

E-Poster #1

Artificial Disc Versus Fusion: A Prospective, Randomized Study with 2-Year Follow-Up on 99 Patients

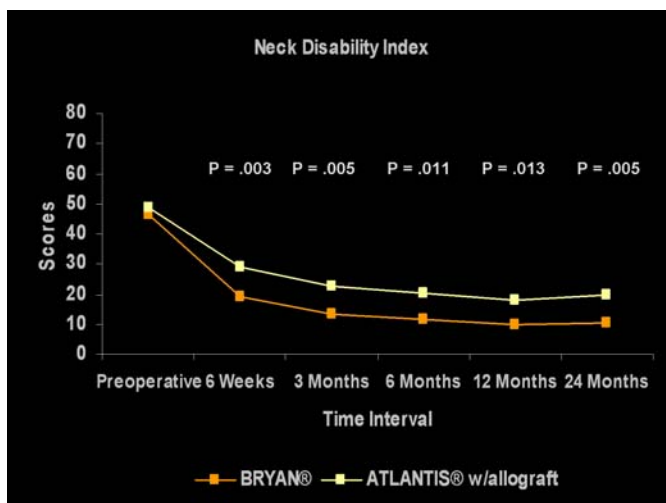
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Introduction: This study is a pooled data set from three centers involved in the United States FDA IDE trial evaluating the Bryan artificial cervical disc.

Methods: 115 patients were randomized in a 1:1 ratio to a Bryan artificial disc replacement (56) or an anterior cervical fusion with allograft and a plate (59). 12 month follow-up is available for 110 patients and 24 month follow-up complete for 99 patients. Disability and pain were assessed using the Neck Disability Index (NDI) and the Visual Analog Scale (VAS) of the neck and arm pain.

Results: The Mean (NDI) preoperatively was 47 (Bryan) and 49 (control). 12 month follow-up NDI 10 (Bryan) and 18 (control) ($p=0.013$). At 2-year follow-up NDI for the Bryan group 11 and control group 20 ($p=0.005$). The mean arm pain VAS preoperatively was 70 (Bryan) and 71 (control). At 1-year follow-up Bryan arm pain VAS was 12 and control 23 ($p=0.031$). At 2-year follow-up the average arm pain VAS for the Bryan group was 14 and control 28 ($p=0.014$). The mean neck pain VAS preoperatively was 72 (Bryan) and 73 (control). 1-year follow-up scores were 17 (Bryan) and 28 (control) ($p=0.05$). At 2-years: 16 (Bryan) and 32 (control) ($p=0.005$). SF-36 scores: Physical component- Preoperatively Bryan-34 and control 32. At 24-months: Bryan-51 and control-46 ($p=0.009$). More motion was retained in the disc replacement group than the plated group at the index level. ($p < 0.006$ at 3, 6, 12, and 24 months) The disc replacement group retained an average of 7.9 degrees at 24 months. In contrast, the average range of motion in the fusion group was 0.6 degrees at 24 months. There were no intraoperative complications. No vascular or neurologic complications. There were no spontaneous fusions, no device failures or explantations in the Bryan cohort.

Conclusion: The Bryan artificial disc replacement compares favorably to anterior cervical discectomy and fusion for the treatment of patients with cervical radiculopathy. At two years follow-up there are statistically significant improvements in the neck disability index, the neck pain and arm pain visual analog pain scores, and the SF-36 physical component score.



neck disability index scores

E-Poster #2

Effect of Obesity on Clinical Outcomes Following Lumbar Fusion

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Introduction: A growing health care crisis in the U.S., obesity is associated with low back pain. Symptoms in obese patients may be summarily dismissed as weight-related, even when structural spine problems are present. Surgeons may also be hesitant to perform surgery on obese patients due to a pre-conceived notion of limited improvement and substantial risk of complications. The purpose of this study is to compare patient outcomes in obese and non-obese patients undergoing lumbar fusion for degenerative lumbar spine conditions.

Methods: Prospectively collected pre-operative and two-year post-operative SF-36 PCS, ODI, back pain and leg pain Numeric Rating Scores (NRS) from 270 patients who had lumbar fusion for degenerative conditions were identified. Patients were classified as Obese (BMI>30) or Non-obese (BMI<30). These two groups were compared based on clinical outcome and complication rate.

Results: There were 109 Obese and 161 Non-obese patients. Patients in both groups demonstrated significant improvements in SF-36 PCS, ODI and back and leg pain NRS ($p<0.001$) at two year follow-up compared with pre-operative. Both SF-36 PCS ($p=0.037$) and ODI ($p=0.028$) at two-years were better in the Non-obese patients compared with the Obese patients. There was no significant difference in the mean improvements seen in Obese patients compared to Non-obese patients with respect to SF-36 PCS, ODI and back and leg pain NRS. Overall complication rates did not differ between the two groups. However wound-related complications were more common in the Obese patients ($p=0.019$).

Conclusion: Obese patients undergoing lumbar fusion achieve similar benefits to non-obese patients. Wound related complications are more common in obese patients.

Significance: Obese patients with evident indications for lumbar fusion should not be denied this procedure due to their weight. Their improvements in pain and health-related outcomes measures can be expected to be similar to the overall population.

E-Poster #3

Comparison of Single-level versus Multi-level Charité Lumbar Total Disc Replacement - 289 Consecutive Prosthesis in a Prospective 6-Year Follow-up Study.

Dr. Geoffrey Lesage, (ZNA Middelheim Hospital); Dr. Robert Hes; Dr. Bart Conix; Dr. Guido Dua

Introduction: Lumbar total disc replacement (TDR) has proven to be a viable alternative to fusion, with preservation of motion and good clinical results in patients with severe low back pain due to degenerative disc disease.

Methods: This is a 6-year follow-up lumbar TDR series of 346 3rd generation Charité prosthesis implants. 289 patients presenting with severe discogenic low back pain were diagnosed with DDD of the lumbar spine through standardised preoperative investigations: MRI, x-ray, bone scintigraphy and provocative discography. 225 patients required single-level arthroplasty and 60 patients required multi-level surgery - double level: 59 cases; three level: 1 case. Pre and postoperative clinical results were measured with Visual Analogue Scale (VAS) for leg and back pain and with the Oswestry Disability Index (ODI) score.

Results: No infection was noted, no iatrogenic neurological damage was seen in either of the 2 groups. Mean (SD) VAS change for leg pain in the multi-level group was -4.00 (3.80) ($p < 0.0001$) (preoperative: 5.53 (3.15), at last follow-up: 1.53 (2.41)). Mean (SD) VAS change for back pain in the multi-level group was -5.47 (3.22) ($p < 0.0001$) (preoperative: 7.31 (2.14), at last follow-up: 1.85 (2.41)). ODI (SD) score went down in the multi-level group from 44.66 (18.83) preoperatively to 13.21 (15.13) postoperatively ($p < 0.0001$). VAS leg and back pain and ODI scores improved similarly in the single-level group (-3.53 (3.70), -5.66 (3.18) and -32.71 (22.85) respectively). In both groups there were statistically significant decreases in leg pain, back pain and ODI between preoperative and last follow-up scores.

Conclusion: This prospective study of lumbar TDR showed no statistically significant differences between changes in leg, back and ODI scores from pre-surgery to last follow-up between patients who had multi-level or single-level surgery ($p = 0.48, 0.68$ and 0.71 , respectively). Complication rate was not augmented when more levels were operated on. This illustrates that multi-level TDR (2-level as well as 3-level) is a save alternative to spinal fusion in patients with multiple level DDD with very good clinical results.

E-Poster #4

Prospective Study of Postoperative Lumbar Epidural Hematoma: Incidence and Risk Factors

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Introduction: Postoperative epidural hematomas have been identified in up to 100% of asymptomatic patients following open microdiscectomy. No prospective study of postoperative hematoma and thecal sac compression has been performed following lumbar decompression surgery with or without fusion.

Methods: Preoperative MRI and clinical data including 10 identified pre- and intra-operative risk factors were prospectively collected on 50 consecutive patients undergoing lumbar decompression surgery with or without fusion. Postoperative MRIs were performed on all patients within 3-5 days of surgery. Thecal sac cross sectional area (CSA) was calculated at each disc space using digital imaging software. Pre- and postoperative CSAs were compared at each level. Relative compression due to hematoma was calculated at all levels where postoperative CSA was smaller than preoperative. Volumes of compressive hematomas were calculated. Multivariate analysis was performed to determine which risk factors correlated with postoperative hematoma volume.

Results: The incidence of soft tissue hematoma was 100%. Despite decompression, 64% of patients actually had a smaller thecal CSA at one or more levels postoperatively secondary to hematoma formation. No patient had new post-operative neurologic deficits. The mean number of levels decompressed was 2.0, with hematoma extension over a mean 2.4 levels. Maximal compression occurred at a non-decompressed level in 62% of patients with compressive hematomas. Multivariate analysis demonstrated correlations between preoperative INR, number of levels decompressed and hematoma volume.

Conclusion: Despite decompression, the majority of asymptomatic patients actually have a smaller thecal sac CSA at one or more levels after surgery than before, secondary to a postoperative hematoma. Maximal compression due to hematoma occurred most often at a non-decompressed level.

Significance: These findings may facilitate interpretation of postoperative MRIs. The potential clinical consequence of adjacent level compression may be important when planning the cephalo-caudal extent of operative decompression.

E-Poster #5

Prospective Study of Post-Operative Lumbar Epidural Hematoma: Does Size Really Matter?

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Introduction: Epidural hematomas are common after lumbar surgery. Most are asymptomatic. Among symptomatic patients, a classic progression from sharp peri-incisional pain to bilateral neurologic deficits has been described. No prior study has correlated MRI hematoma features with postoperative symptoms. We propose and evaluate a new measurement (the critical ratio) to assess the extent of compression by hematoma and the potential for symptom development.

Methods: The study population consisted of 3 patient groups who underwent MRI evaluation within 3-5 days of lumbar decompression with or without fusion. Fifty consecutive patients on whom MRI data was prospectively collected comprised the “asymptomatic” group. No patient developed severe post-operative pain or neurologic deficit. Eleven additional patients who had developed immediate post-operative symptoms within the last 24 months were identified within our institutional database. The “painful” group included 6 patients with severe peri-incisional pain without neurologic deficit. The “cauda equina” group included 5 patients with post-operative cauda equina syndrome. Thecal sac cross sectional area (CSA) was measured on pre- and postoperative MRI at each level. For each patient, digital imaging software was used to calculate: critical ratio, hematoma volume, and volume per level decompressed. The critical ratio was defined as the smallest ratio of postoperative to preoperative CSA at any level within the lumbar spine.

Results: Mean critical ratios were: asymptomatic (0.73), painful (0.48), cauda equina (0.22). Statistical significance ($p < .025$) was achieved between all populations for the critical ratio calculation. Neither mean hematoma volume nor volume per level decompressed differed significantly between the studied patient groups.

Conclusion: The critical ratio correlates more closely with the presence or absence of postoperative symptoms than hematoma volume, and is consistent with the clinical expectation that greater thecal compression is likely to result in more severe symptoms.

Significance: Few guidelines exist for MRI interpretation in the post-operative lumbar surgery patient. The critical ratio correlates well with symptoms due to hematoma.

E-Poster #6

Fusion and Non-surgical Treatment for Lumbar Degenerative Disease: A Pooled Analysis of Prospective ODI and SF-36 PCS Outcomes

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Introduction: Controversy exists regarding indications for which fusion is better than non-surgical treatment for degenerative lumbar spine conditions. Prospective clinical outcomes data in the published literature on lumbar fusion and non-surgical treatment for degenerative lumbar spine conditions were compared.

Methods: A Medline search was done using “low back pain”, “treatment” and “outcome(s)”. Articles in English from 1980 to 2006 with prospectively collected Oswestry Disability Index (ODI) scores and at least 12-month follow-up were included. A cohort found in multiple publications was used only once. Data extracted from each study included demographics, study design, diagnosis, baseline and change in ODI, and baseline and change in SF-36 PCS. The data was pooled and analyzed based on diagnosis: Degenerative Disc Disease (DDD), Chronic Low Back Pain (CLBP) and Spondylolisthesis; and treatment: Fusion (Unspecified, Posterior, Anterior, Combined) and Non-surgical.

Results: 428 articles were identified during the initial search, 31 articles met the inclusion criteria. There were 47 Fusion and 20 Non-surgical cohorts. The distribution of gender and smokers was similar across diagnoses and treatments. No CLBP patients had Anterior Fusion and all Spondylolisthesis patients had Posterior Fusion. Spondylolisthesis patients (mean 60.6 yrs) were older than DDD (46.4 yrs) and CLBP (41.5 yrs) patients. Spondylolisthesis patients had the best ODI improvement (35.4), followed by DDD (26.2), and CLBP (13.6). Fusion produced similar improvements in ODI (Posterior - 24.9, Anterior -26.5, Combined -23.9). Non-surgical patients did not improve as much (13.9), but had a worse baseline ODI. DDD (13.0) and Spondylolisthesis (11.2) patients had similar SF-36 PCS improvements compared to CLBP (8.5). Non-surgical (7.6) patients had the least improvement, followed by Anterior (13.4) and Posterior fusion (12.3) patients.

Conclusion: Substantial improvement can be expected in patients treated with fusion, regardless of technique, when an established indication such as spondylolisthesis or DDD, exists. CLBP patients are less disabled, have a greater disease burden and experience less improvement. The majority of CLBP patients, however, are treated non-surgically.

Weighted Average of Mean Improvement in ODI by Diagnosis and Treatment

Diagnosis	Procedure					
	Posterior	Anterior	Combined	All Surgical	Non-Surgical	Total
DDD	26.5 (689)	26.5 (1097)	26.1 (509)	26.4 (2295)	12.6 (31)	26.2 (2326)
CLBP	13.4 (184)	NA	8.8 (75)	12.2 (435)	13.9 (1693)	13.6 (2128)
Spondylolisthesis	35.4 (96)	NA	NA	35.4 (96)	NA	35.4 (96)
Total	24.9 (969)	26.5 (1097)	23.9 (584)	25.1 (2826)	13.9 (1724)	20.8 (4550)

Values in parentheses are total number of patients in the cohort.

E-Poster #7

Defining Substantial Clinical Benefit in Lumbar Spine Fusion

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Introduction: Health related quality of life (HRQOL) measures, particularly the Oswestry Disability Index (ODI) and SF-36, have become important standards to evaluate lumbar spine surgery outcomes. However, there are few well defined criteria for clinical success based on these measures. The minimum clinically important difference (MCID) is used with increasing frequency. Although MCID is a meaningful demarcation, it is more of a floor value than a goal for defining clinical success. Therefore, we sought to define thresholds of substantial clinical benefit (SCB) for commonly used HRQOL measures in lumbar spine surgery.

Methods: From a multi-center database, prospectively collected pre-operative and one-year post-operative SF-36 PCS, ODI, and back pain and leg pain Numeric Rating Scores (NRS) from 454 patients who had lumbar spine surgery for degenerative conditions were identified. Candidate SCB thresholds for SF-36 PCS, ODI and back and leg pain NRS were developed using receiver operating characteristic (ROC) curve analysis. ROC curves were used to discriminate between two subgroups: the “Much Better” and “About the Same” patients on the SF-36 Health Transition Item, and the “Most Satisfied” and “Unsure” patients on the Satisfaction with Results scale. Three response parameters were used: net change, percent change, and raw score at one-year follow-up, for each HRQOL measure.

Results: SCB thresholds for SF-36 PCS are 6.1 points net improvement, 19.5% improvement, or a final raw score greater than 35.2 points. SCB thresholds for ODI are a 19.0 point net improvement, a 37.6% improvement, or a final raw score less than 30.6 points. SCB thresholds for back pain and leg pain NRS are 2.5 points net improvement or a final raw score less than 3.5 points. SCB thresholds for percent change are 41.4% for back pain NRS and 47.2% for leg pain NRS.

Conclusion: Identification of an SCB threshold for commonly used HRQOL measures in lumbar spine surgery is important, as it describes a magnitude of improvement which the patient recognizes as a substantial benefit. These thresholds are not necessarily intended as a benchmark defining a satisfactory intervention, but rather as a tool for patient discussion and shared decision making.

E-Poster #8

Epidural Steroids for the Management of Symptomatic Lumbar Neural Compression: A Systematic Review

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Introduction: Degenerative spinal conditions can lead to neural compression, causing severe leg pain, either as radiculopathy or neurogenic claudication. Epidural steroid injection is utilized widely as a treatment option. Several small randomized control trials have shown varied results. However, this has not been evaluated systematically.

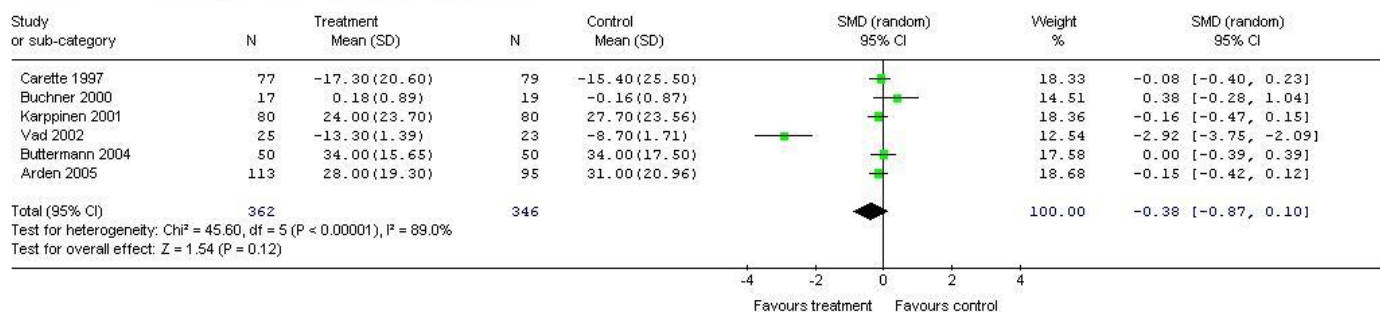
Methods: Searches were performed electronically through Medline (1966-July 2006), Embase, CCTR, CINAHL and journals were hand-searched for past 2 years. Two reviewers independently assessed all articles and extracted data. Inclusion criteria: 1) adults >18 with radiculopathy or neurogenic claudication, 2) single or series of injections, 3) randomized control trial, 4) validated outcome measures reported. I² statistic was used to quantify heterogeneity and Cochrane Q test was used for between-study heterogeneity. Random effects model was utilized.

Results: There was no difference in the spine specific outcome measures between steroid and placebo group (Standardized Mean Difference (SMD) -0.38, 95% CI -0.87, 0.10). Similarly, there was no difference at 4 weeks (SMD = -0.09, 95% CI -0.44, 0.25]. Visual Analog Pain Scores at 6 months showed no improvement with steroids over placebo. There was no difference in the need for future surgery between groups (Relative risk 1.00, 95% CI 0.71, 1.42). There was significant heterogeneity (I² = 89%, Chi² = 45.6) among the studies due to quality of studies, age range, duration of symptoms and cointerventions.

Conclusion: Epidural steroids have no short or long-term benefit over placebo on spine related functional outcomes or pain in patients with symptomatic lumbar neural compression. Steroid administration had no effect on the need for future surgery.

Significance: This meta-analysis of randomized control trials provides strong evidence of lack of efficacy of epidural steroid injections for symptomatic lumbar neural compression.

Review: Epidural Steroids for the Management of Symptomatic Lumbar Neural Compression: A Systematic Review (Version 02)
 Comparison: 01 Epidural Steroid Vs Control Intervention
 Outcome: 01 Validated Spine Functional Outcome Measures At or >6 months



Standardized Mean Difference (SMD) for each randomized control trial and the Overall Weighted SMD with 95% Confidence Intervals (CI) for spine specific outcome measures at 6 months or greater.

E-Poster #9

Efficacy of Aprotinin As a Blood Conservation Technique During Adult Deformity Spine Surgery: A Retrospective Study

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Introduction: Aprotinin is an antifibrinolytic agent which has been proven to be effective as a blood-conserving technique in cardiac surgery. The purpose of this study is to assess its efficacy and safety in reducing blood loss in adult spinal deformity patients.

Methods: A retrospective study analyzed a total of 82 deformity patients who underwent fusion surgery of at least six or more levels. 41 patients who received aprotinin were compared to an historical control group of 41 patients. Specific surgical outcome parameters and postoperative complications were assessed.

Results: The average age of the patients were 47 years (range: 19-70 years; SD: 15) and 41 years (range: 18-69; SD: 15) for Aprotinin group and control group respectively. The average number of levels fused or instrumented was 11.2 for aprotinin group and 10.7 for control group. The mean blood loss and the blood returned by cell-saver were statistically significantly lower in the aprotinin group (1324 ml vs. 2113 ml; $p=0.005$ and 390 ml vs. 657 ml; $p=0.003$). The amount of drainage postoperatively was similar (1421 ml vs. 1388 ml; $p=0.982$). The cases received an average of 2.73 units of blood. This was significantly lower than the average 5.02 units that the controls received ($p= 0.003$). The rate of complications was comparable and no allergic reaction to aprotinin was noted. One case exhibited a transitory elevation of BUN/creatinine which resolved before discharge.

Conclusion: The administration of aprotinin appears to be a safe and effective method to reduce blood loss and decrease the need for transfusions in the relatively younger and healthier adults undergoing spinal deformity surgery requiring six or more levels of fusion.

Significance: Blood loss in spine surgery is often significant and can lead to increased morbidity and mortality, especially in the adult deformity patient. Our study showed that Aprotinin is very effective blood conservation method in complex adult spinal deformity and different from othe studies showed that it is a safe method to use only relatively younger and healthier population. However, further studies are warranted to evaluate the use of Aprtonin in older patients undergoing spinal deformity surgery requiring six or more levels.

E-Poster #10

Effect and Outcome of Prophylactic Vertebroplasty in Long Spinal Fusions on the Incidence of Proximal Junctional Kyphosis (PJK). Minimum Two Years Follow-up.

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Introduction: 11 patients were treated with prophylactic vertebroplasty (cases) in the (PIL) and (PIL+1) and compared to 22 matched (controls) without vertebroplasty. All patients had long spinal fusion to the sacrum, crossing the thoracolumbar junction. Demographics, incidence and risk factors for the development of PJK were examined in both groups.

Methods: Standing 36-inch AP and lateral radiographs were reviewed at pre-op, immediate post-op and final follow-up. (PJK) was defined as the change from immediate post-op to final follow-up in; thoracic kyphosis $\geq 10^\circ$, a change of $\geq 5^\circ$ in the supra-adjacent angle, a decrease of $\geq 20\%$ anterior height of the vertebra at PIL, or a decrease of $\geq 10\%$ anterior height of the vertebra at PIL+1.

Results: In the vertebroplasty group; there were 8 females and 3 males, average age 66 (54-80). In the control group; there were 16 females and 6 males, average age 66 (53-83). At final follow-up, none of the vertebroplasty cases required revision. In the controls; 4/22 (27%) required revision surgery, related to (PJK). -0/11 cases, 4/22 (27%) controls had a change $\geq 5^\circ$ in the supra-adjacent angle, -0/11 cases, 1/22 (5%) controls had a decrease $\geq 20\%$ anterior height of the vertebra at PIL. -0/11 cases, 3/22 (14%) controls had a decrease $\geq 10\%$ anterior height of the vertebra at PIL+1. To compensate for radiographic magnification variables, changes in front to back vertebral body height ratios were measured. -In the PIL there were 0/11 cases and 1/22 control with a change greater than 20% -in the PIL+1 there were 0/11 cases and 1/22 control with a change of greater than 20%

Conclusion: The results in this study indicate that there is benefit to prophylactic vertebroplasty for the prevention of (PJK) and need for revision surgery related to this problem.

Significance: Vertebral augmentation with PMMA may be beneficial in preventing vertebral collapse at the proximal end of the construct in patients requiring long spinal fusion.

Comparison of Cases vs Controls from immediate post op until final follow up

	Cases ¹	Controls ²
Required Revision surgery	0/11	4/22
change $\geq 5^\circ$ in the supra-adjacent angle	0/11	4/22
decrease $\geq 20\%$ anterior height of the vertebra at PIL ³	0/11	1/22
decrease $\geq 10\%$ anterior height of the vertebra at PIL+1 ⁴	0/11	3/22
change $\geq 20\%$ in PIL front to back ratio	0/11	1/22
change $\geq 20\%$ in PIL+1 front to back ratio	0/11	1/22
change $\geq 10\%$ in PIL front to back ratio	2/11	3/22
change $\geq 10\%$ in PIL+1 front to back ratio	1/11	1/22

¹ cases - Patients treated with prophylactic vertebroplasty

² controls - Patient treated without prophylactic vertebroplasty

³ PIL - proximal instrumented level

⁴ PIL+1 - coronally adjacent level

E-Poster #11

Maintenance of Rod Contour When Instrumenting a “Rigid” Spinal Model: Which Rods are Best?

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Introduction: Little is known about how commercially available rods of varying material properties retain their shape following deformity correction. The objective of this study was to determine if rods of varying moduli/yield strengths remain in the elastic region on their stress/strain curve after instrumentation of a rigid deformity.

Methods: An 11-level, rigid, hypokyphotic, bench-top spinal model was instrumented with four 5.5 mm rod types: titanium (Ti), regular-strength (RS; 120 ksi), high-strength (HS; 160 ksi), and ultra high-strength (UHS; 200 ksi) stainless steel (n=12/group). The rods were pre-contoured to 10°, 20°, 30° or 40° of kyphosis, and instrumented into pedicle screws in a surgically relevant manner (Fig 1). After removal, the residual rod contour was measured, and expressed as a percentage of the original contour. A two-way ANOVA (p<0.05) was used to compare differences between rod types in each pre-contour group.

Results: RS rods deformed plastically after only 10° of pre-contour, maintaining only 72±5% of their original curve, while the other three rod types maintained greater than 90% of their original curve (p=0.02). At 20° of pre-contour only the Ti rods maintained their original pre-contour (96±4%) (p≤0.001), while the other three types of steel rods underwent plastic deformation. At 30° and 40° all rods deformed plastically, and no significant differences were found between the metals.

Conclusion: Pre-contoured rods used to instrument rigid spinal deformities often undergo plastic deformation, depending on their yield strengths/moduli. A reduction in as little as 10% of rod contour, for a RS rod, may result in permanent deformation, limiting the correction such a rod can affect (for a given modulus). Titanium and UHS rods have much greater elastic zones of deformation yet the UHS rod may exert greater corrective forces due to a higher elastic modulus.

Significance: During pre-op planning, implants should be chosen based on deformity characteristics, as rods with relatively high elastic moduli that maintain corrective forces without plastic deformation may result in improved outcomes.

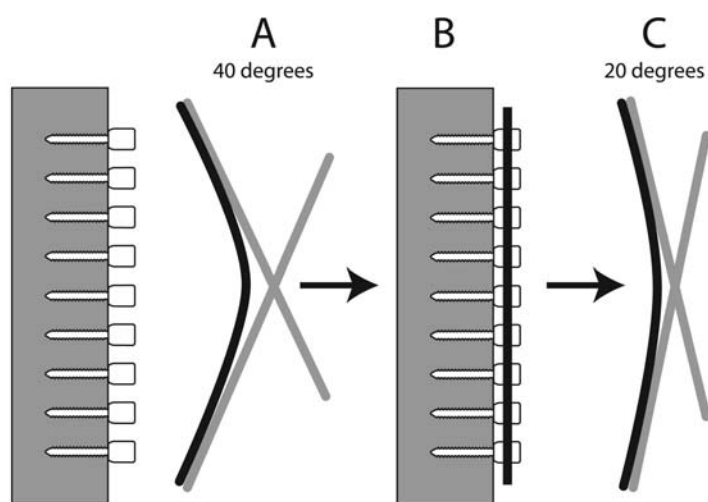


Fig 1: Testing sequence. (A) 5.5mm rod pre-contoured to 40°; (B) Rod implanted to a “rigid” spinal construct; (C) Residual contour of 20° after removal.

E-Poster #12

Stimulus-Triggered EMG Diffusion test. A New Tool for the Accuracy of Thoracic Pedicle Screw Placement

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Introduction: A new triggered electromyography test for detection of stimulus diffusion to intercostal muscles of the contralateral side during thoracic pedicle screw placement was evaluated. Experimental research was carried out in order to determine if, using this test, neural contact at different aspects of the spinal cord and nerve roots could be discriminated.

Methods: Nine industrial pigs (60-75 kg) had 108 pedicle screws placed bilaterally in the thoracic spine (T8-T13). Neural structures were stimulated under direct vision at different anatomic locations from T9 to T12. Recording electrodes were placed over the right and left intercostal muscles. Increasing intensity of the stimulus was applied until muscle response was detected at the contralateral side (diffusion phenomenon). After this first experiment, the thoracic spine was instrumented. Screws were placed in the pedicle in two different positions, the anatomic intrapedicular location and with purposeful contact with the neural elements.

Results: Response thresholds to direct stimulation of nerve root at different points were significantly lower than those obtained by stimulation of the dorsal aspect of the spinal cord (0.44 ± 0.22 mA vs 1.38 ± 0.71 mA). However, a 24-fold stimulation intensity (6.50 ± 0.29 mA) was necessary to obtain diffusion of the EMG response to the opposite left side if the right nerve root was stimulated. Only a 2-fold increment (3.17 ± 0.93 mA) was able to elicit diffusion of EMG responses to the contralateral side when stimulation was applied to the dorsal aspect of the spinal cord. Contralateral EMG responses after high increases of stimulation thresholds indicated nerve root contact. Diffusion phenomenon after low threshold increments reflected medullar contact. Electromyography recordings after triggered stimulation of the screws showed that only screws in contact with the spinal cord had significantly lower responses (2.72 ± 1.48 mA).

Conclusion: Stimulus-triggered EMG could only discriminate screws with violation of the medial pedicle wall if they were contact with neural tissues. Recording EMG-potentials at the contralateral paraspinal muscles (stimulus diffusion phenomenon) proved to be a reliable method to discriminate which of the neural structures was at risk.

E-Poster #13

A Comparative Biomechanical Analysis of a Novel Anterior Trans-Articular C1-C2 Instrumentation for Unstable Dens Fractures: An In-Vitro Human Cadaveric Model

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Introduction: Techniques of posterior C1-C2 instrumentation in the setting of C1-C2 instability have been previously reported. There is a paucity of published reports of anterior C1-C2 instrumentation.

Methods: Multidirectional flexibility testing was performed utilizing seven fresh-frozen human cadaveric spines (Occiput-C7). Following intact spine analysis, each specimen was destabilized and reconstructed as follows: 1] dens fracture with unilateral anterior C1-C2 transarticular screw; 2] dens fracture with bilateral C1-C2 transarticular screw; 3] dens fracture with posterior C1-C2 transarticular screw supplemented with cortico-cancellous C1-C2 bone graft and Gallie wire fixation (Magerl-Gallie technique); 4] dens fracture with bilateral C1-C2 pedicle screw (Harms technique). P value < 0.05 was utilized to establish statistical significance.

Results: Bilateral anterior C1-C2 trans-articular screws demonstrated statistically significantly reduced flexibility in all modes (flexion-extension, lateral bending, axial rotation) compared to intact. There were no statistically significant differences in flexibility in all modes between the bilateral anterior C1-C2 technique and the Harms and Magerl fixation methods. For unilateral anterior C1-C2 fixation, there was statistically significant reduced flexibility in flexion-extension and axial rotation but not lateral bending compared to intact.

Conclusion: Anterior atlanto-axial fixation using cannulated transarticular screws can be achieved in the human cadaveric cervical spine. Biomechanical testing in an odontoid fracture model with bilateral anterior transarticular screw fixation suggests comparable flexibility in flexion/extension, lateral bending, and axial rotation to C1-C2 transpedicular screws (Harms) and posterior transarticular screws (Magerl-Gallie). Unilateral anterior transarticular screw fixation demonstrated flexibility properties intermediate to these fixation methods and the intact condition.

Significance: This novel approach may provide an alternative method to C1-C2 fixation in cases of tumor, severe deformity, or hemodynamic instability in which posterior techniques are not desirable.



A-P radiograph of anterior C1-C2 transarticular screws

E-Poster #14

The development of spinal deformities following open heart surgery for congenital heart disease

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Introduction: Patients with congenital heart disease (CHD) are at an increased risk of developing scoliosis. Cyanotic conditions and the type of surgical approach have been implied. The purpose of this study is to determine the prevalence of spinal anomalies in patients with CHD post open heart surgery (OHS).

Methods: The medical records of 221 patients post sternotomy, thoracotomy or combined procedures for CHD without congenital vertebral anomalies were evaluated. There were 132 males and 89 females with a mean follow-up of 13 years.

Results: Fifty-nine patients presented scoliosis (27%), 33 female and 26 male. There was a similar incidence of scoliosis between the different OHS groups. 18 presented moderate to severe scoliosis. 39% with moderate to severe scoliosis presented with hyperkyphosis (>40 degrees). All patients with severe scoliosis (22% of those with scoliosis) underwent spinal fusion, nine female and 4 male. Forty patients (18%) presented with hyperkyphosis. Only 1/40 with hyperkyphosis had a thoracotomy (2.6% of thoracotomy patients). The remaining 39 patients (underwent a sternotomy or combined procedure. This was statistically significant. This represents 21% of each group of patients. There was no difference in those with cyanosis or not and the development of scoliosis or kyphosis. No difference between those with and without scoliosis and the age at the first procedure was found. Patients with multiple procedures were not at increased risk of deformity.

Conclusion: There is an increased incidence of moderate and severe scoliosis in CHD patients. This study did not find a relationship between the presence of cyanosis, multiple procedures or age at surgery as risk factors. Sternotomy may affect coronal alignment as thoracotomies. But, it was shown to affect sagittal alignment. It is important for continued monitoring of spinal deformities as 80% of our severe curves developed before the age of nine.

Significance: There is increased moderate and severe scoliosis in CHD after OHS. 44% of our severe curves developed before the age of nine. There is an increased risk to develop hyperkyphosis in those patients that underwent sternotomy as part of the treatment of their CHD.

E-Poster #15

Prediction of Brace Treatment Outcomes in AIS Patients

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Introduction: Brace effectiveness for AIS should be partially dependent on how much time and how well the brace is worn. This study determined how well brace treatment outcomes could be predicted by Peterson's risk factors and brace usage in terms of wear time (quantity) and wear tightness (quality).

Methods: Twenty brace candidates (3M;17F), age 13.4 ± 1.7 years participated after signing their consent forms. Each subject wore a brace compliance monitor to log how much time the brace was worn and how much the force the brace exerted upon the body. The Cobb angle of the treated curve at pre-brace, in-brace at time of monitoring and 3 years after bracing was $32.2 \pm 7.6^\circ$, $22.7 \pm 8.5^\circ$, and $35.0 \pm 10.5^\circ$, respectively. The prescribed wear time set by the orthopaedic surgeon was 20.7 ± 3.2 hours/day. The target brace tightness was set by the orthotist. Correlation analysis was performed to determine which factors independently related to curve progression. The factors considered were Peterson's risk of progression, compliance (quantity of brace usage), brace tightness relative to target (quality of brace usage). Two-tailed Student's t-tests ($p=0.05$) for significance were performed. Step-wise regression was used to test the effect of multiple factors.

Results: On average, the braces were used 70% of the prescribed time and the proportion of the time that the brace was worn above 80% of the tightness level was $54 \pm 22\%$. Scoliosis progressed more than 5 degrees in five subjects. Using only Peterson's risk factor predicted 3% of the curve progression. Knowing brace tightness increases the prediction rate to 12%; and wear time further increases it to 25%. Adding the multiple of brace tightness and wear time improves curve progression prediction to 41%.

Conclusion: This study suggests that both compliance and brace tightness are important factors in treatment outcomes.

E-Poster #16

Abnormal Mechanical and Structural Properties of Bone in Adolescent Idiopathic Scoliosis -A Study with Quantitative Ultrasound Vs Bone Densitometry

Ms. Vivian W. Hung; Ling Qin, PhD; Hiu Yan Yeung, PhD; Bobby Ng, MD; K. Y. Fung, MD; **Prof. Jack C. Cheng, MD (The Chinese University of Hong Kong)**

Introduction: Quantitative ultrasound (QUS) is a non-invasive and radiation free tools which has been widely used for screening of osteoporosis as well as predicting fracture. This study was to investigate the structural and mechanical properties of bone in adolescent idiopathic scoliosis (AIS) girls using QUS.

Methods: 101 post-menarchal AIS girls and 113 age- and sex-matched normal controls were recruited. Trabeculae-riched calcaneum and femoral neck bone mineral density (BMD) were measured by QUS and DXA respectively. Parameters measured by QUS included broadband ultrasound attenuation (BUA), velocity of sound (VOS) and stiffness index (SI). AIS patients were divided into osteopenic-AIS (Z-score BMD ≤ -1) and non-osteopenic-AIS (Z-score > -1).

Results: Osteopenic-AIS had significantly lower values in all QUS parameters (Table) than those of the non-osteopenic-AIS and normal controls.

Conclusion: These findings suggested that there was a poor development in material and structural properties of bone in AIS. Weight-bearing exercise training may help to improve the development of musculoskeletal system in AIS girls.

Significance: Poor bone quality in AIS patient may reflect the microarchitecture abnormalities on bone in addition to low BMD. Bone density and quality are the key determinants of bone strength, abnormal in structural and material properties in AIS may results in poor bone strength and increase the risk of fracture.

	Osteopenic-AIS (n=37)	Non-osteopenic-AIS (n=64)	Normal Control (n=113)
Broadband Ultrasound Attenuation (BUA)	117.7 \pm 15.1 ^{c**}	118.0 \pm 9.7 ^{b**}	125.1 \pm 10.5
Velocity of Sound (VOS)	1431.6 \pm 34.3 ^{a*}	1462.0 \pm 46.6	1456.9 \pm 61.3 ^{c*}
Stiffness Index (SI)	340.6 \pm 75.3 ^{c**}	370.1 \pm 64.0	395.1 \pm 68.0

** : p<0.01; * : p <0.05

^aOsteopenic-AIS differ from non-osteopenic-AIS

^bNon-osteopenic-AIS differ from Normal Controls

^cOsteopenic-AIS differ from Normal Controls

E-Poster #17

Assay of Deep Drain Output for rhBMP-2 in Posterior-lateral Fusion

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Introduction: Increasing use of rhBMP-2 to augment posterior spinal fusion has gained popularity. Many cases would benefit from deep wound drainage especially where a laminectomy defect is present. The safety and efficacy of combining deep wound drainage and rhBMP-2 usage is explored.

Methods: Single-level posterolateral lumbar spinal fusions were performed on nine sheep. Each sheep received one of the following: Group 1) rhBMP-2 on an absorbable collagen sponge (ACS) and wrapped around biphasic calcium phosphate (BCP) granules (n=3); Group 2) rhBMP-2 on a collagen-BCP composite matrix (n=3); Group 3) rhBMP-2 on a putty consisting of both soluble and insoluble collagen impregnated with BCP (n=3). Implanted rhBMP-2 varied from 12 mg to 40 mg. Bilateral drains were placed under suction and implanted directly adjacent to the graft materials. All drain fluid was collected hourly for the first 10 hours and at every 8-12 hours thereafter for up to 2.5 days or until clots formed. Samples were analyzed for rhBMP-2 concentration using enzyme-linked immunosorbent assay (ELISA). Concentrations determined from ELISA and known sample volumes were used to calculate the total amount of rhBMP-2 and the percentage of implanted rhBMP-2 in drained fluid. Control samples consisting of plasma from untreated sheep were used to determine the baseline concentration of BMP-2 in sheep blood.

Results: The collected cumulative percentage of the implanted amount (mg) of rhBMP-2 averaged 0.75% (± 0.28) for Group 1, 0.81% (± 0.32) for Group 2, and 0.67% (± 0.56) for Group 3. rhBMP-2 concentration in samples averaged 0.0011 mg/mL (± 0.0006) for Group 1, 0.0035 mg/mL (± 0.0031) for Group 2, and 0.0020 mg/mL (± 0.0019) for Group 3. Testing of control samples revealed negligible quantities of BMP-2 were present in normal sheep plasma.

Conclusion: Despite the drain proximity to graft material, less than 1.5% of the implanted rhBMP-2 was detected in the drained fluid. While further research is warranted, preliminary data suggest draining after posterolateral lumbar spinal fusion may not compromise the amount of rhBMP-2 implanted.

Significance: Deep drain placement in a posterior fusion environment does not significantly alter rhBMP-2 at the surgical site.

E-Poster #18

The Contralateral Lamina -A Reliable Guide in Subaxial Cervical Pedicle Screw Placement

Andy Hacker, MB MRCS; **Jason Bernard, MD (St Georges Hospital);**

Introduction: We have assessed the clinical observation that the angle of the contralateral lamina matches the angle required from the sagittal plane for the placement of pedicle screws in the subaxial cervical spine.

Methods: 54 axial CT scans were examined. All subjects were scanned for the exclusion of fracture between December 2003 and December 2004. The digitised images were analysed on the Philips PACS system using SECTRA software. 168 individual vertebrae were assessed between C3 and C7. The following were measured; the angle of the pedicle relative to the sagittal plane, the smallest internal and external diameter, the angle of the lamina and the distance from the lateral mass to the anterior vertebral body (LMAVB) in the line of the pedicle.

Results: Angular measures had a CV% of 3.9%. The re-measurement error for distance was 0.5mm. 336 pedicles were assessed in 25 females and 29 males. Average age was 48.2 years (range 17-85). Our morphologic data from live subjects was comparable to previous cadaveric data. Mean pedicle external diameter was 4.9mm at C3 and 6.6mm at C7. Females were marginally smaller than males. Left and right did not significantly differ. In no case was the pedicle narrower than 3.2mm. Mean pedicle angle was 130 deg at C3 and 140 deg at C7. The laminar angle correlated well at C3,4,5 ($R^2 > 0.7$) and was within 1 deg of pedicle angle. At C6,7 it was within 11 deg. In all cases a line parallel to the lamina provided a safe corridor of 3mm for a pedicle implant.

Conclusion: The contralateral lamina provides a reliable intraoperative guide to the angle from the sagittal plane for subaxial cervical pedicle instrumentation in adults.

E-Poster #19

High Frequency Electromyographic Discharges (HF-EMG) Indicate Impending Spinal Cord Injury in Pigs

Stan Skinner, MD; **Ensor E. Transfeldt, MD; (Twin Cities Spine Center)**

Introduction: We have observed lower limb HF-EMG as an antecedent to MEP loss in patients undergoing intramedullary and extradural cervical/thoracic spine surgery. Therefore, we have further specified the induction of HF-EMG and recovery from the consequent MEP loss in a porcine model.

Methods: EMG and MEP were recorded from the same hind limb muscles during high thoracic spinal cord injury in 10 adult pigs under propofol anesthesia. In 2 pigs, an intramedullary bipolar stimulator identified the ventral motor tract. The unelectrified electrodes were then used to mechanically irritate the motor tract. 8 pigs were subject to slow (4) vs rapid (4) TC (transaxial diameter reduction = 50%). In each pig, TC was removed at a pre-determined endpoint: initial onset of HF-EMG, loss of MEP, and time (2 -45 secs).

Results: HF-EMG was induced by direct mechanical irritation of ventral motor tracts. HF-EMG were observed in 6/8 TC pigs. In 2 “slow TC” pigs, MEP was lost at 45 seconds without induction of HF-EMG. MEP was lost and did not recover with slow or rapid TC ≥ 45 secs. HF-EMG (seen in all “rapid TC” pigs) were characterized by high frequency phasic bursts and tonic discharges. Transient compressions (2-10 secs) with repeated TC induced HF-EMG in the hind limbs, but effected no MEP loss. With immediate removal of TC after MEP loss, MEP promptly returned.

Conclusion: In a porcine model, descending motor tracts are ventrally located and will generate HF-EMG if mechanically irritated. Rapid application of TC predictably induces HF-EMG. Induction of HF-EMG may depend on the kinetic energy imparted to the cord, since slow (decreased acceleration) TC failed to induce HF-EMG. HF-EMG precedes MEP loss; MEP loss may be prevented if rapid TC is transiently applied or rapidly reversed. In pigs, HF-EMG is a real-time indicator of rapid spinal cord compression. Immediate attention to HF-EMG (removal of TC) may prevent an impending spinal cord injury.

E-Poster #20

Analysis of Construct Mechanical Stiffness and L5-S1 Kinematics after Sacrum Only, Unilateral and Bilateral Sacroiliac Instrumentation

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Introduction: Failure to achieve solid arthrodesis of the lumbosacral junction in long fusions to the pelvis is a clinical challenge. Bilateral iliac screw fixation to increase construct stiffness across the lumbosacral junction has been published previously. However, recent clinical evidence has questioned the need for bilateral instrumentation, as unilateral iliac fixation has demonstrated a greater sagittal profile improvement with fewer complications. This is the first study to specifically investigate biomechanical differences between unilateral and bilateral iliac screw constructs.

Methods: Sixteen skeletally immature porcine spines were instrumented with bilateral segmental pedicle screws from L1 to S1 with 5.5mm titanium rods. Spines were randomized to either have an intact L5-S1 disc space (n=8/group) or an interbody cage at L5-S1 (n=8/group). Prior to testing, four reflective non-colinear markers were placed in both L5 and S1. Spines were tested with bilateral ilium, unilateral ilium and sacrum only fixation in flexion, extension, lateral bending and axial torsion between +7Nm. Range of motion (degrees) of L5 relative to S1 and mechanical stiffness (Nm/deg) was compared between groups with a two-way ANOVA (p<0.05).

Results: No significant differences were found in construct stiffness or relative L5-S1 motion between unilateral or bilateral fixation for any test direction. Both methods of iliac fixation demonstrated significantly less L5-S1 motion compared to sacrum only fixation for all tests. (all p-values < 0.005) Bilateral fixation was significantly more stiff in flexion and extension when compared to sacral only fixation (p<0.0001). The interbody cage significantly decreased construct stiffness in extension, lateral bending and axial torsion (p<0.002), and significantly increased L5-S1 motion compared to an intact disc during axial torsion testing (p<0.03).

Conclusion: Bilateral iliac screw fixation did not significantly increase construct stiffness or limit L5-S1 motion compared to unilateral iliac screw fixation. This study provides biomechanical data to correlate with recent clinical data reporting improved outcomes in patients with unilateral iliac screw fixation.

Table 1: Range of Motion (degrees) for each testing direction and construct.

	Flexion/Extension			Lateral Bending			Axial Torsion		
	bilat	unilat	sacrum	bilat	unilat	sacrum	bilat	unilat	sacrum
Disc.									
Average	2.20	2.58	4.96	1.50	1.34	2.46	1.04	1.52	3.00
SD	0.76	0.90	2.50	0.48	0.54	1.19	0.24	0.54	1.37
Intact									
Average	1.80	2.23	3.31	1.31	1.52	2.46	1.00	0.97	1.92
SD	0.62	0.44	0.37	0.36	0.58	1.00	0.15	0.09	0.34
			p<0.005			p<0.005			p<0.005

E-Poster #21

Left-Right Asymmetry Gene Expression Domains are Reversed in Adolescent Idiopathic Scoliosis

Alain Moreau, PhD; (Research Center CHU Sainte-Justine and Université de Montréal); Bouziane Azeddine, MSc; Cinthia Desrochers, DEC; Hubert Labelle, MD; Dr. Benoît Poitras; Prof. Charles-Hilaire Rivard, PhD; Guy Grimard, MD; Jean A. Ouellet, MD; Stefan Parent, MD, PhD

Introduction: Asymmetrical growth of the spine in humans due to a melatonin signaling dysfunction (Spine, 29:1772-1781, 2004) and in melatonin deficient animals could be caused by a common pathomechanism. This prompted us to investigate whether or not left-right (LR) asymmetry genes expression and domain were affected in bipedal mice developing a scoliosis and in AIS patients.

Methods: Paraspinal muscle biopsies were taken intraoperatively from AIS patients requiring a spinal surgery (n=20) and scoliotic bipedal C57Bl6j mice (n=20). In both cases, muscle biopsies were taken on both sides (left and right) at the apex of the curve as well as above and below the apex and were frozen in liquid nitrogen for subsequent RNA extraction with the Trizol method. Expression analyses of LR-asymmetry genes were performed by RT-PCR. Non-scoliotic bipedal mice (n=10) and quadrupedal ones (n=5) were used as controls.

Results: Expression analyzes showed that left-restricted genes were strongly expressed on the right side instead of the left side of the body in the case of right thoracic curves in scoliotic mice and AIS patients. These changes in spatial expression domain occur mainly at the apex of the curve in scoliotic mice and AIS patients. We observed in the rare cases of left thoracic curves that left-restricted genes remains expressed in the left side although their expression levels were increased significantly.

Conclusion: Our results represent the first experimental demonstration that LR-asymmetry genes are reversed in AIS. These spatial changes occur at the apex of the curve and could explain the prevalence of right thoracic curves over the left ones.

Significance: It is unclear at this stage whether the reversal of LR-asymmetry genes expression domains is limited to the paraspinal muscles and what the roles of these LR-genes are after birth. Nonetheless, the observation of the same phenomenon in bipedal scoliotic mice and in AIS patients strongly argues that LR-asymmetry genes reversal is a key element of the pathomechanism leading to scoliosis.

E-Poster #22

Can Age-Related Intervertebral Disc Changes be Differentiated from Degenerative Disc Disease?

Kenneth MC Cheung, MD; B. J. Fan, Jaro Karppinen, Prof. John C. Leong; Prof. Keith D. Luk; **Wai Yuen Cheung, FRCS**

Introduction: It is known that intervertebral disc (IVD) degeneration progresses with age, and not all subjects with IVD degeneration have symptoms. We hypothesize symptomatic patients have a more severe form of IVD degeneration (degenerative disc disease) than can be accounted for by their age (age-related changes).

Methods: Making use of a large MRI and symptom database of 1244 individuals recruited from the population between 18 to 55 years of age, individuals with IVD degeneration were scored by their severity using the DDD score (1). For each age band, a mean DDD score is calculated and serve as the definition of age-related changes, while degenerative disc disease is defined as individuals that have a score deviated from the mean (>2 SD). Further, an age-adjusted DDD score is calculated based on a logarithmic transformation of the mean (2). The validity of this age-adjustment was then correlated with symptoms and previous genetic pre-disposition findings.

Results: After age-adjustment, individuals with a more severe form of degeneration than can be expected for their age could be identified. The age-adjusted DDD score of these individuals highly correlated with low back pain (LBP) ($p < 0.0001$), whereas without age adjustment, the DDD score only weakly correlated with LBP ($p = 0.024$). All previously identified genetic pre-disposing factors could be reproduced using the new score.

Conclusion: This study is unique and made possible only by the large population database of MRI information. It supports the hypothesis that age-related changes in the IVD occurs, and that this can be differentiated from symptomatic degenerative disc disease. This is an important concept not only as a phenotype for genetic studies, but for clinicians and patients to accept age-related changes, which do not necessarily need treatment, whereas those with degenerative disc disease are much more likely to be symptomatic and early treatment should be contemplated. (1) Cheung KMC, Song YQ, et al. Association of the Taq I allele in vitamin D receptor with degenerative disc disease and disc herniation in Chinese. *Spine*, 1st May 2006. Vol 31, No. 10. 1143-48. (2) Actual formula: Age-adjusted DDD score = $[\text{Ln}(\text{Mean-DDD score} + 2) - \text{mean}] / \text{S.D.}$

E-Poster #23

Pedicle Resection Osteotomy in Complex Spinal Deformities.

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Introduction: Pedicle Resection osteotomy (PRO) in correction of severe spinal deformities is well established. Prospective analysis of its efficacy in complex spinal deformities is sparse in literature.

Methods: Aims and Objectives 1. Assess role of PRO in correction of uniplanar and multiplanar spinal deformity. 2. Assess role of revision PRO in failed corrections. Material and Methods: 50 patients were operated between 2000-2007 and followed up for 2 years (2-6). 27 had uniplanar kyphosis (60-128 degrees) and kyphoscoliosis was seen in 10. Failed corrections were seen in 11 uniplanar and 2 multiplanar deformities. The average preoperative kyphosis and sagittal balance was 78.7 degrees and 22 mm (7-30) respectively. Scoliotic deformity ranged from 97 -138 (average 108 degrees) and the coronal imbalance from 10-55 (average 24mm). Deformity distribution was upper dorsal 5, mid dorsal 22, dorso-lumbar 18 and lumbar 5. Single posterior approach sufficed in 47 cases while 3 required anterior approach for reconstruction. 13 patients had pre-operative neurological deficit (bed ridden 10, ambulatory 3). The average surgical time required was 300 minutes and blood loss was 800cc. The anterior defect reconstructed averaged 16.5mm (5-28).

Results: Pulmonary complications occurred in 8 (21%), (embolism 1, pneumonia 2, hypoxia 5). Wound infection required debridement in 3 (8%). Failed corrections were seen in 10 (3 out of 37 in our series, 8%) due to failure of construct 2, severe disease 2, infection (active 2, quiescent 4). Neurological deterioration occurred in 1 (2%) (Medial pedicle wall perforation). 12 patients regained ambulation (independent 7, support 5). Postoperative kyphosis and sagittal balance was 36.5 (10- 108) and 10mm (5-20) respectively. Average correction was: sagittal 46.4%, coronal 37.5% and revisions 58%. The correction of kyphosis and sagittal balance was statistically comparable between primary and revision cases ($p > 0.05$).

Conclusion: PRO offers an excellent single stage decompression and controlled correction of kyphosis. The procedure can be repeated in failed corrections to achieve comparable correction. The procedure is technically demanding with a high complication rate.

E-Poster #24

Modified Multi-level Vertebral Column Resection (MVCR) in Severe Pott's paraplegia

Yan Wang, MD; **Xuesong Zhang, MD (301 Hospital)**; Yonggang Zhang, MD, PhD; Songhua Xiao, MD; Zheng Wang, MD

Introduction: Tuberculosis of the spine may cause late kyphosis, paraplegia, and respiratory compromise. Surgical correction may be considered for large or progressive deformities. We report a modified Multi-level Vertebral Column Resection (MVCR) through a single posterior approach and clinical outcomes for treatment of severe adult Pott's Deformity and paraplegia.

Methods: A single posterior approach, combining VCR and "egg shell" technique, multi-level spine shorten and interfixation were applied in 12 adult patients with severe pott' s deformity. Patients were followed up for at least 2 years for complications. Neurological status was assessed using the Frankel score. The kyphotic deformity was measured on lateral radiographs taken before surgery and at follow-up.

Results: Total 30 vertebrae were removed, and 2.5 vertebrae(2~4) on average. Spine shorten average 36 mm were achieved during correction, but standing length increased 42 mm on average postoperation. Surgical complication including a dural tear occurred in one patient and a pleural tear in another. Both tears were successfully repaired. The Frankel scores of the 12 patients improved from C or D before surgery to D or E after surgery. The local kyphosis deformity average angle was 92.5 degrees before surgery restored to normal sagittal alignment in thoracic and lumbar region at the final follow-up. Spinal fusion was achieved in all patients. No relapse of spinal tuberculosis was encountered.

Conclusion: One-stage single posterior MVCR and spine shorten technique was an effective option for treating adult Pott's paralysis with large deformity.

Significance: A noval option for treating adult Pott's paralysis with large deformity was reported according to our studies. As a conclusion, one-stage single posterior MVCR and spine shorten technique was safe and effective.

E-Poster #25

Use of the Lenke Classification for Double Thoracic Curves: Does it Increase the Incidence of Fusion of the Proximal Thoracic Curve and Change Radiographic Outcomes?

Daniel J. Sucato, MD, MS; **Bryan Tompkins, MD (Texas Scottish Rite Hospital for Children)**; Anna McClung, RN

Introduction: The Lenke classification has established criteria which designate the proximal thoracic (PT) curve as structural (Lenke 2). However, this classification may overestimate the necessity to include the proximal thoracic curve in the fusion construct. The objective of this study was to compare the incidence of fusing the PT curve for true Lenke 2 curve patterns, comparing a time period when the classification was not utilized and when it was first used.

Methods: A consecutive series of patients with adolescent idiopathic scoliosis (AIS) at a single institution from 1996-2000 (early group) and from 2002-2004 (late group) were reviewed. The curves were all classified by the Lenke classification retrospectively.

Results: There were 44 in the early group and 33 in the late group. There were no differences in the early and late groups with respect to age (14.3 vs. 14.4yrs), the preoperative PT magnitude (40.0 vs. 38.6°), or curve flexibility (16.0 vs. 14.5%), the main thoracic (MT) magnitude (63.4 vs. 62.7°), T1 tilt (7.3 vs. 5.2°), preoperative clavicle angle (1.0 vs. -0.2°), and preoperative shoulder height (1.2 vs. -0.8mm). The early group had fusion of the PT less often (36 vs. 57%)($p<0.05$) which resulted in a greater residual PT curve (26.5 vs. 22.2°), MT curve (33.8 vs. 27.8°), and a greater clavicle angle (4.6 vs. 2.5°)($p<0.05$). At two years the PT continued to be significantly greater in the early group (28.6 vs. 22.8°)($p<0.05$), however T1 tilt (8.8 vs. 8.1°), clavicle angle (1.3 vs. 1.0°), and shoulder height (3.5 vs. 4.7mm) were the same.

Conclusion: The application of the Lenke classification system for AIS increases the likelihood of instrumenting a PT curve resulting in improved postoperative PT curve magnitude. However, similar shoulder balance, T1 tilt and clavicle angle were seen compared to patients in which the system was not used. The classification system should be used to guide decision making, however, other parameters should be evaluated when deciding when to instrument a PT curve.

Significance: This study demonstrates greater likelihood of instrumenting the PT curve when the Lenke classification is used but seems to result in similar shoulder balance, T1 tilt and clavicle angle compared to when it is not used.

E-Poster #26

The Novel Use of Electromyography (EMG) to Detect Acute Spinal Motor Tract Injury (SMTI) during Decompression of the Cervical/Thoracic Spine

Stan Skinner, MD; **Ensor E. Transfeldt, MD; (Twin Cities Spine Center)**; Joseph H. Perra, MD; Daryll C. Dykes, MD, PhD; Carisma Mtenga, BA

Introduction: MEP specifically monitors the corticospinal tract during spine surgery, but MEP related movement of the unrelaxed patient prevents repeated testing during critical periods. We have reported the use of EMG to detect incipient SMTI during resection of intramedullary lesions. Those results have prompted us to study 4-limb EMG as a supplement to MEP during extradural spinal cord decompression.

Methods: We reviewed 184 patients (monitored by MEP and 4-limb EMG) who underwent cervical (175) or thoracic (9) decompression 2005-06. When high frequency EMG discharges (HF-EMG = repeated bursts/prolonged tonic discharges in myotomes ≥ 2 segments below the operative site) were noted, the surgeon paused for MEP. $>90\%$ MEP amplitude loss defined an acute spinal motor tract conduction block and prompted intervention.

Results: Lost MEP was observed in 15 (8.2%) cases. Interventions included patient re-positioning, \uparrow BP, surgical pause, and/or removal distractive/compressive forces. MEP recovered in 10 cases; 5 patients (2.7% true positive) lost MEP without recovery; false negative/ false positive rate =0. HF-EMG anticipated immediate MEP loss in 7/15. HF-EMG occurred in 8 patients without MEP loss. For MEP loss, the positive predictive value of HF-EMG = 0.47 (negative predictive value = 0.95). Surgical context suggested all HF-EMG were related to manipulations near the dura.

Conclusion: SMTI may be produced by patient malpositioning, hypoperfusion, or mechanical distortions of the cord. When mechanical forces generate HF-EMG, the risk of sudden MEP loss approaches 50%. HF-EMG can indicate in real-time an impending MEP loss (acute spinal motor tract conduction block). If MEP is lost, recovery may ensue if the surgeon pauses or distractive/compressive forces are removed. 4-limb EMG is strongly suggested during decompression at spinal cord levels.

E-Poster #27

Towards Standardized Quantification of Sacral Doming in Lumbosacral Spondylolisthesis

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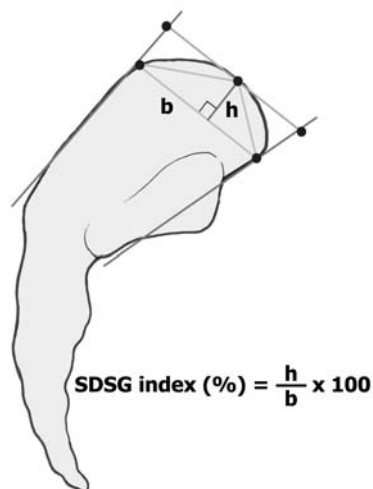
Introduction: Sacral doming is an important dysplastic feature to consider when evaluating progression and planning treatment of spondylolisthesis. The objectives of this study were to evaluate the relevance of the SDSG (Spinal Deformity Study Group) index for quantifying sacral doming and to propose a standardized criterion to identify significant doming.

Methods: In the first part of the study, intra- and inter-rater reliability of the SDSG index was evaluated using intraclass correlation coefficient (ICC) based on the assessment of 30 subjects by two raters. In the second part, five spinal surgeons subjectively assessed sacral doming on lateral radiographs of 100 subjects (34 high-grade spondylolisthesis, 50 low-grade spondylolisthesis, 16 controls) and classified each case as having significant or non-significant doming. An independent observer subsequently measured all 100 radiographs using the SDSG index. A criterion to identify significant sacral doming was sought based on the comparison between the subjective assessment of surgeons and the quantitative evaluation by the independent observer.

Results: Intra- and inter-rater ICC for the SDSG index were respectively 0.91 and 0.88. In the second part of the study, the SDSG index was significantly related to the slip percentage ($r=0.63$). Inter-surgeon agreement on the significance of sacral doming was substantial ($\kappa=0.72$). With a criterion of 25%, 93% concordance was found between the quantitative evaluation using the SDSG index and the multi-surgeons subjective assessment.

Conclusion: The SDSG index is associated with excellent reliability, allows quantification of sacral doming and is in agreement with the clinical perspectives of spinal surgeons. A criterion of 25% is proposed to differentiate significant from non-significant sacral doming. Such criterion will allow standardized quantification of sacral dysplasia and facilitate comparisons between studies.

Significance: This study confirms the relevance of the SDSG index to quantify sacral doming in spondylolisthesis. This finding is significant because sacral doming is an important dysplastic feature that may influence the progression and treatment of spondylolisthesis.



Measurement of sacral doming using the SDSG index

E-Poster #28

Value Of Axial Loading Magnetic Resonance Imaging And Computerized Tomography-Myelography In Decision Making In The Treatment Of Degenerative Lumbar Spinal Stenosis

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Introduction: The degenerative lumbar spinal stenosis (LSS) is a dynamic phenomenon. Changes in posture and physical activities as standing and walking can aggravate symptoms. The aim of the study was to evaluate the results of post axial loading Computed Tomography Myelography (CTM) versus Magnetic Resonance Imaging (MRI) in patients undergoing surgery for multilevel degenerative lumbar spinal stenosis.

Methods: Thirty patients with multilevel degenerative LSS scheduled for elective surgery were enrolled in the study. Preoperatively, all patients underwent both MRI and CTM, in supine psoas relaxed position and post loading by axial compression in slight extension. Quantitative evaluation for LSS was conducted by two experienced radiologists. The parameters included dural sac cross sectional area, lateral recess and foraminal evaluations for stenosis, on CTM and MRI. Statistical analysis of the data was performed to evaluate relative advantages and additional information depicted by axial loaded CTM versus MRI.

Results: In 21 of 30 of patients, axially loaded images demonstrated additional information, such as findings of spinal canal encroachment, deformation of the dural sac and nerve roots, reduction in cross sectional dural sac area, narrowing of the lateral recess, increased number and severity of affected stenotic sites particularly in borderline cases after axial compression. In 11 patients, borderlines for stenosis were passed in at least one level. CTM and MRI findings were comparable.

Conclusion: Axial loading mimics erect posture on CTM and MRI, thus partially eliminating the diagnostic dilemma associated with the dynamic nature of LSS. The study demonstrated underestimation of extent and severity of LSS on preloading images. Post axial loaded CTM and MRI added valuable information to the preoperative assessment of patients of multilevel spinal stenosis by identifying additional levels and severity of stenosis, particularly in borderline cases.

E-Poster #29

A new nickel-depleted nitinol for minimally invasive scoliosis surgery

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Introduction: Minimal invasive scoliosis surgery using nitinol (e.g anterior thoracic epiphyseodesis) is very promising. However, release of toxic nickel particulate debris in nitinol remains a major concern. We developed a novel method of altering the surface to reduce nickel release by using nano-scaled plasma immersion ion implantation (PIII). In addition to the corrosion resistance and surface mechanical properties, this paper also compares the in vitro and in vivo performance of PIII treated samples with untreated nitinol and other medical grade reference alloys.

Methods: Nitinol discs containing 50.8% Ni were implanted with nitrogen and carbon plasma using PIII technique. Their elemental depth profile, surface chemical composition, surface hardness, and corrosion resistance were analyzed. The amount of Ni released into simulated body fluids after the accelerated corrosion tests were determined. Cytocompatibility was assessed by culturing mouse osteoblasts expressing an enhanced green fluorescent protein on the surface of these materials. In vivo behavior was evaluated by surgically implanting the untreated and treated alloys into rabbit models for 2, 4 and 12 weeks.

Results: After PIII treatment a layer of titanium nitride and titanium carbide formed on the surfaces. When compared with untreated materials, the corrosion resistance was five-fold higher, and the surface hardness and elastic modulus were 2-fold higher. The concentration of Ni in the simulated body fluid for the untreated sample was 30ppm compared to undetectable levels in the PIII treated samples. Cell proliferation on nitrogen treated sample was significantly higher among the samples. It also exhibited superior in vivo bone formation at all time points.

Conclusion: PIII treatment is a method of nano-scale surface modification and is not another form of coating technology, therefore it does not de-laminate from the substrate. With enhanced surface mechanical properties, negligible Ni release, and superior osteoconductivity, PIII technology will allow nitinol to be safely implanted in the human body.

Significance: There is potential for this material to be used in the next generation of scoliosis implants in minimally invasive and non-fusion technologies. Acknowledgement: SRS Standard Grant.

E-Poster #30

Thoracolumbar Kyphosis and Spinal Cord Compression in Young Achondroplastic Patients. Surgical Strategies and Difficulties

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Introduction: The frequency of thoracolumbar kyphosis is important in achondroplastic newborns (up to 95%). These deformities have an important risk of progression and structuralisation with growth. Before early taking care with bracing and physiotherapy, 10% of patients developed important and progressive deformity with a significant risk of spinal cord compression.

Methods: Seven operated children were reviewed in these series. Mean age was 10 years at surgery (7-12). The mean pre-op kyphosis angle was 100° (85°-110°). All patients had a spinal cord compression (abnormal spinal cord signal on MRI or neurological injury with claudication). All the patients were adult at review.

Results: - Two patients had a single posterior decompression. They worsened their kyphosis in one year and required complementary anterior fusion. - Five patients had a front and back fusion with a posterior instrumentation in one case. Kyphosis correction was red

Conclusion: In conclusion, important kyphosis deformity requires a front and back fusion with pre-operative reduction by halo or cast if necessary. In case of angular and rigid deformity (above 50°), we recommend also to perform a corporectomy of the apex vertebra in young patients.

E-Poster #31

Cell Quantity and Degenerative Stage Dependent Effect of Allogeneic Mesenchymal Stem Cells on Regeneration of Intervertebral Disc

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Introduction: The therapeutic effect of autogenic MSCs on disc degeneration has been previously reported. However, autogenic transplantation lacks on-shelf availability in practice and may carry intrinsic factors of degeneration. We have tested the effect of allogeneic MSCs in IVD regeneration in terms of various cell quantities and disc degenerative stages.

Methods: By annulus puncture, IVD degeneration was induced at L2/L3 and L4/L5 level in NZW rabbits. One month after, various quantities of bone marrow MSCs from Chinchilla rabbits were encapsulated in 0.25% PuraMatrix™ peptide hydrogel and then injected into the degenerated discs at mild or severe degenerative group. At 1 or 3-month intervals, disc hydration was quantitated by MRI and disc height index was determined from radiographs.

Results: MSCs were able to arrest the continual loss of total disc hydration at one month post-injection. With the minimal quantity of MSCs, discs of mild group but not the severe group can regain hydration at 3 month post-injection, accompanied by maintenance of maximum hydration and disc height index. Implanting higher quantity of MSCs did not result in an effective arrest of degeneration at either degenerative stage.

Conclusion: Allogeneic MSCs can effectively arrest or even reverse rabbit disc degeneration without eliciting adverse immune response. The regeneration effect of MSCs is more prominent at mild than severe degenerative stage. A low cell quantity suffices for provoking the regenerative effect while overdose of cells can be detrimental.

Significance: This study indicates that allogeneic MSCs can effectively arrest or reverse disc degeneration, thus allow clinically-relevant application for treating disc degenerative disease and spinal deformities.

E-Poster #32

Efficacy of Growing Rods in Infantile Marfan Scoliosis

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BSN

Introduction: This is a retrospective analysis of nine patients with Marfan syndrome and scoliosis (developing before age 3) treated with growing rod techniques with a minimum of 2 years follow-up.

Methods: Radiographic and chart reviews included the following parameters: age, lordosis, kyphosis, complications, coronal balance, T1-S1 length, and initial curve degrees. Three patients had single growing rods and six had dual. The mean age at initial surgery was 4.5 years (range 2-9 years). Mean curve was 80° (range 54-105°). Mean thoracolumbar kyphosis was 56° (range 27-85°). Patients on Coumadin were lengthened yearly or throughout longer intervals of time.

Results: The mean follow up was 65 months. Four of the nine patients have undergone final fusion. The common construct was T2/4 to L4 in 4 patients and or to the pelvis in 4. Curve correction was 54%. Single rods produced 41% correction, while dual rods produced 61% correction. Mean coronal imbalance improved from 56 to 18 mm and sagittal imbalance from 31 to 21 mm. Mean T1-S1 length obtained was 10.2cm for the whole group and 13.3cm for those who had undergone final fusion. Complications included two rod breakages and two intra-operative dural leaks. There was one anchor dislodgement and no postoperative dural leak. None of the patients developed clinically significant junctional kyphosis. One patient died of unrelated causes three months postoperatively.

Conclusion: As patients with neonatal Marfan syndrome are living longer, the spinal deformity becomes an increasingly important issue. Current growing rod techniques are an effective solution to the problem. Dual rods were more corrective compared with single rods. Significant spinal length can be obtained to minimize trunk disproportion.

Significance: Growing rod techniques can prevent large infantile curves from becoming severe in patients with Marfan syndrome.

E-Poster #33

Long-Term Health Related Quality of Life after Surgery for Adolescent Idiopathic Scoliosis (AIS) and Spondylolisthesis

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Introduction: The aim of surgical treatment for AIS is to correct deformity and prevent development of back pain and functional impairment in adulthood, while the goal of surgical treatment for pediatric spondylolisthesis is mainly pain relief and secondarily prevention of sagittal deformity progression. The aim of this study was to compare the long-term health related quality of life after surgery for spinal deformity (idiopathic scoliosis) and low back pain (spondylolisthesis) in adolescence.

Methods: 190 (mean (SD) age 15.3 (2.7) yrs at surgery, 30 males, mean major curve 53 deg) patients treated surgically (78 Harrington, 57 CD, 55 USS) for AIS and 270 (mean age 16.0 (5.5) yrs, 113 males, mean slip 44%) treated surgically for low- or high-grade spondylolisthesis (220 posterolateral, 26 anterior, 24 circumferential in situ fusion) participated in the present study. The mean duration of follow-up was 14.8 years (range, 6.1-22.4 yrs) for the scoliosis group and 17.8 years (range, 10.4-26.4 yrs) for the spondylolisthesis group. Radiographs were obtained preoperatively, at 2-year follow-up, and at final follow-up. Additionally, a physical examination was performed, and SRS-24 and SF-36 questionnaires were completed at the final follow-up visit.

Results: The average total score on the SRS-24 questionnaire was 99 (range, 63-118) for the scoliosis and 92 (42-115) for the spondylolisthesis group ($p < 0.001$). Patients in the scoliosis group had better values for general self-image, postoperative self-image, and postoperative function than patients in the spondylolisthesis group ($p < 0.001$). Sixteen patients in both groups reported back pain often or very often at rest. The standardized Physical Component scale (SF-36) yielded slightly but statistically significantly better values for scoliosis group (mean 52.3, range 32-61 points) as compared with spondylolisthesis group (mean 50.6, range, 27 to 59 points) ($p < 0.001$).

Conclusion: Patients with AIS had better long-term health related quality of life after surgery and they also scored better in self-image domains than patients with spondylolisthesis.

Significance: There are no previous long-term studies comparing health related outcomes after surgery for adolescent idiopathic scoliosis and pediatric spondylolisthesis.

E-Poster #34

Efficacy of Iliac S-Hook Fixation in VEPTR Treatment of Early Onset Spinal Deformity: Survival of Bilateral Iliac Hook Fixation is Superior to Unilateral in a Multi-center Study

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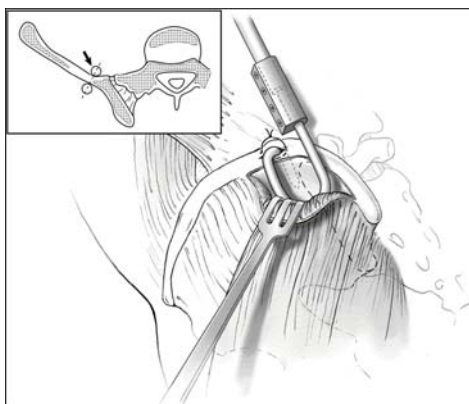
Introduction: VEPTR (vertical expandable prosthetic titanium rib) is commonly used to treat early onset spinal deformity (EOSD) associated with thoracic insufficiency syndrome (TIS). VEPTR allows for growth of the spine and thorax while controlling deformity of both. Constructs requiring pelvic fixation are common in VEPTR treatment of severe EOSD. S-shaped iliac hook fixation used with VEPTR rests on and within the cartilaginous apophysis of the iliac crest. Skepticism has been expressed about the efficacy of this fixation.

Methods: Review of a prospective multi-center database.

Results: 33 patients with follow-up > 2 (2-4.5) yrs received VEPTR with iliac S-hook fixation. Diagnoses included 16 neuromuscular, 2 syndromic, 12 congenital, 1 bone dysplasia, and 2 infantile idiopathic. 17 of 33 were ambulatory. All had severe EOSD. Mean age at initial VEPTR surgery was 6.1(1.9-14.7) yrs. Initial iliac S-hook constructs were 17 unilateral and 16 bilateral. 10 unilateral and 7 bilateral patients ambulated. 10 of 17 unilateral S-hook constructs were revised for iliac hook drift, while no bilateral iliac devices had been revised at last follow-up ($P < 0.001$). A mean of 1.6(1-3) revisions per patient requiring revision were performed at a mean of 1.2(0.13-2.4) yrs after initial implantation. Two unilateral constructs were converted to bilateral configuration. 23 of 33 patients did not require iliac S-hook revision.

Conclusion: Unilateral or bilateral iliac S-hook fixation used with VEPTR constructs appears to be durable and efficacious in the treatment of early onset spinal deformity even in ambulatory patients. Unilateral iliac S-hook fixation is associated with a higher rate of revision, presumably because of larger stresses placed on the unilateral device. Specific criteria for revision are however needed, as migrating iliac hooks are generally stable, asymptomatic and need revision only as the device nears the acetabulum. Load-sharing by bilateral iliac S-hooks is suggested where appropriate.

Significance: Iliac crest S-hook fixation as commonly used in VEPTR is effective either in unilateral or bilateral configurations. Unilateral constructs have a higher rate of revision.



Iliac S-hook fixation as used with VEPTR - Campbell, et al JBJS 86-A Supl 1 2004

E-Poster #35

Arthrodesis using BMP-2 in adult scoliosis: Clinical and radiographic results

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Introduction: The use of BMP in adult scoliosis patients is expected to decrease pseudarthrosis and improve clinical outcomes.

Methods: 68 consecutive patients were surgically corrected by a single surgeon with posterior instrumented fusion. All had interbody fusion (58ALIF, 10TLIF). BMP-2 (dose 4-12mg/disk) on collagen sponges were used with structural support (cage or allograft) in interbody spaces in 53 patients (ave 3 levels/pt, 172 levels) and structural allograft alone in 15 patients (ave 6 levels/pt, 90 levels). Fusion was assessed by CT or flex-ext radiographs with $>3^\circ$ motion or screw halos defining nonunion.

Results: No BMP related complications occurred. Follow-up ave >4 years (24-154months). 5 /15 allograft patients had nonunions (33%). 3/53 BMP patients (6%) had nonunions and 2 delayed unions which fused by 1 year. Dose of BMP (4 vs. 12mg) was unrelated to nonunion occurrence. Oswestry and VAS pain scores were better in the patients that fused.

Conclusion: BMP-2 significantly improves the fusion rate and clinical outcomes in patients surgically treated for adult scoliosis.

E-Poster #36

Linkage Analysis on Familial Early-Onset Degenerative Disc Disease

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Introduction: Low back pain is commonly caused by degenerative disc disease (DDD). While the etiology of DDD is not known, recent evidence from twins studies and case-control association studies suggests that genetic factors play a significant role. Family-based linkage analysis has the ability to discover new candidate genes without prior biological knowledge. Success of linkage analysis is based on the ability to identify a discriminating phenotype and the recruitment of sufficient families.

Methods: Southern Chinese subjects with low back pain and early-onset DDD, defined as MRI-proven disc degeneration or herniation occurring under 30 years of age, were recruited into the study together with their family members. T2-weighted sagittal MRI of the whole spine were performed, and their blood were taken for DNA isolation. MRI were graded using Schneiderman's classification. The initial genome wide linkage mapping was based on the ABI PRISM Human Mapping Set with 400 microsatellite markers at an average resolution of 10 cM. Besides Schneiderman's score, which does not differentiate between age-related changes and DDD, we have also created a novel age-adjusted scoring system to account for the effect of age on DDD status.

Results: Altogether 18 families with 126 individuals were recruited in this study. The families were screened and chosen based on the involvement of several generations and presence of multiple members with early-onset DDD. After data analysis, candidate regions with suggestive linkage were identified on chromosomes 1, 5, 8, 10, 14, 20.

Conclusion: It has revealed a number of promising loci for further study. Work is on-going to perform fine-mapping of these regions in order to identify possible candidate genes for further analysis.

Significance: An understanding of the contribution of genetics to the etiology of disc degeneration will also shed light on the issue of adjacent level degeneration after fusion, and whether this is part of the natural history of degeneration rather than increased stress on the motion segment.

E-Poster #37

Reliable Warning Criteria of Intraoperative Somatosensory evoked potential monitoring in scoliosis surgery. Results of a Prospective, Consecutive Series of 313 Cases.

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Introduction: The commonly used warning criteria in intraoperative somatosensory evoked potential(SEP) monitoring consisted of amplitude decrease and/or latency increase. In our experience, the change course and waveform pattern of SEP should be considered. This prospective study was designed to evaluate the monitoring reliability based on a proposed comprehensive warning criterion in considering gradual, rapid SEP changes and waveform distortion.

Methods: A consecutive series of 313 scoliosis patients underwent surgery between July 1997 to June 2005 were recruited. Posterior tibial nerve SEP monitoring was employed for intraoperative spinal cord monitoring. Three criteria were compared, including: a) traditional criterion: amplitude decrease>50% or latency increase>10%; b)modified criterion: amplitude decrease>60% or latency increase>10%; c) comprehensive criterion: criterion B plus amplitude decrease more than 30% within 30 minutes or a sudden SEP waveform distortion. The abnormal SEP was defined by criterion C. The monitoring outcomes were compared among the above 3 criteria, in terms of specificity and sensitivity with the false-negative and false-positive rates.

Results: Four patients presented neurological complications post-operation. Two of the 4 positive cases were detected by criterion C, but only one was detected by criterion A and B. In the other negative cases, 5 cases were defined abnormal by criterion A, but no any case was found abnormal based on criterion B and C. The monitoring outcomes from different warning criteria were presented in Table 1. The proposed comprehensive criterion showed least false cases, highest specificity, sensitivity and accuracy in this series.

Conclusion: Warning criterion with general consideration of gradual changes, rapid changes and waveform distortion is a comprehensive assessment of SEP changes. It could decrease false-positive and false-negative outcomes. This comprehensive criterion was recommended as a reliable warning criterion for intraoperative spinal cord monitoring.

Significance: The proposed comprehensive criterion can improve the reliability of spinal cord monitoring by reducing both false positive and false negative rates. The use of it can provide much reliable and accurate monitoring to scoliosis surgery.

Spinal cord monitoring outcomes by different criteria

Outcomes	Traditional criterion	Modified criterion	Comprehensive criterion
True negative	304	309	309
True positive	1	1	2
False negative	3	3	2
False positive	5	0	0
Specificity	98.4%	100%	100%
Sensitivity	25%	25%	50%
Accuracy	97.4%	99%	99.4%

E-Poster #38

Expression of Estrogen Receptor in osteoblasts of patients with adolescent idiopathic scoliosis (AIS)

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Introduction: AIS occurs and progresses at puberty during the hormone-controlled rapid growth period. This period coincides with many biological changes related to estrogen signaling via two nuclear receptors, ER α and ER β . Here we investigate the expression of ER α and ER β in AIS and control (trauma) patients.

Methods: RNA extracted from osteoblasts of AIS and control patients was investigated by RT-PCR using primers covering all 4 domains of ER α and ER β (protein-protein interaction, hinge, ligand-binding and DNA binding domains). In addition, ER α and ER β were detected by immunohistochemistry on spinal biopsy tissues and on osteoblasts exposed in vitro to 17- β -Estradiol.

Results: All AIS patients (n=10, age=14 \pm 2.02, Cobb=59.37 \pm 20.9) and controls (n=8, age=14.7 \pm 3.0,) show transcripts of many isoforms of ER α . However, the expression of ER β varied between patients and controls, and results suggest the presence of various isoforms in human osteoblasts. We identified by sequencing an insert specific to isoform h-ER β S1, in 6/10 AIS patients and 8/8 controls. Immunohistochemistry revealed high levels of ER α and low levels of ER β (Figure 1). Finally, osteoblasts of AIS patients exposed to 17- β -Estradiol show increased nuclear expression of ER α , which was not observed in control osteoblasts.

Conclusion: ER α and ER β have overlapping roles in regulating growth and differentiation of bone tissues. However, ER β is the dominant receptor in many ER-dependent signaling pathways in bone cells, and some isoforms exhibit an antagonistic effect on ER-mediated transcriptional activity. Surprisingly, the level of ER β was very low in AIS cells, compared to ER α . In addition, the lack of the isoform h-ER β S1 in some AIS patients, as well as the altered balance between ER α and ER β , appears to be critical for estrogen-dependent functions of osteoblasts, which could impact bone homeostasis and lead to decreased bone mineral density and osteopenia in AIS.



Figure 1: Immunohistochemistry of ER α and ER β , on vertebrae of an AIS patient

E-Poster #39

Does Body Mass Affect Surgical Outcomes in Adolescent Idiopathic Scoliosis?

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Introduction: Obesity has reached epidemic proportions globally, and has been associated with a greater risk of co-morbidities and an increased rate of postoperative complications in adult and adolescent populations. The objective of this study was to determine if an association exists between body mass and surgical outcomes in AIS patients.

Methods: Radiographic measures, peri-operative data, and Scoliosis Research Society (SRS) Outcomes Instrument scores were collected on surgically treated AIS patients. The body mass index (BMI; kg/m²) was calculated for each patient and normalized to sex and age (BMI%). Analysis of variance was used to identify differences between healthy weight (BMI% < 85) and overweight patients (BMI% ≥85). The data was checked for normality and equal variances, and the level of significance was set at $p < 0.01$.

Results: In 241 patients (204 females, 37 males; 14.3 ± 2.0 years old) with a minimum of 2-year follow-up, the average BMI was $20.7 \text{ kg/m}^2 \pm 3.7$ (BMI% average: 54.5%, range: 1-99). No significant differences were found between the overweight (n=48) and healthy weight (n=193) patients with regards to surgical time, estimated blood loss, major Cobb percent correction, post-operative infection rate, rate of implant failure, rate of perioperative neurologic compromise, and SRS scores (pre-operative and 2-year post-operative). However, the pre-operative thoracic kyphosis was significantly greater in the overweight group ($27.0 \text{ degrees} \pm 12.6$) compared with the healthy weight patients ($21.8 \text{ degrees} \pm 12.5$) ($p=0.004$).

Conclusion: Even though our sample size was limited, this study did not find an association between body mass and peri-operative morbidity, the ability to achieve and maintain coronal and sagittal deformity correction, and patient-based outcome measures. The significantly greater preoperative thoracic kyphosis in overweight patients may be related to increased compressive forces on the anterior vertebral growth plates and warrants further investigation.

Significance: As the prevalence of overweight and obese children increases, the effect of body mass on spinal sagittal alignment and the ability to achieve deformity correction after scoliosis surgery needs to be considered during pre-operative planning.

E-Poster #40

Infection Following the Surgical Treatment of Adolescent Idiopathic Scoliosis: Evaluation of Diagnosis, Treatment, and Impact on Radiographic and Patient-Reported Outcomes

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Introduction: The purpose of this study was to evaluate a single surgeon's experience with infection following surgical treatment of adolescent idiopathic scoliosis (AIS), with a focus on the diagnosis and treatment, as well as the impact infection has on radiographic and patient-reported outcomes.

Methods: From 1986-2004, 236 patients were identified who underwent surgical treatment of AIS and had at least 2 year follow-up. The medical records of patients who developed infection were retrospectively reviewed in detail. Preop and most recent postop radiographic parameters and SRS 24 outcomes of both infected and non-infected patients were compared.

Results: Of the 236 study patients, 7 (3%) developed a postop infection. One was acute, presenting 17 days postop, and 6 were delayed, presenting an average of 34.2 months postop. All infections involved the posterior wound. The most common presenting complaints were back pain(5/7) and localized swelling(4/7). Avg. WBC and ESR were 10.5 and 52.5, respectively. All patients with delayed infection were treated with one surgery, i.e. I&D and removal of instrumentation, and 6 wk of IV antibiotics. 2/6 patients had pseudarthrosis. Cultures were as follows: *S. epidermidis*(n=2), *P. acnes*(n=1), *E. faecalis*(n=1), Group A Strep(n=1), no growth despite purulence (n=1). The acute infection required 6 procedures (including bone graft and instrumentation removal) and 16 wk of antibiotics for treatment. Cultures grew MRSA and *Serratia marcescens*. Revision surgery was performed 5 months after the infection was treated. Compared to non-infected patients, those with infection had lower % MT (p=.01) and TL/L (p=.06) curve correction on most recent radiographs (avg. f/u 3.8 yrs). There was no difference, however, in the pain, function, self-image, satisfaction, or total SRS scores (avg. f/u 5.6 yrs).

Conclusion: Infection following the surgical treatment of AIS is usually delayed and can successfully be treated with I&D, removal of instrumentation, and IV antibiotics. Acute infection caused by more virulent organisms may require multiple I&Ds. Although less curve correction is achieved in patients who develop infection, there are no differences in patient-reported outcomes when compared to the non-infected group.

(See table next page)

Comparison of radiographic parameters and SRS 24 outcomes in infected and non-infected patients

Radiographic Parameters	Infection	No infection	P value
Preop MT Cobb*	60 ± 9°	55 ± 12°	0.23
Preop TL/L Cobb*	53 ± 17°	45 ± 14°	0.09
Preop coronal offset C7 from CSL (mm)*	15 ± 12	19 ± 15	0.55
Postop MT Cobb*	45 ± 18°	28 ± 11°	<0.01
% MT correction*	28 ± 22	48 ± 20	0.01
Post op TL/L Cobb*	40 ± 17°	25 ± 13°	<0.01
% TL/L correction*	24 ± 29	47 ± 42	0.06
Postop coronal offset C7 from CSL (mm)*	7 ± 9	10 ± 11	0.49
SRS 24 Outcomes			
Pain	21 ± 6	22 ± 9	0.79
Function	23 ± 3	22 ± 8	0.53
Self Image	21 ± 3	21 ± 7	0.90
Satisfaction	11 ± 3	12 ± 4	0.45
Total	76 ± 13	76 ± 27	0.98

*MT= main thoracic; TL/L=thoracolumbar/lumbar; CSL= center sacral line

E-Poster #41

Late Lateral Neck Flexion Deformity in Duchenne Muscular Dystrophy Patients Treated with Segmental Spinal Fusion.

Simon Gatehouse, FRACS (Freeman Hospital); Michelle Eagle, PhD, MSc, MCSP; Jwalant Mehta; Prof. Kate Bushby; Michael J. Gibson, FRCS

Introduction: Lateral flexion deformity has not been reported postoperatively. Deformity involving the cervical spine has been reported in muscular dystrophy with respect to extension contractures in the unoperated scoliosis.

Methods: Forty-eight patients with Duchenne Muscular Dystrophy operated on between 1991 and 2005 by a single surgeon were reviewed. All patients were treated with segmental fixation utilizing pedicle screw with selective hooks in hybrid constructs. Records of forty-three were adequate for review. There was a range of 2 to 14 years follow-up. Patients were followed radiologically for 2 years and clinically for life.

Results: The mean Cobb angle and pelvic tilt were 42° and 12°. Postoperatively the means were 12° and 5° respectively. Fusion levels were from T3 (40%) to L5 (84%) in the majority of cases. There was a moderate to strong correlation (0.72) between preoperative and postoperative Cobb and Pelvic obliquity angles. Pelvic obliquity of >10° was present in 5 (12%) patients postoperatively at last follow-up. Two interfered with function. Six patients (14%) developed lateral flexion deformity of the neck 5 to 10 years postoperatively. All were a functional problem. Lateral flexion did not appear truly junctional, developing in the cervical spine with preservation of the unfused proximal thoracic segments. There was no relationship to deformity measurements.

Conclusion: Distal junctional deformity with choice of fusion levels has been well discussed. Neck extension contractures treated with interspinous grafting at the time of thoracolumbar fusion has been reported. There are no reports of late lateral neck flexion deformity postoperatively. It appears not to relate to pre or post-operative deformity measurements. We have treated this deformity to date with orthotics. This has appeared satisfactory. At a rate of 14% we consider this deformity a significant underreported late complication.

Significance: Distal junctional deformity with choice of fusion levels has been well discussed. Proximal lateral flexion deformity has not been reported postoperatively. At a rate of 14% we consider this deformity a significant underreported late complication.

E-Poster #42

Parameters Which Predict a Good Outcome When Deciding to Fuse to L3 in Double Major Idiopathic Scoliosis

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Introduction: Factors determining fusion to L3 or L4 for a successful outcome when performing a posterior spinal fusion and instrumentation (PSFI) for double major adolescent idiopathic scoliosis (AIS) have not been fully defined.

Methods: A retrospective review of all patients who underwent a PSFI down to L3 for double major AIS using lumbar pedicle screws was performed at a single institution. Radiographic parameters were analyzed preoperatively, postoperatively and at 2 year follow-up. A good radiographic outcome at 2 years was defined as: L3 $\leq 10^\circ$, L3 translation ≤ 25 mm, L3-4 disc angle $\leq 10^\circ$ and LAVT ≤ 30 mm. Predictive factors leading to a good 2 year outcome were divided into preoperative and intraoperative.

Results: There were 41 patients, with an average age of 14.1 years, all fused to L3. Preoperatively, the distal end vertebra was L3 in 20 patients (L3 group) and L4 in 21 (L4 group). Preoperative Factors: When the preoperative end vertebra was L3, there were no preoperative predictors for a good outcome. For the L4 group, the following preoperative parameters predicted a good outcome: L3 tilt $\leq 15^\circ$, lumbar apical vertebral translation (LAVT) ≤ 34 mm, and a thoracolumbar curve (TL/L) $\leq 52^\circ$ ($p < 0.05$). Intraoperative Factors: For the L3 and L4 groups, intraoperative TL/L curve correction ($p < 0.0006$), L3 tilt % correction ($p < 0.0007$), and improvement in LAVT ($p < 0.0389$) correlated with a good outcome.

Conclusion: Determination of the preoperative end vertebra is important when performing a PSFI to L3 for double major AIS curves. When the end vertebra is L3, successful outcome is dependent only on the intraoperative deformity correction. When the end vertebra is L4, preoperative assessment of L3 tilt, LAVT and the magnitude of the thoracolumbar curve, and the amount of intraoperative deformity correction determine success.

Significance: The decision to stop at L3 or L4 for double major scoliosis is often difficult. This study provides guidelines for surgeons to preoperatively and intraoperatively determine whether fusion and instrumentation to L3 for double major scoliosis will yield a good result.

E-Poster #43

Flow Dynamics of Cerebrospinal Fluid (CSF) at the Craniocervical Junction in Adolescent Idiopathic Scoliosis: A Morphological and Functional Study with Phase Contrast MRI

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Introduction: Previous studies have documented obstructed CSF flow in patients with Chiari I malformation. Low-lying cerebellar tonsils and syringomyelia are also observed in AIS patients. We sought to investigate whether disturbed CSF flow is also evident in AIS subjects at the foramen magnum level and its relationship with level of cerebellar tonsils and dimensions of foramen magnum. In this study, using phase-contrast magnetic resonance (MR) imaging, the cerebrospinal fluid (CSF) flow dynamics at craniocervical junction in adolescent idiopathic scoliosis (AIS) was evaluated and compared with normal controls. Correlations were made with the morphology of cerebellar tonsil, foramen magnum and somatosensory cortical evoked potentials (SSEP) in all subjects.

Methods: Phase-contrast and conventional MR were performed in 105 adolescent girls, which include 69 AIS subjects (Cobbs angle 20-80, 40 had thoracic curve, 27 lumbar curve, 2 thoracolumbar curve) and 36 age-matched controls. Measurements of peak velocity of CSF flow in both the anterior and posterior subarachnoid space through foramen magnum, cerebellar tonsillar level related to the basion-opsithion (BO) line, anteroposterior (AP), transverse (TS) diameter and area of foramen magnum were obtained. Correlations were made among different parameters and SSEP findings.

Results: Peak CSF velocities through foramen magnum showed no significant difference ($p > 0.05$) between AIS and normal subjects though 42% subjects in AIS group had the cerebellar tonsillar tip positioned 1mm below the BO line. The cerebellar tonsillar level in AIS subjects was significantly lower than the median tonsillar level in normal controls ($p < 0.01$) while the AP diameter and area of foramen magnum were significantly larger in AIS subjects when compared with normal controls ($p < 0.05$).

Conclusion: Peak CSF velocities through foramen magnum were not significantly different in AIS subjects despite the presence of low-lying cerebellar tonsils. This might be explained by the compensatory effect of larger foramen magnum in AIS subjects.

Significance: Full manuscript of the above results have been accepted for publication in SPINE journal

E-Poster #44

Posterior lumbar interbody fusion and posterior instrumentation in the surgical management of lumbar tuberculous spondylitis

Jung Sub Lee, MD (Pusan National University School of Medicine); Prof. Kuen Tak Suh; Seong-Jang Kim, MD, PhD

Introduction: There are currently a few reports on the treatment of lumbar tuberculous spondylitis through the posterior approach using a single incision.

Methods: Between January 1999 and March 2004, we performed operations on 16 patients with lumbar tuberculous spondylitis. All the patients underwent a posterior lumbar interbody fusion with an autogenous iliac bone grafting and pedicle screw instrumentation through the posterior approach. The clinical outcomes were assessed utilizing the Frankel neurological classification and the Kirkaldy-Willis criteria.

Results: Under the Frankel classification, 1 patient improved by two grades, 7 patients improved by 1 grade, and 8 patients demonstrated no change. The Kirkaldy-Willis functional outcomes were classified as excellent in 8 patients, good in 5, fair in 2 and poor in 1. Bony union was confirmed by 1 year after surgery in 15 patients, but not in 1 patient who underwent removal of an implant because of a postoperative deep infection. The mean preoperative lordotic angle was 27.8 degree and the mean lordotic angle at the final follow-up was 35.8 degree. Postoperative complications were encountered in 4 patients, which included a transient root injury in 2, a superficial wound infection in 1, and a deep wound infection in 1.

Conclusion: Our results demonstrate that posterior lumbar interbody fusion with an autogenous iliac bone grafting and pedicle screw instrumentation for tuberculous spondylitis through the posterior approach can provide satisfactory results.

E-Poster #45

***Radiographic Assessment of Enhanced vs Standard Dose rhBMP-2 Utilized as Iliac Crest Graft Substitutes in Instrumented Single Level Lumbar Fusions.**

James Hardacker, MD (The Spine Institute); Jill Richardson, PA-C; Phillip Pryor, MD

Introduction: rhBMP-2(1.5mg/cc) has been approved for anterior lumbar reconstructions. The optimal dose of rhBMP-2 for posterior spinal procedures has not yet been determined. This pilot study was undertaken to evaluate the effectiveness of 2 doses of rhBMP-2 as iliac crest graft substitutes in posterolateral lumbar fusions.

Methods: Single level instrumented posterolateral lumbar fusions were conducted in a consecutive series and reviewed retrospectively comparing two doses of rhBMP-2 as iliac crest bone graft replacements. Eighteen patients received standard dose INFUSE(1.5mg/cc) soaked on a collagen sponge wrapped around ceramic granules creating a 'fajita' placed along the posterolateral lumbar spine. Twenty patients received enhanced dose AMPLIFY rhBMP-2(2.0mg/cc) applied to ceramic granules formed into a compressive resistant matrix and placed along the posterolateral lumbar spine. We compared fusion rates and outcome measures in this pilot study utilizing sequential radiographs and fine cut CT scans of the fusion mass to evaluate the bone formation in the fusion. A modified fusion grading scale was utilized.

Results: At 24 months, the fusion rate was 95% for enhanced dose rhBMP-2 patients and 100% for standard dose rhBMP-2 patients and not statistically different. However, fusion scores were statistically delayed at 6 months in the standard dose versus the enhanced dose. This effect gradually resolved at one year and completely resolved at 2 yr radiographic and CT follow up. Outcome measures and pain scores improved in all groups. No inflammatory reactions occurred with these doses of rhBMP-2.

Conclusion: Both doses of rhBMP-2 are effective in obtaining posterolateral lumbar fusion with instrumentation. However, the commercially available standard dose of rhBMP-2 used as a bone graft replacement has significantly poorer posterolateral fusion grading at 6 month postop radiographs and CT scans when compared to the enhanced dose rhBMP-2 fusions.

Significance: Dosing of rhBMP-2 is crucial in obtaining solid spinal reconstructive procedures. This pilot study compares a consecutive series of patients receiving standard and enhanced dose rhBMP-2. It provides insight into rhBMP-2 dosing for lumbar posterolateral arthrodesis.

PFTs before and after rehabilitation

	Before rehabilitation	After rehabilitation	P
VC (L)	2.51 ± 0.50	2.61 ± 0.47	P<0.05
%VC	85.5 ± 12.2	88.5 ± 12.3	P<0.05
FEV1.0 (L)	2.09 ± 0.47	2.24 ± 0.44	P<0.05
FEV1.0%	85.8 ± 8.2	88.0 ± 8.0	N.S.

N.S.:not significant

E-Poster #46

Evaluation of Respiratory Rehabilitation in Scoliotic Patients using Dynamic Breathing MRI.

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Introduction: While there have been studies on the deleterious effect of scoliosis on pulmonary function, there have been few reports on the efficacy of respiratory rehabilitation before surgery. The purpose of this study was to evaluate the effectiveness of pulmonary rehabilitation in scoliotic patients using dynamic breathing magnetic resonance imaging (B-MRI).

Methods: Prior to respiratory rehabilitation, Pulmonary function tests (PFT) and dynamic breathing MRI scans using Fast Imaging Employing Steadystate Acquisition (FIESTA) sequences were performed on 18 patients with right thoracic scoliosis (18 women; mean age 16.2 years, age range 13 - 20). Chest wall and diaphragm movements were evaluated dynamically with a cine-loop view, and the data analyzed quantitatively by measuring displacements of the chest wall and diaphragm. Respiratory rehabilitation included stretching of thorax, aerobic exercises, and triball as guided by a physiotherapist. After a two-week rehabilitation period, MRI and PFT were performed to assess the effectiveness of rehabilitation.

Results: A significant improvement in VC, %VC and FEV1 values was observed after rehabilitation. The diaphragm motion was not significantly altered, increasing from 51.0 ± 12.5 mm to 55.3 ± 15.6 mm on the right side and from 44.6 ± 15.8 mm to 49.7 ± 15.5 mm on the left side. In contrast, significant changes were seen in chest wall motion, with the right chest wall rising from 13.9 ± 8.6 mm to 19.2 ± 8.2 mm, and the left chest wall rising from 10.3 ± 6.6 mm to 16.4 ± 10.1 mm.

Conclusion: One of the distinguishing features of respiratory dysfunction in scoliotic patients is limited chest wall motion. Two weeks of preoperative respiratory rehabilitation provided improvements in pulmonary function and chest wall motion, suggesting this as a useful modality for reducing respiratory complications. B-MRI emerges as a useful tool for the dynamic assessment of respiratory rehabilitation and planning for respiratory rehabilitation in scoliotic patients.

Characteristic	Level Fused (n=288)	Level Not Fused (n=14)	p value
Group (Mean Levels Fused)			
1 (2.33)	99 (34%)	10 (71%)	
2 (3.72)	147 (51%)	4 (29%)	
3 (6.00)	42 (15%)	0	
Female Gender	259 (90%)	12 (86%)	0.64
Age (years)	52.7±11	53.7±8.9	0.84
Number of Levels BMP Was Used	4.83	3.50	0.14
Follow-up (years)	2.6	2.5	0.54
Laminectomy Level (Group 2)	43/171 (25%)	2/4 (50%)	0.27
Previous Pseudarthrosis	33 (11%)	1 (7%)	1.0
Smoking History	35 (12%)	2 (14%)	0.70
Medical Comorbidities	73 (25%)	7 (50%)	0.12

E-Poster #47

***Bone Morphogenetic Protein (rhBMP-2) as a Substitute for Iliac Crest Bone Graft in Multilevel Adult Spinal Deformity Surgery: Minimum 2-year Evaluation of Fusion**

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Introduction: No previous study has evaluated rhBMP-2 for multilevel adult spinal deformity fusion with a minimum of 2-year follow-up. We postulated a solid fusion could be achieved without distant autogenous graft harvest at the dosages listed below and that confounding variables would not impact fusion rate.

Methods: Prospective radiographic analysis was performed for 97 patients (302 levels, mean age 51.4 yrs) who underwent multilevel anterior (ASF) or posterior spinal fusion (PSF) with a minimum 2-year follow-up (average 2.6yrs). Group 1 (10mg/level) contained 47 patients (109 levels) who underwent ASF in the lumbar spine: BMP placed on an absorbable collagen sponge (ACS) with a single titanium mesh cage. Group 2 (20mg/level) included 43 patients (151 levels) treated with PSF: BMP placed on an ACS with local bone graft (LBG) and Tricalcium Phosphate/Hydroxyapatite [TCP-HA]. Group 3 (40mg/level) contained 7 patients (42 levels) treated with rhBMP-2 and TCP-HA: no autogenous bone. No patients in any group had iliac crest or distant graft harvest. Postop films (AP, lateral, oblique) were evaluated by independent observers and average fusion grade was recorded based upon a published 4-point scale.

Results: Overall fusion rate was 95%. Fusion rate for Group 1 was 91%, Group 2 97%, and Group 3 100%. Presence of medical comorbidities, previous laminectomy, previous pseudarthrosis, history of smoking or number of levels fused was not found to be a statistically significant negative factor in fusion rate.

Conclusion: RhBMP-2 without iliac crest bone graft produced an excellent fusion rate. In multilevel ASF, BMP (10mg/level) is capable of generating fusion without autogenous bone. In multilevel PSF, BMP (20mg/level) with LBG produced fusion. BMP (40mg/level) without LBG achieved PSF. Lower doses of rhBMP-2 with the addition of LBG and bulking agents can achieve fusion similar to high-dose BMP in adult spinal deformity surgery. In multilevel spinal fusion, rhBMP-2 eliminates the necessity for iliac crest bone graft and may neutralize negative confounding variables.

E-Poster #48

Follow-up of Major Spine Deformity Surgery in Patients with Multidisciplinary Problems. Risks and Complications versus Pre-Surgery Status, Staged Surgery, Type of Instrumentation, and Production Unit Logistics.

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Introduction: Purpose: Complication and risk analysis of major spine surgery in high risk patients aiming to compare: two hospitals; one stage procedure with additional neurosurgery versus deformity correction alone; one stage combined anterior and posterior procedure versus only posterior; caudal fixation below/above L5.

Methods: 137 patients, 2-22 years of age, with neuromuscular, syndrome related and congenital spine deformities w/wo intraspinal pathology, surgically treated by one surgeon 1997-2004 at two production units (hospital 1 with a multidisciplinary team; hospital 2 with a standard spine unit), were followed up 24-104 months. Depending variables were age, diagnosis, curve size, producer unit, surgery type (only ant or post, combined ant + post, additional neurosurgery in the same session), type of caudal fixation. Result variables were clinical and radiographic outcome, surgery time, length of intensive care and hospital stay, relative bleeding, and occurrence of complications.

Results: Age, gender, diagnosis, curve size and surgical procedures did not differ between hospital 1 and 2. The mean correction of the curve was 59%, and of the pelvic obliquity 66%. The mean loss of correction was 2 degrees. More than 10 degrees progression was seen in 11 cases. No neurologic complications or deaths occurred. There were 15 complications which altered the planned course or outcome. 13 of these 15 were infections and one pseudoarthrosis. Complications were not related to type of surgery or to pre-surgery data. Neither one-stage surgery nor adding on neurosurgery increased the occurrence of complications, whereas the number of infections increased with a third and the number of complications doubled when the production unit was changed.

Conclusion: One-stage major spine surgery, also when neurosurgery is included, is safe. It does not increase the risk for major complications. The increase in hospital and ICU stay is marginal. Sacrum/pelvic fixation enhance the correction without increasing risks. Organisational and professional quality of production units can be a risk factor.

Significance: The quality routines and logistics of a hospital have an important impact on the surgical outcome.