker, Jeffrey W; Lane, Joel R; Karaikovic, Eldin E

University of Missouri-Columbia, Columbia, Missouri, USA

STUDY DESIGN
A retrospective review of all the surgically managed spinal fractures at the University of Missouri Medical Center during the 4½-year period from January 1989 to July 1993 was performed. Of the 51 surgically managed patients, 46 were instrumented by short-segment technique (attachment of one level above the fracture to one level below the fracture). The other 5 patients in this consecutive series had multiple trauma.

OBJECTIVES
The choice of the anterior or posterior approach for short-segment instrumentation was based on the Load-Sharing Classification published in a 1994 issue of Spine. The purpose of this review was to demonstrate that grading comminution by use of the Load-Sharing Classification for approach selection and the choice of patients with isolated fractures who are cooperative with spinal bracing for 4 months provide the keys to successful short-segment treatment of isolated spinal fractures.

RESULTS
All patients were observed over 40 months except for 1 patient who died of unrelated causes after 35 months. The mean follow-up period was 66 months (5 ½ years). No patient was lost to follow-up evaluation. Prospective application of the Load-Sharing Classification to the patients’ injury and restriction of the short-segment approach to cooperative patients with isolated spinal fractures (excluding multisystem trauma patients) allowed 45 of 46 patients instrumented by the short-segment technique to proceed to successful healing in virtual anatomic alignment.

CONCLUSIONS
The Load-Sharing Classification is a straightforward way to describe the amount of bony comminution in a spinal fracture. When applied to patients with isolated spine fractures who are cooperative with 3 to 4 months of spinal bracing, it can help the surgeon select short-segment pedicle-screw-based fixation using the posterior approach for less comminuted injuries and the anterior approach for those more comminuted. The choice of which fracture–dislocations should be strut grafted anteriorly and which need only posterior short-segment pedicle-screw-based instrumentation also can be made using the Load-Sharing Classification.
POSTERIOR COLUMN RECONSTRUCTIONS IN TOTAL SPONDYLECTOMY
Jae Yoon, Chung
Department of Orthopaedic Surgery, Chonnam National University Hospital, Gwang-Ju, Korea

INTRODUCTION
Total en bloc spondylectomy is frequently performed in the management of primary and metastatic spine tumors to obtain local control of disease and stability. Traditionally, spinal reconstruction after total spondylectomy is concentrated only for the anterior column. Recently, however, life expectancy in the spine tumors are dramatically improved due to the development of medical, radiological and surgical treatment methods. Long term stability after reconstruction, only of anterior column is questioned, when the patient has life expectancy over several years, especially, with the lesion of thoracic and lumbar area where needs more strenuous load bearing. The authors tried to reconstruct the posterior column along with anterior column.

MATERIAL AND METHODS
Thirteen cases with follow up period over one year, among twenty-seven patients with primary and secondary tumors of thoracic and lumbar spine, who underwent total en bloc spondylectomy between 1998 and 2008, and had expected life expectancy more than one year at the time of operation were included in this study. In these patients, posterior column was reconstructed after performing posterior pedicle screw instrumentation, anterior column reconstruction using Harms cage. Four methods were tried: 1. Grafting autogenous iliac cortico-cancellous bony plate (N=7). 2. Recapping of taken-out en bloc lamina after intra-operative pasteurization (N=4), 3. Recapping of taken-out en bloc lamina after intra-operative irradiation (N=9), 4. Bridging of Titanium mesh plate covered with autogenous cancellous bone chips (N=7). Primary malignant lesions were three, solitary metastatic lesions were twenty two, and benign bone tumor with pathologic fracture were three. Twenty four lesions were single level and three were double. The data were followed up through periodic X-ray and CT scan at every 6 month: bony union, the time of fusion and local recurrence.

RESULTS
In thirteen patients who could survived over one year, the solid fusion of reconstructed lamina was obtained in ten cases between 6~12 months period and three showed non-union. The non union occurred only in the group 3: recapping of irradiated lamina. Other groups showed good reconstruction. Five cases of Titanium mesh plate whose follow up period was over one year showed good bony incorporation of mesh plate with proximal and distal normal lamina bone and was covered by new bony lamina. The patients with successful posterior column reconstruction showed no metal failure, no occurrence of local kyphosis, and no recurrence of tumor at the reconstructed posterior column.

CONCLUSIONS
Reconstruction of posterior column was successful in total en bloc spondylectomy. And it was believed to provide better long-term stability, because load bearing could be shared by anterior and posterior column. The methods could be selected depend on the local condition: width of gap that needed bridging, amount of local involvement of posterior column and the type of tumor.
SURGICAL TREATMENT OF AGGRESSIVE SACRAL TUMORS
Keith Dip Kei, Luk
Department of Orthopedics and Traumatology, University of Hong Kong, Hong Kong

INDICATIONS
• Tumors
  – Benign aggressive
  – Malignant
    • Primary
    • Secondary
      – Local invasions from intrapelvic tumors
• Most commonly reported
  • GCT
  • Chordoma
  • Osteosarcoma
  • Chondrosarcoma

ISSUES TO CONSIDER
• Anatomy
• Level of resection
  – Root level preservation
    • Functional neurologic level
    • Necessary reconstructions
• Concomitant pelvic viscera resection
• Preoperative preparation
• Technical
  – Biomechanics

NEUROLOGIC LEVEL PRESERVATION
• Regain sphincter control
  – One S3 preserved – 100%
  – Both S2 preserved – 50%
  – One S2 preserved – 0% (Gennari et al JBJS 69B, 1987)
  – Only S1 preserved – 0%
• Motor
  – S1 or above, may need walking aid
• Sensory
  – Saddle anaesthesia above S2

SAMSON, SPRINGFIELD, SUIT, MANKIN. JBJS 75A, 1993
PREOPERATIVE PREPARATION
• Tumor workup
  – Arteriogram
    • Embolization
• Bladder and bowel preparation
  – Rectal resection
• Team work with vascular / colorectal surgeons / urologist

SURGICAL APPROACHES
• Sequential anterior-posterior
• Combined anterior-posterior
• Posterior alone

EXCISIONS AT / ABOVE S1 (TOTAL SACRECTOMY)
• Sequential anterior-posterior approach
  • Combined anterior-posterior approach
  • Advantage of simultaneous visualization
    – Simpson, Porter, Davis et al. JBJS 77A 3:405-411, 1995

ANTERIOR APPROACH
• Retroperitoneal if no rectal excision
  • Transperitoneal if rectal excision

POSTERIOR APPROACH ONLY (S2 / BELOW)
• Gennari, Azzarelli, Quagliuolo. JBJS 69B 4:565-569, 1987
• Samson, Springfield, Suit, Mankin. JBJS 75A 10:1476-1484, 1993

POSTERIOR APPROACH ONLY
• Partial posterior ilieectomy to approach upper sacrum for high resections
• Middle sacral artery bleeding
  • Feasible
  • Definitely easier than combined approach for low resections

RESECTION TECHNIQUES
• Patient positioning
• Incision
• Excisions below S1
  • Excisions including / above S1
    – Reconstruction of pelvic ring
    – Reconstruction of anal sphincter
  • Lateral position
    – Simultaneous anterior-posterior
  • Prone
    – Kraske’s position
  • Knee chest position
    – Surgeon stands in the middle of sacrum
    – Rectum falls away from sacrum

POSITIONING
• Supine + prone
  – Anterior + posterior

INCISIONS (ANTERIOR)
• Midline longitudinal
  – Transverse division of abdominals
  – Detach rectus abdominis
  • Ilio-inguinal (uni- or bi-lateral) with posterior extension
STRUCTURES TO ADDRESS (ANTERIOR APPROACH)

• Proximal control of common iliac
• Divide internal iliac vessels
• Divide middle sacral vessels
• Divide lumbosacral vessels

• Mobilize rectum / colostomy
• Lumbosacral discectomy
• Divide anterior sacroiliac ligaments

INCISIONS (POSTERIOR)

• Midline longitudinal
  - Long and distal
  - Cuts anal sphincter
  - Close to anus
• Transverse
  - Limited cranio-caudal exposure

• Inverted Y incision
• Inverted-smiling incision
  - Versatile exposure
  - Avoid faecal soiling

**Inclusion of biopsy tract

STRUCTURES TO IDENTIFY AND DIVIDE (POSTERIOR APPROACH)

• Muscles
  - Gluteus maximus
  - Piriformis
  - Sacrospinalis
• Ligaments
  - Sacrospinous
  - Sacrotuberous
  - Rectal coccygeal

• Blood vessels
  - ± Superior and inferior gluteal
• Neural tissues
  - Ligate & divide dural sac through a laminectomy
  - Sacral roots to the sciatic nerve

STRUCTURES TO IDENTIFY AND PRESERVE (POSTERIOR APPROACH)

• Neural tissue
  - Pudenal nerve
  - S1 root
  - Lumbosacral trunk
• Mobilize rectum from pre-sacral fascia*
  - Not between sacrum and pre-sacral fascia
  - Pre-sacral fascia may be contaminated
• Get above the tumor

• Mobilize laterally to SI joint through greater sciatic notch
• Osteotomize sacrum with finger guidance
• Reconstruct / augment pelvic ring
  - Stable as long as one-half of S1 is left intact

PELVIC FLOOR RECONSTRUCTION

• Preserve enough of gluteus maximus to close

• Reconstruct with synthetic mesh

PARTIAL SACRECTOMY / SACRAL ALA RESECTION

• Done in conjunction with ilium excision
• Sacroiliac joint excised

• Reconstruction of pelvic ring
SACRAL ALA

- Anterior and posterior sacral foramina
  - Anatomically equates to inter-transverse space
  - Muscular branch dorsally
  - Sacral roots anteriorly
  - Identify and protect sacral roots anteriorly
  - Pass T-saw between
    - Adjacent foramina
    - Foramen-lateral border of sacrum
    - Foramen-top of ala (below L5 transverse process)
  - Multiple segmental cuts made
- Reconstruction between remaining ilium and sacrum
  - Individualized

COMPICATIONS

- Haemorrhage
  - Ave 5 to 11 litres
- Unclear margin
  - Intraoperative frozen section
  - Metal clip markers for postop adjuvant therapy
- Dead space
  - Haematoma, seroma
- Wound infection
- Sacral herniation

SUMMARY

- Do not compromise on margin of excision
- Spare nerve roots as feasible
- Use of adjuvant therapy
- Reconstruct sphincters and pelvis
SPINAL METASTASIS: WHEN SHOULD WE OPERATE?
Abdul Malik Mohamed Hussein
Damansara Specialist Hospital, Damansara Utama, Petaling Jaya, Selangor, Malaysia

EVALUATION OF PATIENTS FOR PROGNOSIS, WITH REGARDS TO BENEFIT OF SURGERY WOULD DEPEND ON
1. General condition of patients
2. Number of extra spinal Metastasis
3. Number of metastasis in the spine
4. Metastasis to major internal organs
5. Primary site of tumor
6. Neurological status

THE SOSG (SPINAL ONCOLOGY STUDY GROUP) HAS CLASSIFIED SPINAL INSTABILITY INTO
1. Spinal Location (Junctional, Mobile, Semi Rigid, Rigid)
2. Mechanical Pain (Pain on movement)
3. Bone Lesion (Lytic, Mixed, Blastic)
4. Spinal Alignment (Subluxed, Kyphotic/ scoliotic, Normal alignment)
5. Verterbral Body collapse (Percentage of Body Height Collapse)
6. PosteroLateral Involvement of Spinal Elements

Points given to the classification system has good evidence in terms of evaluating who benefits in terms of pain relief, return of neurological status with regards to spinal surgery.

Metastatic Epidural Spinal Cord Compression (MESCC) single level is best treated surgically with radiotherapy/ chemotherapy with superior results compared to radiotherapy / chemotherapy alone.

Percutaneous Vertroplasty/ kyphoplasty is also recommended for those who are medically unfit for surgery.
PALLIATIVE SPINE SURGERY IN SPINAL METASTASIS USING MISS TECHNIQUES
Nils Hansen-Algenstaedt, Christian Schäfer, Lennart Viezens, Lothar Wiesner
Spine Center, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

OBJECTIVE
Spinal surgery in metastasized patients is discussed very controversial. Not only the technique but also the extent of surgery varies significantly. New surgical techniques such as the percutaneous stabilization allowed us to widen the spectrum of treatable pathologies but so far we failed to proof their superiority compared to open spinal surgery with regards to objective parameters.

METHODS
Tumor patients requiring surgical interventions. Inpatient time, BMI, gender, neoadjuvant chemotherapy, neoadjuvant radiation, Tomita score, Frankel score and number of segments treated were analyzed. Also intra-operative irradiation per screw, number of transfused EC correlated to the pre- and postoperative Hb and hematocrit were documented. CRP levels, creatin kinase (CK), myoglobin, Plated derived growth factor (PDGF) were analyzed.

RESULTS
Percutaneous stabilization was performed in 57 tumor patients, 21 tumor patients were treated with open spinal surgery. There were no significant differences in Age, BMI, Gender, tumor entity and pre- and postoperative Frankel score. However, MIS treated patients received significantly more frequently neo-adjuvant chemotherapy and radiotherapy, also their Tomita score was significantly higher (p=0.021) 5.7 +/- 2.6 compared to open surgery 4.1 +/- 2.8 as well as the number of segments treated (MIS: 5.4 +/- 3.1; open: 3.0 +/- 1.5; p < 0.001). Hospital stay was significantly shorter (MIS: 11 +/- 4.8 vs. Open: 14.5 +/- 7.4; p=0.018) with non significant difference in time at the ICU (MIS: 0.9 +/- 1.5 vs. Open: 0.6 +/- 0.5; p=0.3). Postoperative pain medication was significantly less in MIS patients also the number of EC transfusions was significantly less (MIS: 1.2 +/- 1.7 vs. Open: 2.8 +/- 3.3; p=0.007): Irradiation per segment did not differ significantly (MIS: 27.4 +/- 13.2 vs. Open: 32.0 +/- 17.4; p=0.22). Parameters evaluating soft tissue damage, such as: CRP; CK, myoglobin, VEGF and PDGF were signifanctly lower in MIS treated patients.

CONCLUSION
As demonstrated earlier, percutaneous techniques are successful in the treatment of tumor patients, even in multi-level procedures requiring long constructs. Our results demonstrate not only the feasibility but they also underline the superiority of percutaneous techniques with regards to soft tissue damage, reduced wound-healing processes and reduced cytokine expression levels relevant for tumor progression. The fact that the percutaneous treated patients had higher Tomita scores and less level treated strenghten these results even more since they point out that the MIS patients have been sicker and treated more extensively than the open group. These results underline the relevance for the development of new image-guided techniques. As a consequence from the superiority of MIS techniques, tumor patients should be treated predominantly with percutaneous techniques. Also these results may have an impact in decision making processes up to which extent tumor patients profit from spinal surgery. Clearly these results widen the spectrum of treatable pathologies.
MISS IN DEFORMITIES
Nils Hansen-Algenstaedt, Christian Schäfer, Lennart Viezens, Lothar Wiesner
Spine Center, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

OBJECTIVE
Minimal invasive techniques have been used for decompressive surgery and short segment fusion such as MiTLIF or intravertebral fracture reduction. Multiple studies have proven their superiority, therefore MISS techniques have become a widely accepted technique. However they also have been accused not to address the problem of overlying deformities. The aim of this presentation is to proof equivalency to open deformity surgery.

METHODS
This is a retrospective study of patients undergoing deformity correction procedures. We included different aetiologies such as degenerative, neuromuscular and idiopathic scoliosis as well as infection, tumor and trauma associated deformities.

RESULTS
Our results demonstrate that percutaneous techniques can be used to address different entities of deformities. Those indications requiring fusion where treated with intercorporeal fusion techniques and / or facet fusion. Patients with reduced bone quality where treated with cement augmented techniques. De novo scoliosis where treated using a 2 staged procedure with an anterior release and intercorporeal MIS fusion technique (XLIF) followed by posterior derotation and deformity correction. If indicated microsurgical decompression techniques where used to address central and or foraminal stenosis. Infection associated deformities were stabilized extrafocal and fused in the infected segments only. Tumor associated deformities were corrected accordingly and received a 360° decompression at the level of myelocord compression. Deformity correction techniques included microsurgical PSO, closed wedge osteotomies, costotransversal or thoracoscopic VBR and MiTLIF procedures.

DISCUSSION
The use of percutaneous techniques in spinal deformity surgery widens the range of treatable pathologies, which is with regards to aging population an important innovation. Traditional open surgical treatment of scoliosis may be effective, but is often fraught with complications such as “dead Space”. While percutaneous scoliosis surgery can be challenging, careful implementation of 2 staged procedures and or the combination with new intraoperative imaging and monitoring techniques such as intraoperative CT and neuromonitoring help to make it a safe and effective technique. In our opinion, MIS procedures require not only the use of new techniques, but also to identify the origin of the pathology and the clinical dominating problem. The combination with a variety of intercorporeal techniques such as XLIF and thoracoscopy enables the MIS surgeon to achieve at least the same clinical and radiographic result as with traditional open surgery. However, it must be emphasized that there is a steep learning curve and that MIS procedures have to prove to be beneficial in the long term.
Endoscopy of the spinal column and disc is a mixed bag of procedures included in the broad category of minimally invasive spine surgery. Endoscopy of the spine is a fast advancing field with promises of pinpoint and precision surgery with lessen tissue damage and specific targeted surgical objectives. Some of these procedures are easily identified as modification of an established procedures like discectomies. Some procedures are entirely new surgical concepts like endoscopic facetal neurectomies, endoscopic foraminoplasty and endoscopic annuloplasties.

How far has these modifications and revolutionary concepts has achieve the intended success is currently being investigated. What is fact and what is just hype is becoming clearer. In experienced hand, endoscopic lumbar discectomies has the same success as open microsurgical disc excision with less complications. Many procedure are losing popularity like the B twin stabilization. The advantages and disadvantages of the percutenous endoscpic procedure will be discussed.
THE ROLE OF ENDOSCOPIC DECOMPRESSION IN LUMBAR SPINAL STENOSIS

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Spine and Spinal Cord Rehabilitation Unit, Department of Orthopaedic, School of Medical Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian, Kelantan, Malaysia

BACKGROUND
Surgical decompression is a standard and established procedure for spinal stenosis. Issues with the procedure are related to its approach and balancing between adequate decompression and preserving stability. Endoscopic surgery could provide some answers to those issues.

OBJECTIVES
1. To compare the early results of endoscopic decompression with the standard open technique
2. To identify cases that need not undergo fusion
3. To identify teething problems in early phase experience

METHODS
From 2009 to 2011 125 consecutive patients were operated using Destandau translaminar technique. We use Karl Storz endoscopic system with a 4 mm HOPKINS® 00- telescope and 9mm working channel of ENDOSPINE® working insert

RESULTS
86 cases were endoscopic decompression and the remaining were discectomy. 8 cases were revision of which two were prior open decompression, 10 cases were 3 level decompression, 47 cases were 2 level and 28 cases were one level decompression. Early results were very promising with average hospital stay of three days, less than 200 cc of blood loss and no infection. The duration of surgery is about average of 1.5-2 hours per level and with three levels it took between 3.5-4 hours.

8 cases of spondylolisthes of grade 1, 3 cases of degenerative scoliosis and one case of scoliosis with grade 2 listhesis without significant back pain have no instability pain post operatively but one patient with grade 2 and have mild-to-moderate back pain need subsequent fusion surgery.

CONCLUSION
Endoscopic translaminar decompression using Destandau technique is effective in achieving adequate decompression and preserving stability with its excellent visual aids and endoscopic system provides early recovery and reduce the needs to do fusion.

KEYWORDS
Endoscopic, spine, lumbar, decompression.
The increasing radiation exposure to spine surgeons is becoming a concern with the rising popularity and acceptance of minimally invasive spine surgery techniques in recent years. While open surgery allows us to make use of visible anatomical landmarks to identify the surgical site and to guide instrumentation, minimally invasive surgical techniques depend largely on imaging using ionizing radiation to guide the course of surgery. Thus intra-operative imaging has become the new “eyes” of the surgeon, which in turn could also result in potentially damaging effects of excessive radiation exposure. The fact that radiation is invisible and the effects are cumulative from multiple exposures rather than acute from a single exposure may compound the lack of attention to it, particularly in the “excitement” of completing the surgery expeditiously. Studies have shown that a surgeon can easily exceed occupational safe doses to the eyes and extremities by placing percutaneous pedicle screws after 10-15 years. Others have shown that after 3 months of vertebroplasty, the annual risk of developing a cancer is 0.025%; the dose for the eye lens was about 8% of the threshold dose to develop a radiation induced cataract; and the doses to the skin are 10% of the annual effective dose limit. Each vertebroplasty procedure carries a radiation dose equivalent to 72 chest radiographs or 173 day equivalents of natural background radiation. Simple measures like the donning of lead gowns, thyroid shields, lead goggles and gloves should be used to reduce radiation exposure. The positioning of the image intensifier has a significant role in reducing radiation to the surgeon and team members. At all times, the surgical team needs to observe the basic concepts of radiation protection like screening time, distance away from the radiation source, shielding, and the A.L.A.R.A. principle.
INFECTIONS IN IDIOPATHIC SCOLIOSIS
B Stephens Richards
Texas Scottish Rite Hospital, Dallas, Texas, United States

HOW COMMON ARE INFECTIONS?

<table>
<thead>
<tr>
<th>Delayed</th>
<th>Acute</th>
<th>*All following posterior spinal fusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4 %</td>
<td>1.1%</td>
<td>Richards Spine 2006</td>
</tr>
<tr>
<td>1.3%</td>
<td>0.6%</td>
<td>Luhman Spine 2009</td>
</tr>
<tr>
<td>2.7%</td>
<td>0.5%</td>
<td>Rihn Spine 2008</td>
</tr>
<tr>
<td>1.7%</td>
<td></td>
<td>Clark Spine 1999</td>
</tr>
</tbody>
</table>

ACUTE (EARLY) INFECTIONS

Risks

– Preoperative
  • Obesity, immunocompromised, malnourished

– Intraoperative
  • Increased OR time, increased blood loss
  • Antibiotic coverage imperative

– Postoperative
  • Wound seroma/hematoma
  • Drains

Most common pathogens

– Staphylococcus aureus
– Staphylococcus epidermidis
– 50-79% acute infections

TREATMENT – ACUTE (EARLY) INFECTIONS

Medical management alone is insufficient for deep wound infection

– Persistent drainage from incision
– Recurrent hematoma following aspiration
– Increasing pain, elevated temps, increasing CRP

Surgical Management

• Incision down to instrumentation
• Deep cultures – Beware MRSA!
• Debridement
• Pulsatile lavage
• Consider leaving wound packed open, or use vacuum-assisted treatment, returning for delayed primary closure over drains in 48 hours
DELAYED INFECTIONS

Occurs 20 weeks or later from the index procedure
Usually presents 2-3 years following surgery
- Originally thought to represent an aseptic inflammatory soft tissue reaction to “fretting corrosion” of the metal implants.
- Corrosion occurs in stainless steel constructs, but not in titanium.
- Propionibacter Acnes and Staph epidermidis (coag-neg) are most common

MECHANISM OF INFECTION
- Most likely: Intraoperative seeding followed by subclinical quiescent period

Risk Factors
- Presence of significant comorbid conditions
  - Sickle cell, ITP, Cardiomyopathy, hypothyroid, acne
- Surgeon
- Surgical time
- More distal fusion level (lumbar > thoracic)
- Not using postoperative drains
- The need for blood transfusions

Factors NOT associated with delayed infection
- Body mass index
- Number of anchor points used
- Allograft bone
- Antibiotic regimen

Clinical Picture
- Poorly localized back pain, for 1-6 months before infection is diagnosed
- Fluctuance may be present
- Spontaneous drainage subsequently occurs
- ESR is modestly elevated (50 mm/h)

Treatment – Delayed Infections
- Removal of all implants
  - Eliminate the biofilm (glycocalyx)
  - Deep cultures - Prolonged incubation
- Primary closure
- Antibiotics

MSS-SRS International Spine Congress 2011
- 70 -
SINGLE SURGERY FOR SPONDYLODISCITIS WITH EPIDURAL ABSCESS.  
THE LEVEL DICATES THE APPROACH

Hazem Elsebaie  
Department of Orthopaedic Surgery, University of Cairo, Egypt

Anterior debridement and bone grafting was recommended for spondylodiscitis, instrumentation has gained popularity as an adjunctive procedure to augment fusion in addition an epidural extension dictates the need for an adequate decompression. We advocate a single approach for these cases from which debridement, decompression, fusion and instrumentation can be done. In the lumbar spine the need for adequate decompression of individual nerve roots, the relatively challenging anterior approach and the relative easiness of reaching anterior to the dura make the posterior approach more adequate in contrast to the dorsal spine where the anterior approach can be simple and effective.

Twenty five cases of spondylodiscitis with epidural abscess (14 dorsal and 11 lumbar) were treated between 2001 and 2007. All patients had neurological affections in the form of sensory impairment, 14 had additional motor affection in one or both lower limbs, 3 had urinary incontinence. Eighteen cases were associated with kyphosis of an average of 26 degrees. All cases were treated via a single approach; the dorsal through anterior and the lumbar through posterior; all with instrumentation.

The follow-up period ranged from 2y 7m to 8 y 2m (average 3 y 3m). Average kyphotic angle deformities corrected from 26 degrees to 7 degrees post operative and 11 degrees at the latest follow up. All cases except 4 (3 lumbar and one dorsal) had neurological improvement of one or more grades and there were no neurological deterioration post operative in any of the cases. Screw loosening with partial loss of correction occurred in 3 cases (2 dorsal and 1 lumbar). One dural tear and wound gaping needing debridement occurred in the lumbar group. No vascular complications, no recurrence of infection during the follow up period.

Spondylodiscitis with epidural extension can be treated surgically via a single approach. Choosing an anterior approach for the dorsal levels and a posterior approach for the lumbar levels may present a safe and effective strategy for such demanding surgeries.

A well chosen single approach can decrease the morbidity when treating spondylodiscitis cases associated with epidural abscess
THE USE OF ENDOSCOPIC SURGERY IN THE TREATMENT OF SPINAL INFECTIONS
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INTRODUCTION
Most spinal infections involve the anterior column. When surgery is indicated, anterior approach is the most direct to the site of pathology. However, classical open thoracotomy is associated with certain complications. The advent of endoscopic surgery helps to reduce the invasiveness of thoracotomy.

MATERIAL & METHODS
This is a retrospective review of 18 patients with tuberculosis of the thoracolumbar spine who underwent endoscopic assisted anterior surgery of debridement, bone grafting and stabilization, with at least 1 year follow up.

RESULTS
18 patients, 10 males and 8 females. Mean age 41.6 years (11-60). Level of involvement was between T6-L1, most common at T10-11. Pre-op kyphosis was 35º (18º-45º). Indication for surgery is significant neurological deficit 15 and pain 3 patients. All patients underwent left sided endoscopic-assisted mini-thoracotomy to debride the infection, decompress the cord, bone grafting. Additional stabilization was performed in 12 patients with plating. Blood loss was 405mls (200-1000). No case of conversion to open thoracotomy. No pulmonary complication. Post-operative antibiotics therapy was 9 months. No patient has recurrence of infection. Latest follow up kyphosis was mean 15º (-7º to 25º).

CONCLUSION
Endoscopic assisted anterior surgery in the treatment of spinal infection reduces iatrogenic trauma and post-operative lung complications. It does not jeopardise the advantages of anterior surgery to the spine.
Tuberculosis is an infestation still prevalent in a number of developing & underdeveloped countries. Large chunks of South & South East Asia are still in the endemic zone & the management still remains a challenge to the treating physicians & surgeons.

The management of Spinal TB is principally multi drug chemotherapy for prolonged duration (about nine months to a year or longer) and surgical intervention is essentially reserved for complications arising from the disease intrinsically. Surgical decompression and stabilization is required only when the patient either has deteriorating neurology or a new neurological deficit on Anti tuberculous treatment (ATT) or when there is no improvement in the neurological status of the patient with at least 4-6 wk of ATT. Instability (involvement of more than three contiguous vertebra, kyphosis >40°, pan vertebral involvement) is a separate indication for operative stabilization of the vertebral column.

Surgical debridement of Tuberculous foci in spine has evolved in the past few decades and a whole gamut of surgical procedures are available at present. Transthoracic anterior debridement & instrumentation, posterolateral decompression with posterior instrumentation, thoracoscopic assisted drainage of abscess, debridement & decompression of cord ± anterior instrumentation, and more recently posterior percutaneous pedicular screw system with tubular retactor aided posterolateral decompression and grafting are some of the options.

Though the initial preference of surgeons was an anterior approach (as advocated by the Hong Kong group in the sixties), posterior and posterolateral approach is now favoured & gives equally good outcomes. With the evolution & growing popularity of Minimally Invasive techniques in spine surgery, MIS is now being applied for Tuberculous spondylitis too with similar outcomes as open surgery.

We present our experience of surgical management of Tuberculous Spondylitis with a review of literature on the subject.
RECENT ADVANCEMENTS IN MINIMALLY INVASIVE SPINE SURGERY (MISS)
Nils Hansen-Algenstaedt
Spine Center, University Medical Center Hamburg-Eppendorf, Hamburg, Germany

OBJECTIVES
In recent years MISS procedures became a promising alternative to traditional open spine surgery. Yet, these procedures have mostly been limited to decompressive surgery and/or short segment fusions. However, multilevel procedures, reconstructive spine surgery, deformity and cervical spine surgery have not been considered to be applicable for MISS procedures.

METHODS
The rational for MISS as well as the historical evolution is described for tumor, infection and degenerative spinal pathologies. Value and use to combine MISS procedures with new technologies such as neuromonitoring and navigation are assessed.

RESULTS
We demonstrate that MISS procedures can be also used for complex and reconstructive spinal pathologies. Even deformities such as kyphoscoliosis in neuromuscular disease and PSO in Spondylitis ankylosans can be addressed with MISS procedures.

CONCLUSIONS
The combination with navigation to reduce radiation exposure and neuromonitoring to evaluate critical function of the myelocord are recommended. Also the use of retractors and magnification techniques such as microscopes and endoscopy are beneficial. Even in areas with critical sized anatomy such as the cervical spine MISS procedures can be used. Although the benefits of MISS procedures could be corroborated, the routine use in complex spinal pathologies is still limited due to the steep learning curve.
INTRODUCTION
Deformity in the sagittal plane has a significant and measurable impact upon health related quality of life. The radiographic parameter most closely correlated with patient self-reported pain and function was global sagittal balance measured from C7 to the Sagittal Vertical Axis based at the posterior margin of the sacrum.

Recognition and treatment of sagittal plane deformity is an important goal of the physician caring for spinal deformity. The purpose of this presentation is to describe the causes and analysis of sagittal deformity in patients with a broad spectrum of spinal disorders.

ETIOLOGY OF SAGITTAL IMBALANCE
a. Congenital
   i. Type I
   ii. Type II
b. Developmental
   i. Scheuermanns Kyphosis
   ii. Kyphoscoliosis
c. Degenerative
   i. Lumbar Hypolordosis
   ii. Thoracic Kyphosis
d. Traumatic
e. Infectious
   i. Tuberculosis
   f. Inflammatory
   i. Ankylosing Spondylitis
g. Neoplastic
   h. Post-operative
   i. Flatback deformity
   ii. Kyphotic Decompensation

SURGICAL GOALS
The amount of correction needed is determined by the goals of deformity correction. Measurable goals in planning correction of deformity include:

1. Restoration of Global Balance
   a. C7 < 4cm from SVA in sagittal plane
   b. C7 <4cm from CSL in coronal plane
2. Restoration of Regional Alignment
   a. Lumbar Lordosis = Pelvic Incidence +/- 10 degrees
3. Improvement of Lumbopelvic Alignment
   a. Pelvic Tilt <25 degrees
4. Restoration of segmental anatomy
   (intervertebral disc trapezoidal deformity)
5. Correction of Chin-brow to vertical angle
6. Shift of Line of Weight-bearing posterior to the osteotomy sites

Guidelines for Deformity Correction Expectation:
Ponte Osteotomy : 8-10 degrees per osteotomy 1 degree/mm of posterior resection
Smith-Peterson Osteotomy : 15-20 degrees per segment
Transpedicular wedge resection osteotomy : 30-50 degrees per osteotomy
Vertebral Column Resection : 30-50 degrees per osteotomy Trunk Translation up to 8cm
Sagittal balance is important for biomechanical optimization of force at segmental interspaces. Many of the ankylosing spondylitis (AS) patients were presented with kyphotic deformity of the spine, osteoporosis, and pseudarthrosis. The kyphotic deformity mostly involves lumbar spine upward to the thoracic and even to the cervical spine. In such cases, patients may have forward thrust of the head, trunk stiffness, and deformity, and severe back pain. If hip joint is involved too, life quality may be deteriorated. Therefore, correction of the kyphotic deformity is mandatory in the severe patients. Posterior correction is the most common approach. The procedures are many, such as 1. Extension Osteotomy, a. Smith-Peterson osteotomy (1945), b. Zielke (1986), Chen (1987), Multiple Spinal Osteotomy (MSO) with fixation and pedicle screw. 2. Subtraction correction a. Thomasen procedure (1985), b. Heinig Wedge decancellation of V body, c. McMaster Osteotomy, and 3. Vertebral column resection (VCR).

MSO is indicated when the global deformity is < 70 degree in the thoraco-lumbar or lumbar segments and no dense calcification of the anterior spinal ligament. The level of posterior Osteotomy is depending on the level and severity of the kyphosis. Usually the osteotomy was performed from T7 down to S1 in the V shape with gape about 6 to 8 mm. Thomasen procedure is selected for kyphosis greater than 70 degrees. This can be performed by Osteotomy or curettage below the pedicle, also in the wedge shaped fashion. For one segment correction, about 35 degrees can be obtained. The Osteotomy level is at L2 or L3 body. VCR is preserved for patients with severe kyphus. It is technically demanding and possessing higher complication.
INTRODUCTION

The treatment of adult deformity has been significantly improved with the development and use of modern segmental instrumentation, including posterior instrumentation. Proximal junctional kyphosis (PJK) is an important complication of posterior-based deformity correction. (Glattes et al., 2005; Hee et al., 2007; Hollenbeck et al., 2008; Kim et al., 2005; Kim et al., 2007; Lee et al., 1999; Yang et al., 2003). PJK is defined as a kyphotic deformity (progression of segmental kyphosis of more than 5 degrees) in the spinal motion segment immediately cephalad to the instrumented segments and is an important clinical problem in patients (reported in 9.2 to 46% patients) treated with long segmental instrumentation including posterior spinal fusion. Lee et al., (1999) reported PJK in 46% of patients treated with instrumented posterior spinal fusion at a 2-year follow-up.

The etiology of proximal junctional kyphosis is shown to be related to age (Kim et al., 2008), pre-operative PJK (>5 degree is an important predictive factor for the development of postoperative PJK) (Lee et al., 1999), choice of levels (T10-11 vs T12-L1), number of fused vertebrae (>11) Kim et al., 2007), implant type (Kim et al., 2007), thoracoplasty (Kim et al., 2007) and fusion technique (combined anterior and posterior technique is at higher risk for developing PJK) (Kim et al., 2008).

The purpose of this presentation is to present the causes of proximal junctional kyphosis and the outcome of care in a consecutive series of patients with adult spinal deformity

Treatment of PJK usually requires extension of posterior instrumentation and posterior-based osteotomies. Occasionally, the posterior based vertebral column resection is required for patients with severe sagittal imbalance. The role of vertebral augmentation and transitional or dynamic instrumentation systems remain undefined.
NEURAL ARCH SAVING TECHNIQUE OF SHORTENING OSTEOTOMY FOR SAGITTAL CORRECTION

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INTRODUCTION

Many methods of spinal osteotomy technique were reported and each technique have their advantages and also limitations at a same time. The authors develop a new technique of spinal column shortening osteotomy that can preserve the anterior, middle and posterior columns by preservation of the integrity of posterior neural arch.

METHODS

From 1998 to 2009, 47 patients with spinal kyphotic deformity underwent surgical treatment by neural arch saving spinal osteotomy technique. The mean age was 59 years (9-79) and mean kyphotic angle was 29 degrees (15-40). The causes of kyphotic deformity were osteoporotic fracture, posttraumatic, junctional degenerative change, flatback, and ankylosing spondylitis. The vertebra performed shortening osteotomy was L1 (16 cases), T12 (14), L3 (7), T11 (4), L2 (3), T9 (2), L4 (1). We evaluated the radiographic results such as correction angle of kyphosis and clinical results such as symptom improvement and postoperative complication.

SURGICAL TECHNIQUE

2-3 adjacent vertebra above and below shortened vertebra was performed pedicle screw and rod fixation at one side before osteotomy for preventing spinal cord injury according to instability and osteotomy was performed at other side. Shortening osteotomy was performed at anterior, middle column and some of anterior column through wedge type osteotomy. Inferior edge of osteotomy site is just above the inferior wall of pedicle parallel to inferior endplate of deformed vertebra and superior edge is just beneath the superior endplate of deformed vertebra or inferior endplate of upper adjacent vertebra to preserve inferior part of neural arch. In case of angle of wedge osteotomy being 20, 30, 40 degree, the location of correction hinge was before anterior one forth, anterior one forth, one half of vertebral body.

RESULTS

In all cases, pre-operative symptoms such as pain and myeloneuropathy were improved and solid fusion was attained within postoperative 3 months. Kyphotic angle was improved to 4 degrees (-7-14), and mean amount of correction angle is 24 degrees (7-44). There was no implant failure, neurovascular complication or infection.

CONCLUSIONS

This technique can preserve inferior wall of pedicle and posterior neural arch combined with decompression of spinal cord. It can be restored 3 columns resulting in more mechanical stability. Because its correction amount is comparable to pedicle subtraction ostetotomy and the range of osteotomy is shorter than this, there was a little axial compression of spinal cord and the risk of neurologic complication can be decreased.
LYSIS REPAIR IN SPONDYLOLYSIS AND LISTHESIS

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Spondylolysis refers to the defect in ‘pars interarticularis’ which may be unilateral or bilateral. Inheritance plays a major role as its prevalence is more common within a ‘family-tree’ esp. Eskimos. It most commonly affects the L5 vertebra. Spondylolisthesis refers to forward slippage of top vertebra in relation to bottom vertebra. Wiltse classified them into five main types – Dysplastic, Isthmic, Degenerative, Traumatic and Pathological. The degree of this forward slippage was graded by Myerding from I to IV.

Lysis defect may cause back pain as fibrous tissue in the region of lysis has been shown to have nociceptive nerve endings and high levels of neuropeptides. Surgical repair of pars defect is undertaken to alleviate pain and improve function / quality of life. Numerous techniques / surgical strategies, both instrumented and non-instrumented have been described to address this pain. CT / Bone / SPECT scans are undertaken as a part of routine diagnostic work-up and follow-up to evaluate the extent of union following surgery.

The author (MHHN) has developed a novel fixation technique to repair lysis and correct Gr I Listhesis using pedicle screws and modular ‘U’ shaped link connector passing beneath the spinous process. Cancellous bone graft is held in compression as the link connector is tightened to pedicle screws. The preliminary results were published earlier this year (Jan 2011; J Bone & Joint Surg [Br]). The surgical technique and tips are covered in this lecture.

High grade spondylolisthesis (Myerding III - IV & Spondyloptosis) may produce cosmetic deformity with lumbosacral kyphosis and sagittal imbalance. Aggressive two / three stage corrective surgeries have been described in literature to restore sagittal balance and are associated with high incidence of neurological complications.

Literature is unclear if non-union / pseudoarthrosis are predictive of poorer outcomes. Many researchers have observed functional outcomes to be similar in patients with non-union following surgery vs. healed group without pseudoarthrosis.
PATHOMECHANISM OF DEGENERATIVE SPONDYLOLISTHESIS
– WHEN AND HOW TO FUSE?

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DEGENERATIVE SPONDYLOLISTHESIS
Pathoanatomy
- Reduction of disc height
- Reduction of intervertebral foramen
- Subluxation of facet joints
- Infolding of ligamentum flavum
- Bulging or herniated disc

Pathomechanics
- Reduction of anterior column support
- Slackening of paravertebral ligaments
- Decrease in segmental stiffness in all planes

ASSESSMENT
- Neurology
- Stability
- Deformity

CAUSES OF NEUROLOGICAL DEFICIT
- Spinal stenosis
  - central
  - root canal
- Bulging discs / osteophytes
- Facet hypertrophy
- Ligamentum flavum hypertrophy
- Foraminal stenosis
- Olisthesis
- Stretching of cauda equina

Static measurement of instability
Dynamic measurement of instability
Flexion / extension radiographs

SUSPENSION RADIOGRAPH
FRIBERG SPINE 1987

TRACTION RADIOGRAPHS
50% body weight traction
supine traction radiograph (ST)
prone traction radiograph (PT)
PRONE TRACTION RADIOGRAPH
Maximum
- reduction of olisthesis
- restoration of lordosis
- restoration of disc height / area

INSTABILITY IN SPONDYLOLISTHESIS
Loss of anterior column support

TREATMENT STRATEGY
- Nerve decompression
- Stabilization
- Correction of deformity (if necessary)

WHEN TO FUSE?
- Back pain
- Dynamic neurological deficit
- Instability on traction radiograph
- Young patients (<65)
- Iatrogenic instability

WHEN NOT TO FUSE?
- Old / debilitated patients
- Claudication without back pain
- No demonstrable instability
- Uneventful medial facetectomy

REDUCE OR NOT REDUCE
- Majority do not require reduction
- Risk of neurologic complication

REDUCTION OF SPONDYLOLISTHESIS
- Facilitates nerve decompression
- Facilitates fusion
- Improves body posture

PRINCIPLE OF SURGICAL TREATMENT
Reconstruct anterior column

INTERBODY FUSION (GRAFT / SPACER)
- Decompresses
- Stabilizes
- Reduces deformity
SURGICAL COMPLICATIONS ASSOCIATED WITH HIGH GRADE SPONDYLOLISTHESIS. HOW DO WE AVOID THEM?

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MANAGEMENT OF HIGH GRADE SLIP

- **Fusion in situ** (will not solve the problem of neurological symptoms, will not change the abnormal biomechanics of lumbosacral junction)

- **Reduction, instrumentation, fusion**
  - Posterior only reduction/fusion
  - Posterior reduction/ALIF
  - Posterior reduction/PLIF(TLIF)
  - Posterior reduction/transaxial interbody fixation

COMPLICATIONS

- Neurological complications
- Blood loss
- Pseudoarthrosis
  - Implant failure
  - Loss of correction
- Loss of lumbar lordosis
- Loss of fixation
- Pelvic/sacral fracture
- Anterior vascular injury
- Retrograde ejaculation

PREVENTION OF THE COMPLICATIONS

**NEUROLOGICAL COMPLICATIONS (L5 ROOD INJURY)**

- Complete bilateral foraminectomy, follow the roots out into the muscles, keep them under vision all the time, relieve any tension from the pars or the pedicles
- EMG and SSEP monitor
  - Short period of IV steroids
  - Gradual reduction (allow for visco-elastic property of tissue stretching)
  - Be aware of possible dural tear (thin dura)

**BLOOD LOSS**

- Proper hemostasis
- Auto transfusion
  - Cell saver
  - FFP if needed

**PSEUDOARTHROSISS**

- Implant failure
- Loss of correction

**LOSS OF LUMBAR LORDOSIS**

**LOSS OF FIXATION**

**PELVIC/SACRAL FRACTURE**

**ANTERIOR VASCULAR INJURY**

**RETROGRADE EJACULATION**
LONG-TERM RESULTS FOR OPERATIVE RECONSTRUCTION OF HIGH GRADE SPONDYLOLISTHESIS AND SPONDYLOPTOSIS

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The author’s lifetime experience with these difficult problems will be outlined, with particular emphasis on the careful diagnosis, and common use of anterior and posterior reconstruction for surgical management.

Risk-factors which lead to spondyloptosis will be carefully identified and presented.

Very long-term results of successful operative management will be shown and principles of successful surgical management will also be carefully outlined.
CAN WE HAVE BOTH SATISFYING CORONAL AND SAGITTAL CORRECTION IN LENKE 1 ADOLESCENT IDIOPATHIC SCOLIOSIS CURVES?

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³Clinical Research Department, GCS CHU Lenval, Nice, France

Surgical management of scoliosis is a concurrent correction between the 3 planes of deformity. Publications reported a negative correlation between the coronal and the sagittal correction. Moreover recent oral presentation stated posterior spinal instrumentation and fusion (PSIF) have unintended effect on sagittal spine and pelvic parameters: lose of Thoracic Kyphosis (TK) and Lumbar Lordosis (LL) and increase of Pelvic Tilt.

OBJECTIVES
To present the results of an original technique of PSIF: the Simultaneous Translation on 2 rods (ST2R) to correct hypokyphosis in patients with Lenke 1 Adolescent Idiopathic Scoliosis (AIS).

METHODS
25 patients with Lenke 1 AIS and preoperative thoracic hypokyphosis (<20°) were surgically treated by the ST2R technique and followed during a minimum of 2 years. Coronal and sagittal x-rays were taken preoperatively and postoperatively at 1 month, 1 year and a minimum of 2 years of follow up.

RESULTS
10 levels were instrumented with 13 anchorages (implant density = 65%) in an average time of 190 min.

In the coronal plane, the main curve was reduced from 50° to 15° and maintained 67% of reduction at last follow-up.

In the sagittal plane, TK was significantly improved from 8° to 30° postoperatively and to 32° at last follow-up, with a gain of 24° (p<0.0001). The 12 patients with severe hypokyphosis (<10°) had a gain of 28° at last follow-up and the patients with a moderate hypokyphosis (10≤TK<20°) had a gain of 20°. LL was significantly improved from 44° to 51.2° (p= 0.005) becoming in agreement with the Pelvic incidence which remains unchanged.

CONCLUSION
With a high implant density but a short surgical time, ST2R allowed good correction in the frontal and the sagittal plane. The increase of TK is associated with an increase of LL without any changes in pelvic sagittal parameters.
DOES THE SURGICAL CORRECTION OF THORACIC HYPOKYPHOSIS CHANGE THE LUMBAR LORDOSIS AND SAGITTAL PELVIC PARAMETERS IN ADOLESCENT IDIOPATHIC SCOLIOSIS?

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The chain of correlation between the adjacent sagittal pelvic and spine parameters has been well established. The Pelvic Incidence (PI), a constant and morphological parameter, determines the Lumbar Lordosis (LL). In turn, LL balances with Thoracic Kyphosis (TK). In Adolescent Idiopathic Scoliosis (AIS), correlation exists between PI and LL but not between TK and LL. No study has evaluated the influence of the surgical correction of the hypokyphosis on LL and sagittal pelvic parameters.

OBJECTIVES

To evaluate if the surgical correction of thoracic hypokyphosis changes the LL and the PI, Sacral Slope (SS) and Pelvic Tilt (PT).

METHODS

55 patients with thoracic AIS (Lenke 1-2) were treated by Posterior Spinal Fusion and Simultaneous Translation on 2 Rods with a lowest instrumented vertebra L1 or above and 1 year of minimum follow-up. We measured spinal parameters (TK and LL) and pelvic parameters on pre- and post-operative coronal and sagittal x-rays. Patients were divided in 2 groups according to their preoperative kyphosis: Normokyphosis Group (NG), (20°≤TK<45°) and Hypokyphosis Group (HG), (TK<20°).

RESULTS

The TK gain was significant for the whole cohort (14.4°) and was higher for the HG (21.4°) than for the NG (7.6°). LL improved significantly for HG (4°) (p=0.01), but not within NG or the whole cohort. There was no change in pelvic parameters which remained correlated with LL (Pearson correlation).

CONCLUSION

The surgical correction of thoracic hypokyphosis induced an increase of LL without any compensatory mechanisms in pelvis. The increase of the TK might only influence the proximal part of LL (above the apex) whereas the distal part (equivalent to SS) remained constant.

SIGNIFICANCE

Compensatory mechanism is an adaptive phenomenon with unknown consequences in the future. The restoration of a normal sagittal profile can be achieved without unintended effects on pelvis.
The aim of this study was to identify prognostic factors for curve progression in patients with AIS.

The study comprised 97 females with AIS with mean age of 13 years old. Standing AP radiographs of the entire spine and right hand were taken every 4 to 6 months. Cobb angle and Risser sign were calculated from the spine X-rays. DSA staging was based upon the Sander’s classification, using the hand X-rays. Height measurements were recorded at each clinic visit, and HV was calculated as change in height during the time-interval (in centimeters) divided by time-interval (in years). Curve progression was defined as an increase in the final Cobb angle exceeding 30 degrees, on the basis of which the study patients were divided into progression and non-progression groups. The following parameters were analyzed: chronological age (C-age), pubertal status (M-stage), Risser sign (R-sign), DSA stage, and maximum height velocity during the follow-up period (m-HV). Distribution of m-HV according to C-age, M-stage, Risser sign, and DSA was examined. For statistical analysis, numerical and categorical data were collected, and differences between the progression and non-progression groups were evaluated using the chi-square test. Following univariate logistic regression analysis, prognostic factors for curve progression were also performed using multivariate logistic analysis with a forward stepwise procedure and expressed as odds ratios (OR).

The value of m-HV reached a peak at 10 years old in C-age, 1 year before menarche, Grade 0 in Risser sign, and stage 2 in DSA. Chi-square testing identified intergroup differences in M-stage, R-sign, DSA stage, and m-HV as statistically significant. Multivariate logistic analysis determined that m-HV was the only significant independent variable, with an OR ratio of 4.31.

We conclude that assessments of the risk of curve progression in patients with AIS should include HV along with measures of skeletal maturity.
CORRELATION BETWEEN PREOPERATIVE SIDE BENDING LOWEST INSTRUMENTED VERTEBRA TILT AND POSTOPERATIVE LOWEST INSTRUMENTED VERTEBRA TILT IN RELATION TO CORONAL BALANCE IN ADOLESCENT IDIOPATHIC SCOLIOSIS WITH STRUCTURAL LUMBAR CURVE

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BACKGROUND
Structural lumbar curves with and without thoracic curves (Lenke 3, 5 and 6) can be treated via posterior approach. Coronal imbalance associated with limb length discrepancy frequently becomes an important issue post operatively. Preoperative side bending lowest instrumented vertebra (LIV) tilt which represents the flexibility of the LIV, would theoretically determine the amount of correction allowed for the upper fused curve(s) to achieve post operative coronal balance.

OBJECTIVES
To determine the correlation between preoperative side bending LIV tilt with the postoperative LIV tilt following posterior spinal pedicle screw fixation for Lenke 3, 5 and 6 curves.

METHODS
Thirty patients with at least 12 months of follow-up were identified in this study. Preoperative and postoperative radiographs were reviewed. Correlation of preoperative side bending LIV tilt to postoperative LIV tilt was evaluated. Balance and imbalance groups were compared for their radiographic parameters. Global Coronal Imbalance is defined as C7 to CSVL >20mm.

RESULTS
Twenty eight females and two males with mean age of 15.5 years (12-35) and mean follow up of 17.3 months (12-35) were studied. Sixteen were Lenke 5, eleven Lenke 6 and three Lenke 3. There was no difference in between mean preoperative side bending LIV tilt (6.8 +/- 4.6º) and mean postoperative LIV tilt (5.7 +/- 4.2º, p=0.11). Pearson correlation test showed that the preoperative side bending LIV tilt correlated significantly with postoperative LIV tilt (r=0.68, p=0.00). 7 patients demonstrated global coronal imbalance during follow up; 3 of them compensated and the remaining were still not balance at latest follow up. There was also no difference in between mean preoperative side bending LIV tilt and mean postoperative LIV tilt for both balance and imbalance group. Balance group (n=26): Preoperative 6.4 +/- 4.7º, postoperative 5.6 +/- 4.2º, p=0.25. Imbalance group (n=4): Preoperative 9.0+/− 3.6º, postoperative 6.5 +/- 4.2º, p=0.21. Of these 4 imbalance patient, 2 were caused by inability of the LIV to centralize the overcorrected curves, and the remaining 2 were due to worsening of upper thoracic curve.

CONCLUSIONS
Preoperative side bending LIV tilt is an important radiographic parameter that determines postoperative LIV tilt. It represents the ability of LIV to centralize the corrected curve(s).
CURVE CORRECTION IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS) TREATED BY DYNAMIC BRACING (SPINECOR): A MID TERM REVIEW

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OBJECTIVE
This study is to evaluate the curve correction achieved by a dynamic brace (SpineCor) in Adolescent Idiopathic Scoliosis

METHOD
156 patients with flexible, newly diagnosed AIS, were treated with the SpineCor brace at 3 centres. They were evaluated by standard cobb’s method for coronal curve correction. The radiographs were performed at the standard review periods. 55 patients who had records for more than 1 year are included in this study. 70 were excluded because the follow up currently was less than a year, and 31 were excluded because they were lost to follow up or were referred for surgery.

RESULTS

<table>
<thead>
<tr>
<th>Cobb angle at diagnosis</th>
<th>&lt; 20°</th>
<th>20°-50°</th>
<th>&gt; 50°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &lt; 10 yrs</td>
<td>nil</td>
<td>6.0° / yr</td>
<td>nil</td>
</tr>
<tr>
<td>Age &gt; 10 yrs</td>
<td>3.5° / yr</td>
<td>2.0° / yr</td>
<td>2.0° / yr</td>
</tr>
</tbody>
</table>

CONCLUSION
The dynamic brace (SpineCor) is effective for curves detected before 10 years of age and less than 50°. This suggests that the threshold for referral for dynamic brace should be much earlier, as this may alter the natural history of curve progression.
MULTIMODAL INTRAOPERATIVE SPINAL CORD MONITORING IN YOUNG CHILDREN

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Background: Maturation of the peripheral and central nervous system may not be complete in younger age group of childhood. This incomplete maturation leads to differences in structural and electrophysiological characteristics which are considered as normal in adults.

OBJECTIVES
Define success rate and performance of multimodal intraoperative spinal cord monitoring (MISCM) in two different age groups of children.

METHODS
A consecutive series of 60 patients were included in this study. Patients were divided into two cohorts according to their age. Patients aged below 5 years was Group A (n=19) and above 6 was Group B (n=41). Standard anesthesia protocol was given to both groups. After propofol induction, baseline somatosensory evoked potentials (SSEPs) and motor evoked potentials (MEPs) were recorded. Then all patients were intubated under single dose of atracurium 0.5mg/kg. Maintenance of anesthesia was provided with the combination of propofol, remifentanil, ketamine HCl.

SSEPs and MEPs were monitored during the operations in all patients. The 50% decrement in the MEP amplitude as compared to the baseline values was accepted as serious event.

RESULTS
MEPs and SSEPs were recorded in all patients. No false negative results were noted. Ten serious events (Group A=3, Group B=7) were observed in both groups. Diagnosis was congenital kyphoscoliosis in 6 patients, diastematomyelia in two patients, post traumatic kyphosis in one patient, post-TB kyphosis in one patient. MEPs recovered to the baseline values at the end of the operation except one patient with post-TB kyphosis. In this patient revision operation was done and complete neurologic recovery was achieved. Kyphosis was found as the most important risk factor for the serious events in both groups.

CONCLUSIONS
MISCM can be performed successfully in younger ages of childhood with a specified and safe anesthesia procedure. Partial or complete loss of MEPs was noted more frequently in patients with kyphosis.
CASE SERIES

This is a case series of 10 patients, diagnosed with Early Onset Scoliosis, that had undergone ‘growing rods’. This report aims to highlight the general principle of this method, and especially our own evolving experience.

The clinical notes & radiographs of all consecutive cases were analysed. All patients had MRI and CT (including 3D-reconstruction) of the whole spine. Pre-operative Lung Function Test was also performed.

A revision procedure was defined as the need to replace or remove implant(s). A major complication was taken as significant neurological deficit, and or death. A minor complication was defined as superficial infection not requiring surgical debridement.

Our cases are from early 2007, until the present time. There were 4 cases of juvenile type, 3 cases of congenital type, and 4 cases of neurofibromatosis. 7 patients had double rods, while 3 had single rod. A mean of 4 lengthening procedures were performed. There were 6 revision procedures, with 1 major complication (complete neurological deficit) – with delayed minimal recovery. 2 patients have undergone definite surgery.

This represents our still evolving experience, given our resources and available facilities. The limited number of patients, compounded with the very heterogenous nature of the curves, make this an interesting challenge.
NEGLECTED NONUNITED ODONTOID TYPE II FRACTURE WITH MYELOPATHY: TREATMENT WITH FOUR DIFFERENT FIXATION TECHNIQUES

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BACKGROUND
Displaced, neglected nonunited odontoid type II fracture resulted in atlantoaxial instability, causing myelopathy. Posterior atlantoaxial fusion was the treatment of choice.

OBJECTIVES
To compare the results of 4 surgical fixation techniques for treatment of nonunited type II odontoid fracture with myelopathy.

METHODS
Twenty-two patients who developed myelopathy from displaced nonunited type II odontoid fracture were collected during April 2007 to June 2011. Posterior C1-C2 fusion was done by using wiring technique (group 1), Magerl’s C1-C2 transarticular screw fixation (group 2) and C1-C2 segmental fixation (group 3). Four patients (group 4) required fusion extending to the occiput. Operative time, blood loss, total hospital stay, postoperative ambulation, fusion period and complications were compared.

RESULTS
Total results showed that operative time, total hospital stay, postoperative ambulation and fusion period were statistically significance difference among the groups (P<0.05). With wiring, the operative time was significantly shorter than C1-C2 transarticular screw fixation or Occipito-cervical fusion. Patients operated with C1-C2 transarticular screw fixation had the length of stay significantly shorter than those with wiring or Occipito-cervical fusion. With C1-C2 transarticular screw fixation or C1-C2 segmental fixation, the patients were able to perform earlier postoperative ambulation than those who were treated with wiring or fusion extending to the occiput. Patients with wiring achieved the solid fusion later than all other groups. No major complications were found.

CONCLUSION
Construct stability was improved by performing C1-C2 transarticular screws and C1-C2 segmental fixation. This allowed the patients to perform early ambulation and increased union rate. We did not consider transarticular fixation when there was a radiographic evidence of high-riding vertebral artery, narrow C2 isthmus (less than 3-4 mm.), kyphotic back and unreducible fracture. The latter circumstance would turn us to perform C1-2 segmental fixation or extending the fusion cranially to the occiput combined with C1 posterior arch resection.
COMPARISON OF OSWESTRY DISABILITY INDEX AND MAGNETIC RESONANCE IMAGING FINDINGS IN LUMBAR CANAL STENOSIS: A CLINICORADIOLOGICAL STUDY

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OBJECTIVE
Comparison of oswestry disability index and magnetic resonance imaging findings in lumbar canal stenosis.

MATERIALS AND METHODS
350 patients with clinical suspicion of lumbar canal stenosis were included in the study over a period of 3 years. All patients included completed the Oswestry disability Index questionnaire and accordingly percentage disability was interpreted. Also, all patients underwent noncontrast lumbosacral spinal MRI scan. Spinal canal anteroposterior and thecal sac cross sectional area was measured using sagittal and axial section at all lumbar intervertebral levels. Analysis of data was done to compare radiological findings recorded and percentage disability by ODI.

RESULTS
The sample size was 50 patients with clinical suspicion of lumbar canal stenosis. Mean age was 46 years. Average duration of pain was 3.4 years. 46% of our patients had severe disability as per ODI scores. We observed that no significant correlation was found between imaging appearance and level of disability. The degree of narrowing did not correspond to the severity of ODI percentage disability. The critical level of stenosis was found to be at a CSA (cross sectional area) 70 mm2. The strength of our study includes the use of standardized technique to analyse the imaging with the use of validated patient oriented outcome scale to quantify patient disability.

CONCLUSION
Our study thus concludes that radiological findings should be considered in association with the ODI index when assessing the patients which would provide a valuable tool in the management of the patients with lumbar canal stenosis.
OUTCOME OF PERCUTANEOUS PEDICLE SCREW STABILIZATION IN ADVANCE SPINAL METASTASIS

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Prevalence of spinal metastasis is increasing due to early detection and advances in the treatment of primary tumor. The management of this condition can be difficult. The immunocompromised status, previous exposure to radiotherapy or chemotherapy subject patients to higher risk of wound breakdown, implants infection and significant blood loss. The advent of percutaneous pedicle screw stabilization system had revolutionized the treatment of spinal metastasis.

We had performed 30 cases of percutaneous stabilization for advance spinal metastasis cases in between 2008 and 2010. Average follow up was 11 months (range 5 – 22 months). The indication for surgery was mainly pathological fracture causing mechanical back pain with or without neurology deficit. The primary tumor was Breast (9), Prostate (3), Lung (7), Gastro intestinal (3), Multiple Myeloma (2), Liposarcoma (1), Osteosarcoma (1), renal cell carcinoma (3) and Nasopharyngeal carcinoma (1). Average age at presentation was 56.4 years old (range 17-78 years). Average levels of stabilisation were 7.2 levels per patient, longest instrumentation span across 15 levels and the shortest was 2 levels. Twenty three cases had decompression of the spinal cord at same sitting.

The average operating time was 3 hours 52 min (range 1 hour 30 min to 7 hours), blood loss 1.9 L (range 200ml to 3.3 L). Average VAS score at pre-operation was 8.7 and post-operation 3.2; average neurological recovery for those with neurological deficit was one Frankel grade. None of the patient was bed ridden post-operative and no case faced problem of wound infection or breakdown. Up to today, only 12 patients are still alive. There was no case of implant loosening at last follow up.

CONCLUSION

Percutaneous pedicle screw stabilization offers a new option of treatment for patient with spine metastasis. It provide good relieve of mechanical back pain; at the same time allow surgeon to perform neural decompression through a minimal incision. There were much lower amount of blood loss and no case of wound breakdown in our series.
A BIOMECHANICAL ANALYSIS OF ANTERIOR CORPECTOMY RECONSTRUCTION IN A THORACO-LUMBAR CALF SPINE FRACTURE MODEL: DOES POSTERIOR INSTRUMENTATION CONFER ADDITIONAL STABILITY?

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OBJECTIVE
To compare biomechanical characteristics of (a) anterior allograft/anterior fixation with anterior allograft/posterior fixation (b) structural femoral allograft with synthetic cage, both augmented by anterior stabilization alone, after thoracolumbar corpectomy in bovine thoracolumbar fracture model.

METHODS
Seven 6 week old calf spines and femur used to create two motion segment section (L3-L5) and mounted. Corpectomy with sectioning of supraspinous and interspinous ligaments and destruction of facet joints to simulate posterior element instability (AOSpine Type B fracture).

Non destructive multiplanar testing was performed using a ABB industrial robot incorporating a 6 degree-of-freedom JR3 force sensor. Each spine was tested in 4 configurations: (a) allograft with anterior instrumentation, (b) allograft with anterior and posterior instrumentation, (c) titanium adjustable interbody insert with anterior instrumentation (d) titanium adjustable interbody insert with anterior and posterior instrumentation. The stiffness of each construct was determined in flexion / extension, lateral bending and rotation.

RESULTS
Stiffness of allograft and anterolateral plate was 3.8 ± 0.2, 3.2 ± 0.15 and 2.7 ± 0.1 Nm/º in lateral bending, flexion extension and rotation respectively. The stiffness of allograft and anterolateral plate with posterior instrumentation was 4.7 ± 0.25, 5.2 ± 0.6 and 3.2 ± 0.2 Nm/º in lateral bending, flexion extension and rotation respectively. The stiffness of synthetic cage and anterolateral plate was 1.9 ± 0.2, 2.3 ± 0.15 and 1.6 ± 0.1 Nm/º in lateral bending, flexion extension and rotation respectively. The stiffness of synthetic cage and anterolateral plate with posterior instrumentation was 3.0 ± 0.4, 3.0 ± 0.2 and 1.6 ± 0.1 Nm/º in lateral bending, flexion extension and rotation respectively.

CONCLUSION
Allograft with anterior reconstruction alone imparts comparable biomechanical stability to synthetic cage reconstruction in same circumstances in this bovine thoracolumbar burst fracture model. Posterior instrumentation added significant stability of the construct (p<0.001). Although concerns remain regarding its safety, bone allograft is an effective and inexpensive option in anterior column reconstruction of the spine.
IN THE ERA OF RECOMBINANT BMP, DOES ADDITIONAL ANTERIOR STABILISATION ADD VALUE TO A POSTEROLATERAL FUSION IN LOW GRADE LUMBAR SPONDYLOLISTHESIS?

P Dhoke, S Mehta, B Goss, S Stanojevic, R Williams
AO Brisbane Spine Reference Centre IHBI, QUT, Brisbane, Australia

OBJECTIVE
To study if additional Transforaminal Lumbar Interbody Fusion (TLIF) add any significant benefit over solid posterolateral fusion with Bone Morphogenic proteins (BMP) use in low grade lumbar spondylolisthesis?

METHODS
We performed a retrospective review of patients who had surgery for grade I or II lumbar spondylolisthesis stratified into two groups. Group 1 had 46 patients who underwent TLIF along with posterolateral fusion while group 2 had 40 patients who underwent posterolateral fusion alone. In both groups adequate posterior decompression with pedicle screw instrumentation was performed and recombinant BMP was used. All patients were evaluated clinically with Oswestry Disability Index (ODI) and radiologically at 3 months and follow up of at least 12 months.

RESULTS
40 patients had posterolateral fusion (PL) with BMP. 46 patients had TLIF with BMP-7 and posterolateral fusion with BMP. 27/40 (67.5%) Patients at 3 months and 28/40 (70%) patients after 12 months in the PL fusion group obtained a clinically significant benefit from the operation based on ODI. 35/46 (76%) patients at 3 months and 37/46 (80%) of patients at 12 months in the TLIF+PL fusion group obtained a clinically significant benefit from the operation based on ODI. 7.5% (3/40) of patients in the PL group were not fused posteriorly by Lenke’s criteria at 12 months. 2.2% (1/46) of patients in the TLIF group were not fused posteriorly by Lenke’s criteria at 12 months. 2.2% (1/46) of patients in the PL group were not fused anteriorly by modified Lee’s criteria at 12 months. The complication rate was similar with both procedures.

CONCLUSION
The results of our comparative study of the above two techniques showed that there was no difference in clinical outcome measured by ODI, in fusion rate and complication rates.
THE EFFECT OF CHRONICITY OF SYMPTOMS ON PAIN OUTCOME MEASURES IN THE SURGICAL TREATMENT OF SPINAL STENOSIS

Myint Thaung

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Degenerative lumbar stenosis is steadily increasing in incidence among middle and elderly aged Myanmar people. Localized lumbar pain and radicular pain with or without neurological complications are the obvious symptoms with variable clinical spectrum, socioeconomic backgrounds and unpromising outcome after selected spine surgery. Pain intensity and chronicity in relation to individual daily functional requirements is the considerable surgical indication for timing of surgery, with objective evidence in possible source of pain. Even than after surgical clearance of pathology, pain after persist or even more worse without further solutions.

We have done clinical study in 50 cases of clinically diagnosed spinal stenosis patients in patient group in between 40 – 75 years of age with variable chronicity of pain and other symptoms. The outcome measures particularly post-operative pain relief was measured with Oswestry Disability Index, Low Back outcome score & Visual Analogue Scale (VAS). The surgery was performed by experienced surgeon and independent observer analyzed the results. Overall improvement was assessed in post-operative 3 months, 6 months and one year.

The conclusion of our findings showed that chronicity of pain, associated neurological complications, individual biopsychological backgrounds, initial pain management and surgical stress greatly influence the outcome of pain relief after standard surgical decompression in spinal stenosis.
STUDY OF RADIOGRAPHIC CERVICAL SPINE SEGMENT SETTLING IN PATIENTS RECEIVED ANTERIOR DYNAMIC CERVICAL PLATE OPERATION

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²Department of Orthopaedics, Hospital Tuanku Fauziah, Kangar, Perlis, Malaysia

BACKGROUND
Anterior cervical plates are used to provide stability during decompression and fusion of cervical spine. Anterior dynamic cervical plates have been introduced to improve the fusion rate in anterior cervical surgery. They allow continual axial graft loading in case of graft settling. The objective of this study is to evaluate the radiographic settling properties in patients have received anterior dynamic cervical plate surgery.

METHODS
20 patients who received anterior cervical surgery in year 2009 and 2010 at Hospital Sultanah Bahiyah and Hospital Tuanku Fauziah are included in this study. They are divided into discectomy & fusion group (12 out of 21) and corpectomy & fusion group (9 out of 21). Tricortical iliac bone graft and dynamic cervical plate used in corpectomy group. PEEK (polyetheretherketone) cage and dynamic cervical plate are used in discectomy group. Immediate post operation and 6 months post operation radiograph measured under the parameters of cranial settling, screw position and segmental height. We check the changes of these parameters and compare the findings of both groups.

RESULTS
Anterior cervical corpectomy & fusion group shows significant changes in cranial settling (mean = 1.9mm, p < 0.005) and segmental height (p < 0.05). Anterior cervical discectomy & fusion group shows only significant changes in segmental height (p < 0.005). There is no significant difference between these two groups.

CONCLUSION
Sizing of the tricortical iliac graft is important in anterior corpectomy and fusion group to allow cranial settling and maintain the segmental height. Oversizing of graft is recommended. With the use of appropriate PEEK cage in anterior discectomy group, cranial settling shows no significant changes. Dynamic cervical plate may not be necessary in such surgery.
CSF LEAKS IN SPINE SURGERY. INCIDENCE, RECOGNITION, PREVENTION AND MANAGEMENT

Brian K, Kwon

Department of Orthopaedics, Combined Neurosurgical and Orthopaedic Spine Program, University of British Columbia, Vancouver, British Columbia, Canada

In an era where informed consent takes more and more importance, unintended durotomy is among the most common complication encountered in lumbar spine surgery and is certainly the most frequent cause of cerebrospinal fluid (CSF) leak. CSF leak may also occur secondary to trauma, congenital malformations, or can be spontaneous. Incidence of unintended iatrogenic durotomy varies from below 1% to over 17%, depending on the complexity and type of surgery performed. Several predisposing factors have been recognized in the literature: revision surgery, old age, and experience of the surgeon are among the most often cited ones.

Diagnosis can often be confirmed on clinical examination. MRI, including MRI myelography, is often the first imaging study ordered when diagnosis is in doubt. Other tests, such as CT myelography, radionuclide cysternography, and beta-2 transferrin can also be helpful when clinically indicated. Possible sequelae of dural tears include CSF leak, including pseudomeningocele and CSF fistula, hemorrhage, infection, herniation of neural elements through the defect and associated neural injury. The most common symptoms are related to intracranial hypotension and include orthostatic headache, although recurrent neurological symptoms can also dominate the clinical picture.

Rigorous use of meticulous surgical techniques cannot be overemphasized to avoid causing a dural tear. Treatment must be tailored to each clinical scenario as many factors will impact the final decision including size, location, and timing of durotomy discovery. Treatment options include observation, conservative measures, blood patch, lumbar drain, and definitive surgical repair. When recognized and managed properly intraoperatively, there does not seem to be any impact on final outcome.
Epidural haematomas are a known complication of spinal surgery. Fortunately, clinical significant haematomas that result in neurological deficit are rare. The incidence of significant post-operative spinal epidural haematomas has been reported to range from 0% to 1%. The condition should be suspected in a patient who develops new neurological deficit or symptoms suggestive of cauda equina syndrome in the immediate post-operative period. Due to the small number of patients, the risk factors for developing post-operative haematoma are not well defined. In one series, patients who require multilevel lumbar procedures and/or have a preoperative coagulopathy are at a significantly higher risk for developing a postoperative epidural haematoma. Post-operative chemical thromboprophylaxis did not seem to increase the incidence of developing clinically significant post-operative haematoma. In a recent MRI study, the size of hematoma and the degree of dural sac compression were significantly larger in patients with symptoms needing surgical revision. Dural sac area of less than 75 mm2 in early postoperative MRI was found to be the threshold for clinical significance. Early evacuation of the haematoma leads to better outcome and recovery of neurological deficit. In one series, evacuation of the hematoma within 12 hours resulted in better neurologic outcomes than surgery after 12 hours. Rapid diagnosis and early surgical treatment can maximize neurological recovery.
Spinal deformity surgery will cause a significant blood loss. All effort should be made to prepare for the loss, conserve and avoid blood loss, and appropriately replace the loss.

**PREPARATION FOR BLOOD LOSS**
- Autogenous blood donation
- Allogeneic blood reserved
- Improve the general metabolic condition of the patient
- Maintain high HB (erythropoietin protocol)
- Normalize the coagulation profile
- No Aspirin and NSAID prior to surgery
- Iron administration before and after surgery

**INTRA-OPERATIVE**
- Positioning (free abdomen) on four posters frame
- Hemodilution
- Hypotension anesthesia (mean pressure 65-70)
- Meticulous tissue dissection and hemostasis
- Use of cell saver
- Use of antifibrinolytic therapy (tranexamic acid, amicar, aprotonin is off the market)
- Be aware of disseminated intravascular coagulopathy DIC and replace with fresh frozen plasma and possibly platelets transfusion
- Maintain reasonable level of HB (>8) and HTC (>24) with Autogenous or if necessary with allogeneic blood transfusion

**RISKS OF ALLOGENEIC TRANSFUSION**
- Transfusion reaction
- Graft vs. host disease
- Transfusion-related immunomodulation (TRIM)
- Transfusion-related acute lung injury
- Metabolic and coagulation disturbance and imbalance
- Massive transfusion, Increase the incidence of infection

**IN SUMMARY**
Patient preparation before surgery, meticulous surgical technique, blood conservation, intraoperative hypotension and the use of antifibrinolytic agents will decrease the need for allogeneic transfusion.
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<td>²Neurosurgical Division, Department of Surgery, Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia</td>
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<td>³Department of Radiology, Kulliyyah of Medicine, International Islamic University Malaysia, Kuantan, Pahang, Malaysia</td>
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PO 16  Outcome Of Percutaneous Pedicle Screw Fixation And Instrumentation In Spine Infections  
A M Abdelhai, C K Chiu, C Y W Chan, L B Saw, M K Kwan  
Department of Orthopaedic Surgery, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia

PO 17  Biomechanical Review Of Rod-Screw Interface In Withstanding Torque – A Comparison Between Different Pedicle Screw Systems  
K G Premganesh¹, C Y W Chan¹, L B Saw¹, M K Kwan¹, C C Wong²  
¹Department of Orthopaedic Surgery, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia  
²Department of Orthopaedic, Hospital Umum Sarawak, Kuching, Sarawak, Malaysia

PO 18  Symptomatic Calcifying Pseudo Tumor Of Thoracic Spine Which Resolved With Indomethacin Treatment. A Case Report  
A M Abdelhai, C Y W Chan, L B Saw, M K Kwan  
Department of Orthopaedic Surgery, Faculty of Medicine, University of Malaya, Kuala Lumpur, Malaysia
EARLY POSTERIOR FIXATION OF SPINAL FRACTURES IN CONCOMITANT THORACOLUMBAR FRACTURES AND PELVIC RING DISRUPTION: A REVIEW OF 2 CASES
S M Tan, G K P Liu
National University Hospital, Singapore

OBJECTIVES
To describe the rationale and operative technique used in the treatment of unstable spinal injuries in patients with concomitant pelvic ring injuries treated with pelvic external fixators.

METHODS
A retrospective review of two patients with concomitant thoracolumbar fractures and pelvic ring injuries treated in a Level 1 Trauma Centre. We describe the operative technique and measures taken in preparing the patients with pelvic external fixators for posterior approach to spinal stabilization. The external fixator was re-tightened and the stability of the construct tested to ensure the pelvic ring remains intact before proceeding to turn the patient prone. Jelly bolsters were used to support the external fixator when the patient adopts a prone position. An Amscol (radiolucent) table was used to allow imaging for confirmation of the position of the external fixator before and after spinal surgery. Using a log roll method with the anesthetist protecting the airway, we turned the patient to a prone position. Upon completion of surgery, the patient was turned supine with the pelvic external fixator. The external fixator was retightened in the operating suite and its position together with the integrity of the pelvic ring confirmed with fluoroscopy before transferring the patient.

RESULTS
Both patients underwent spinal stabilization via a posterior approach in prone position with pelvic external fixators. They were able to achieve early mobilization post-operatively with no significant bed-bound complications.

CONCLUSION
Early spinal stabilization in polytrauma patients have been shown to improve mortality and morbidity outcomes. This review illustrates a technique that allows spinal stabilization to be carried out using a posterior approach in the presence of a pelvic external fixator. With the understanding of the biomechanical aspects of pelvic external fixators, we recommend the technique described to be performed in patients with concomitant thoracolumbar fractures and Type B pelvic fractures.
Primary Ewing’s Sarcoma of the Lumbosacral Area: A Case Report

Zamzuri Zakaria¹, Mohd Adham Shah Ayeop¹, Mohamed Saufi Awang², Azian Abd Aziz³, Fadhli Mustaffa⁴

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Ewing sarcoma is a miscellaneous tumor first discovered by James Ewing 1921. It is more common in bone or skeletal compared to soft tissue or extra osseous Ewing sarcoma. Among soft tissues Ewing’s, spinal cord involvement is even rarer with minority number of published reported case in the literature. We report a case of 9 year-old girl presented with low back pain for 2 months following a fall and progressive neurological deficit of bilateral lower limb. Magnetic resonance imaging suggestive of well define margin of intradural of extramedullary tumor. With probable nerve sheath tumor in mind, surgical excision with laminectomy L2-S1 was performed. Intraoperatively revealed an extradural mass from L3-L5 with extension to bilateral neuroforamen. Histopathology report defines a round cell tumor of Ewing’s sarcoma from the mass.

KEYWORD
Extradural, Ewing’s sarcoma, primary spine tumor, cord compression.
TRANSORAL ENDOSCOPIC EXCISION OF AXIAL CHORDOMA: A CASE REPORT
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BACKGROUND
Chordoma is a rare primary malignant tumour of nototochordal origin. It is slow growing; locally invasive however may metastasize to the other organs. It is refractory to chemotherapy and radiation therapy making surgical excision the only treatment to improve the patient’s survival. Upper cervical chordoma is even rarer and poses unique challenges to the surgeons. Currently, transcervical approach is the most widely performed technique to approach the area and has been accepted as the standard procedure among the spine surgeons. To our knowledge, there is no report on the usage of Destandau endoscopic technique to excise the tumour using this approach.

CASE REPORT
We report a 44-year old Malay lady who presented to us with a one month history of insidious onset of neck pain without neurological symptoms, dysphagia or evidence of metastasis. A pre-operative diagnosis of chordoma involving C2 was made based on MRI findings and later confirmed by histopathological examination.

She initially underwent posterior C1-C4 instrumented fusion (B Braun Surgical system) and followed by transcervical endoscopic excision of the odontoid in two stages. Intralosomal excision of the tumour was performed transcervically using Destandau endoscopic system (Storz, Germany) through a 3.0cm incision. Satisfactory intralosomal excision of the tumour was successfully achieved. There were no neurovascular complications and infection following the surgery. The blood loss was 350 ml and the duration of surgery was 9 hours. She underwent adjuvant radiotherapy to minimize local recurrence.

CONCLUSION
Endoscopic excision of upper cervical chordoma using Destandau endoscopic system has not been reported. Based on our experience of lumbar decompressive surgery using this technique, excision of upper cervical tumour was successfully performed. Though the technique involves a steep learning curve; it is a surgical option for transcervical approach to the upper cervical spine, which provides an excellent magnified view and ease of resection.
INTRODUCTION
High-grade spondylolisthesis is extremely rare. Mostly due to congenital dysplasia of the superior articular process of the sacrum. Traumatic spondylolisthesis of the lumbar spine is uncommon and can result in canal narrowing and spinal cord injury. Traumatic L5 over S1 spondyloptosis without neural involvement is hard to find in literature.

METHODS
32-year-old manual laborer came with injury to his back while at work due to fall of a heavy object on his flexed back. No treatment was taken except for analgesics for a week or two. He presented to us with persistent deformity in the back, back pain on prolonged standing and moderate work, unable to return to his job after accident. Examination revealed a large step in lower lumbar region. Detailed neurological evaluation of lower limbs didn’t reveal sensory or motor deficit. There was no perineal hypoesthesia or other features suggestive of involvement of bowel/bladder. Radiography revealed L5 over S1 traumatic spondyloptosis. CT scan showed normal wide neural canal. MRI showed spondyloptosis of L5 over S1 without any compromise of the spinal canal with normal looking cauda. Keeping in view, the delayed presentation and no neurological deficit, the patient was managed conservatively.

RESULTS
We followed up this patient clinically and radiologically for progression of deformity and for development of any neural sign and symptoms (a through sensory and motor examination including perineal sensation, function of the bladder and rectal tone). Patient returned back to his work at 6th month and was free from back pain at 15 months.

CONCLUSION
We present a unique case of L5 over S1 traumatic spondyloptosis with normal neurology. Pathomechanism is thought to be a flexion type injury. Surgery as a high rate of complication in spondyloptosis, so resorting to more conservative means of treatment for late presentations, can lead to satisfactory outcome.
A NOVEL TECHNIQUE OF USING CONTRAST ENHANCED TRANSPEDICULAR BONE GRAFTING IN UNSTABLE TRAUMATIC BURST FRACTURE

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BACKGROUND
Current methods of posterior spinal fusion with transpedicular bone grafting in unstable traumatic thoracolumbar burst fractures remains doubtful. We employ a new method of transpedicular bone grafting which is safer and more precise.

OBJECTIVES
The aim of this article is to describe a modified technique of transpedicular bone grafting using contrast impregnated cancellous bone.

STUDY DESIGN
Surgical technique article with a case illustration.

METHODS
A 36 year-old man sustained traumatic burst fracture of T12 vertebra. His Load-Sharing Classification (LSC) score was 8. He was treated with posterior short segment fusion from T11 to L1 with contrast enhanced transpedicular bone graft of T12 vertebra.

RESULTS
We are able to correct the kyphosis from 19º to 1.4º. Anterior bone graft augmentation was achieved with transpedicular bone grafts. At six months follow up, good bony integration of the anterior column was achieved with maintenance of the anterior vertebral body height.

CONCLUSIONS
With contrast enhanced transpedicular bone grafting technique, a safe and adequate anterior column reconstruction can be achieved. This will allow a more ideal posterior fusion surgery requiring less instrumentation thus saving more motion segments.
THE USE OF INTRA-OPERATIVE CT GUIDED COMPUTER NAVIGATION IN SEVERE DEFORMITY: EFFICACY AND ACCURACY – AN ANALYSIS OF 47 SCREWS IN SEVERE SCOLIOSIS (COBB> 90°)
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BACKGROUND
Severe scoliosis is a surgical challenge requiring tremendous skills to achieve correction which improves both appearance and lung function. Correction has the risk of neurological deficit due to implant malposition and over enthusiastic correction. Accurate screw placement is the key to strong correction maneuvers. Computer navigation has been proven effective in increasing accuracy of pedicle screw placement in multiple studies. However, its efficacy and accuracy in severe scoliosis has not been evaluated.

OBJECTIVES
To study the accuracy of pedicle screw placement in severe scoliosis (Cobb>90°).

METHODS
3 Patients with severe scoliosis (Juvenile idiopathic-1, Marfan’s syndrome-1, Neurofibromatosis-1) were operated between Sept 2010 and Nov 2010 in the iOR (Intelligent Operating Room, Brainlab, Germany) at our institution. The iOR is similar to the Brain Suite with a CT scanner (Seimens, Somatom Emotion, 6 slice, Germany) and Computer navigation compatible. All patients underwent CT scans of the ROI after exposure and pedicle screws (n=47) were inserted with navigation assistance. All patients underwent CT scans post operatively to assess screw placement.

RESULTS
We classified pedicle breech as Grade 0- No breach, Grade 1-Breach <2 mm(only threads outside the pedicle), Grade 2- Breach 2-4 mm(core diameter of screw outside pedicle) and Grade 3- Entire screw outside pedicle. 39 screws were well placed with no pedicle breach. There were 4 screws with a Grade 1 and 4 screws with a Grade 2 breach. We were also able to identify dysplastic pedicles and change our anchor plan as well as plan in-out-in screws with navigation assistance.

CONCLUSIONS
Intra-operative CT based navigation is a useful tool providing real time information of pedicle anatomy in severe scoliosis. CT based navigation provides distinct advantages like an unlimited ROI and excellent imaging clarity.
FRACTURE AS AN OPPORTUNITY FOR CORRECTION OF CERVICAL DEFORMITY IN ANKYLOSING SPONDYLITIS
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We present a case of ankylosing spondylitis with flexion deformity of the cervical spine presenting with an acute fracture through the ossified c5/6 disc upto the posterior element of the cervical spine without any neurological deficit. Correction of the deformity was achieved via anterior approach, placement of a wedge shaped iliac crest tricortical graft and a long 91 mm anterior cervical plate from C3 to T1. The fracture was united at 3 months post operatively with correction of deformity and horizontal gaze for the patient. There were no previous report of deformity correction anteriorly using a fracture as an opportunity.
A Hydrolift is an expandable cage using water pressure to expand the cage smoothly. It was designed for anterior insertion via an anterolateral approach. By angulating the end plates of the cage to 45 degrees, we were able to use the cage for posterior insertion after an all posterior vertebrectomy. The water powered expansion of the cage allows us to correct the deformity and restore the correct height of the vertebrae without further risking of kinking of the spinal cord from a smaller cage insertion which is common when doing all posterior vertebrectomy. As the cage expands using water it also avoids fiddling with mechanical parts of cages and further reduce chances of spinal cord injury.
SPINAL TUBERCULOSIS TREATED WITH ALL POSTERIOR INSTRUMENTATION, DEBRIDEMENT AND ANTERIOR RECONSTRUCTION

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OBJECTIVE
We study the surgical results of single-stage posterior surgical procedure performed in our hospital and propose single-stage posterior surgical approach, laminectomy and anterior debridement with or without anterior reconstruction with transpedicular instrumentation as an alternative operative method for spinal tuberculosis.

METHODS
We study 20 patients who were suspected to have spinal tuberculosis clinically with suggestive radiological finding were treated with posterior decompression, debridement and transpedicular instrumentation that was supplemented with posterolateral bone fusion and chemotherapy.

RESULTS
Spinal tuberculosis was clinically cured. Improvement of kyphotic deformity. The visual analog scale improved and Frankel grade of neurology improved in majority of cases. There was no persistence or recurrence of infection possibly related to the instrumentation. The kyphosis was significantly corrected after surgical management. However, the loss of correction also occurred. The functional outcome was good.

CONCLUSIONS
In our experience, the single stage posterior approach is a useful treatment for moderate to severe spinal tuberculosis. It brought improvement in neurologic status and kyphotic angle. However, complication may occur such as worsening neurology, bleeding intraoperatively and surgical wound infection.

KEY WORDS
Spinal tuberculosis, transpedicular instrumentation, posterior surgery.
GROWING ROD FIXATION IN A CONGENITAL SCOLIOSIS COMPLICATED WITH TRANSIENT PARAPLEGIA: A CASE REPORT OF A FALSE NEGATIVE SOMATOSENSORY EVOKED POTENTIAL AND COMPOUND MOTOR EVOKED POTENTIAL

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Somatosensory and Motor evoked potential (SSEP, MEP) are the common intraoperative neurophysiologic monitoring of the spinal cord function. We report a case of a posterior distraction instrumentation of a congenital scoliosis complicated by transient paraplegia despite a normal monitoring of the spinal cord by SSEP and MEP of both cortex.
PERCUTANEOUS VERTEBROPLASTY FOR SYMPTOMATIC OSTEOPOROTIC VERTEBRAL COMPRESSION FRACTURE ADJACENT TO LUMBAR INSTRUMENTED CIRCUMFERENTIAL FUSION

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BACKGROUND

Few studies have investigated adjacent vertebral compression fractures (VCFs) and their management following spinal fusion surgery for degenerative lumbar disease. The purpose of this study was to evaluate the efficacy and safety of percutaneous vertebroplasty (PV) for treating patients with symptomatic osteoporotic VCFs adjacent to lumbar instrumented circumferential fusion.

METHODS

We retrospectively reviewed 18 patients with osteoporotic VCFs following lumbar instrumented circumferential fusion. All of the patients received PV with polymethylmethacrylate bone cement augmentation. Radiography and magnetic resonance imaging were used for imaging studies. The visual analogue scale (VAS) and modified Brodsky’s criteria were used to compare clinical outcomes before and after surgery. The minimum follow-up period was 18 months (range, 18 to 39 months).

RESULTS

All patients were diagnosed with osteoporosis on the basis of the results of dual-energy X-ray absorptiometry examination. One level PV was performed in 13 patients and 2 levels were performed in 5 patients. The patients’ VAS scores improved by an average of 53 points after the surgery. Fifteen patients returned to their pre-injury activities of daily living. The average restoration of the fractured vertebral body height was 12.1%. No surgery related complications occurred except asymptomatic cement leakage in 3 patients.

CONCLUSIONS

Elderly patients undergoing lumbar instrumented fusion surgery should be informed of the possibility of adjacent VCFs. PV is a minimally invasive and effective procedure to treat such adjacent segment disease. Postoperative patient care and medication for osteoporosis are mandatory to maintain good long-term results.
BIOMECHANICAL ASPECTS OF A NOVEL BIOMATERIAL FOR INTERVERTEBRAL CAGE: FINITE ELEMENT STUDY

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BACKGROUND
Biomaterials that are used for the production of cages have enough mechanical support. But direct osteointegration between the host bone and material may not be observed. Bioglass is a biocompatible and strong material that can bear physiological loads.

OBJECTIVES
Aim of the study is to design a novel bioglass lumbar interbody cage.

METHODS
Bioglass contains hydroxyapatite 47.5%, pseudowollastonite 47.5 % and frit 5 % CaHA powder was produced by sintering. Compression test was done with Instron testing machine and elastic modulus of the material was found. Bioglass cage was produced in four different geometry (K1, K2, K3, K4). L3, L4, L5 lumbar vertebrae were modeled and converted to surface model. Then the solid model was constructed and transferred to Ansys 12.0.1. After finite element modelling of the lumbar spine, posterior discectomy and posterior instrumentation model was simulated. Axial compression, bending, flexion, extension forces were applied to all cage designs and statistically compared.

RESULTS
Elastic modulus of the bioglass was calculated 32 GPa after compression test of the prototype cage. Prototype cage was loaded 25 kN in the FEM. When Von Misses graphics were analysed high values which exceed the mechanical capacity were seen in a small area. Mostly, compression values were between 80-120 MPa. These results overlap the real compression test results The best biomechanical performance were detected in K2 model.

CONCLUSIONS
When biomechanic performance and graft space availability evaluated K2 model was found to be the most promising cage model. Failure may not be seen even loads greater than 5 kN. Bioglass is a promising material for producing of the intervertebral cage.
Dumbbell tumours present with both paraspinal and intraspinal components, and mostly neurogenic in origin. These tumour masses are usually connected through the enlarged intervertebral foramen. Neurofibroma and schwannoma are 2 types of neurogenic tumour that can give rise to dumbbell appearance. Of these two, neurofibroma is less common. Management of these tumours can be challenging due to difficult surgical exposure and tumour resection.

We present 2 cases of dumbbell tumours involving cervical and thoracic spine. Both of these cases presented with severe paralysis. MRI findings showed compression of the spinal cord in both cases. They underwent decompression, tumour resection and instrumented fusion via anterior approach. Surgical techniques and intra-operative findings are described and discussed.
RADIOLOGICAL EVALUATION OF THE MORPHOMETRY OF PEDICILE RIB UNIT TO PEDICILE IN THE THORACIC SPINE: A COMPARISON BETWEEN MALAY, CHINESE AND INDIAN

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BACKGROUND CONTEXT
Thoracic pedicles are small and its anatomy is complex especially in mid thoracic region. Therefore it is crucial to become familiar with the morphometry and safety of transpedicular and extrapedicular screw fixation.

OBJECTIVE
This study was designed to evaluate and compare the anatomical parameters of thoracic vertebrae in relations to their pedicle and pedicle rib unit between Malay, Chinese and Indian race for safe insertion of transpedicular and extrapedicular screw fixation.

METHODS
A total of 2160 pedicles (1080 thoracic vertebrae) from 90 patients (45 male and 45 female) were used for analysis. There were 30 Malays, 30 Chinese and 30 Indians respectively. Twelve parameters were measured after converting the CT scan images into 3D anatomical structures using the software Mimics® version 14.1 (Materialise, Belgium): the transverse outer and inner pedicular diameter, medial and lateral pedicle cortical thickness, chord length and angle of the pedicles, pedicle rib unit width, chord length and angle of pedicle rib units, outer and inner sagittal pedicle diameter, and sagittal angle.

RESULTS
The mean age of the patients were 49.0 years and ranged from 24 to 65 years. The narrowest transverse outer pedicular diameter was at T4 (malay male 4.5±0.7mm and female 4.2±0.5mm, Chinese male 5.0±1.3mm and female 4.3±0.7mm, and Indian male 4.6±0.9mm and female 3.7±0.8mm), while the narrowest pedicle rib unit width was at T4 for Malay male and female (12.9±1.4mm and 11.4±1.0mm), Chinese male and female (14.1±1.4mm and 11.5±1.2mm), and Indian female (10.5±1.4mm), and at T5 vertebra for Indian male (13.7±1.7mm). For chord length, the shortest was at T3 for all study specimens (Malay male 35.0±2.4mm and female 29.8±2.6mm, Chinese male 36.3±3.1mm and female 30.3±2.3mm, Indian male 30.9±3.2mm and female 29.7±2.4mm) while for pedicle rib unit chord length, the shortest was at T1 (Malay male 50.0±2.2mm and female 44.8±1.7mm, Chinese male 50.1±2.3mm and female 46.2±1.9mm, and Indian male 48.8±2.0mm and female 43.7±2.1mm). For both transverse pedicular angle and pedicle rib unit angle, T1 has the largest angle (range 32.5 to 35.2 degree and 47.2 to 50.2 degree respectively). For sagittal angle, T1 has the smallest angle (range 2.7 to 4.1 degree) in all study specimens.

CONCLUSION
Special care must be taken during application of transpedicular screws in Asian population. Extrapedicular screw fixation is feasible and should be considered as an alternative if there is high risk of medial cortical wall violation especially at the mid thoracic region.
BACKGROUND
There are several methods of determining the lowest instrumented vertebra (LIV) in selective thoracic fusion in Lenke types IA and IB (Kings III and IV) adolescent idiopathic scoliosis curves. Suk et al, Lenke et al and Luk et al suggested that lowest fusion levels can safely be higher than stable vertebrae if certain conditions are observed.

OBJECTIVES
The aim of this study is to compare between different methods of selection of the lowest instrumented vertebrae in selective thoracic fusion.

STUDY DESIGN
This is a retrospective study with radiographic assessment and measurements.

METHODS
Patients with Lenke types IA and IB (Kings III and IV) curves were selected to be included in this study. The radiographs of these patients were used to derive the needed data and measurements to determine the lowest fusion level for each respective method. Data collected were tabulated and comparison made descriptively and statistically. Salvage levels (defined as the number of spared fusion levels from the stable vertebrae; SV-LIV) were measured for each method.

RESULTS
Twenty eight patients (24 females and 4 males) with the mean age of 15.0 ± 2.38 were selected into this study. The salvage levels for Suk et al was 1.57 ± 0.92 (p<0.05), Lenke et al was 1.25 ± 0.65 (p<0.05) and Luk et al was 1.29 ± 1.24 (p<0.05).

CONCLUSIONS
All methods showed significant conservation of spinal motion segments of at least one level compared to the conventional recommended lowest fusion level to the stable vertebrae.
OUTCOME OF PERCUTANEOUS PEDICLE SCREW FIXATION AND INSTRUMENTATION IN SPINE INFECTIONS

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BACKGROUND
Conventional posterior surgical approach to treat patients with spinal infection and neurological deficits involves a large exposure. This is to allow instrumentation, posterior decompression and debridement to be done. Percutaneous pedicle screw fixation allows the posterior decompression and debridement wound to be smaller in size and separated from the pedicle screw sites.

OBJECTIVES
The aim of this article is to describe the treatment outcome of spinal infection patients with neurological deficit who had percutaneous pedicle screw fixation, instrumentation and minimal exposed posterior decompression and debridement.

STUDY DESIGN
This is a retrospective study looking into the neurological improvement and radiological union rate of percutaneous pedicle screw fixation used in spinal infections.

METHODS
Patients diagnosed of spinal infection with neurological deficits who had surgery done from June 2009 to June 2011 were included in this study. Their records were traced and their radiographs and imaging were reviewed. Neurological deficits were classified using the Frankel classification. Radiological union is considered achieved when a solid bony bridge or bar is noted across the affected site. The amount of lordosis or kyphosis was also measured before and after the surgical procedure.

RESULTS
A total of 20 patients were initially identified including 11 men and 9 women with a mean age of 59.19 years. The primary diagnosis was Tuberculosis of the spine in 12 patients and the rest 8 patients were pyogenic discitis. The predominant sites of infection were in dorsal spine T4 to T12, 14 patients and in Lumbar spine 6 patients. Approximately all of patients presented with instability back pain, they reported neurological affection of the lower limb those with infection in the thoracic region presented with Frankel C 5 patients, Frankel B 2 patients, Frankel D 2 patients and non of them with Frankel E or A. Those with the Lumbar spine infection their main presentation was instability. On regular follow up they showed improvement to Frankel D 6 patients, Frankel E 2 patients, Frankel B one patient.

TB organism was isolated in 6 patient (out 12 patients suspected TB spine), 3 patients were S.Aureus, one patient MRSA, one patient E.coli and negative results in the rest of the patients (9 patients). 7 patients needed bone graft, 2 patients needed cage. All patients, during followed up, showed clinical improvement, the pain disappeared, CT scan showed good fusion in 18 patients, non union in 2 patients, deep infection in 2 patients necessitated longer hospital stay. One patient died after 9 month of cardiac disease. One patient had metal failure planned for open revision.

CONCLUSIONS
We found that percutaneous pedicle screw fixation is a feasible instrument to be used in spinal infection with benefits of containment of infective material contamination.
BIOMECHANICAL REVIEW OF ROD-SCREW INTERFACE IN WITHSTANDING TORQUE – A COMPARISON BETWEEN DIFFERENT PEDICLE SCREW SYSTEMS
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INTRODUCTION
The aim of surgical intervention in adolescent idiopathic scoliosis is mainly to prevent curve progression and to improve body image. Factors which would improve the body image of patients with scoliosis include better truncal balance, head and neck balance as well as reduction of the rib hump. Reduction of rib prominence can be achieved by derotation of the thoracic curve. Forceful derotation of the vertebrae can lead to failure of the construct at either the screw bone interface or the rod screw interface. So far no study has been carried out to analyse the ability of the rod screw interface in withstanding derotation torque in view of these newer derotation manoeuvres.

MATERIALS AND METHODS
This is a biomechanical investigation into six different pedicle screw systems used for scoliosis surgery and were tested for stiffness against torque, load to failure of the different rod screw interface, as well as the ability of the rod screw interface to withstand rotational torque after repetitive tightening and loosening of the locking nuts. 4 screws from each system were tested and independent Anova tests were carried out to determine statistical significance.

RESULTS
The stiffness of the 3 systems with 5.0 mm rods were 503.4 (+- 42.0) Nmm, 224.5 (+- 59.0) Nmm, 236.9 (+- 91.7) Nmm respectively while for the 6.0 mm rod system the stiffness were 900.8 (+- 96.9) Nmm, 558.7 (+- 63.3) Nmm and 361.9 (+- 78.3) Nmm respectively. The load to failure of the 5.0 mm rod system were 361.3 (+- 27.7) N, 274.9 (+- 41.3) N, and 237.6 (+- 6.4) N respectively. The load to failure of the 6.0 mm rod system were 627.0 (+- 14.4) N, 348.0 (+- 6.1) N, and 395.0 (+- 41.3) N respectively. There were significant differences between stiffness and load to failure of 5.0 mm rod and 6.0 mm rod systems. Significant differences also exist within different systems utilizing 5.0 mm rod as well as within systems utilizing 6.0 mm rod. Factors which could lead to the difference between the various spinal systems were also reviewed.

CONCLUSION
In conclusion, the rod screw interface of spinal systems utilizing 6.0 mm rods have better stiffness and load to failure properties in withstanding rotational torque compared with systems utilizing 5.0 mm rods. Variations in properties of the locking of the rod screw interface in each system also contribute towards better stiffness and load to failure properties.
SYMPTOMATIC CALCIFYING PSEUDO TUMOR OF THORACIC SPINE WHICH RESOLVED WITH INDOMETHACIN TREATMENT. A CASE REPORT

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Calcifying pseudo-tumor of the thoracic spine is a very rare condition. The nature of the disease condition still remains unknown. This lesion has a tumor-like behavior and has been postulated to be a form of inflammatory condition.

A 48-year-old man presented with severe left T9 radicular pain for two months. The pain was so severe that it disturbed the patient sleep. Clinically he has no myelopathy signs. CT and MRI scans showed an intracanal calcified mass over the T9/10 level compressing the left side of the spinal cord and exit nerve root. The patient was treated conservatively with Indomethacin 25mg TDS for a duration of 8 weeks. His radicular pain resolved after 72 hours of Indomethacin treatment.

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