

COA Paper Session 15: Spine 1 •

Moderators Eugene Wai, ON, and Brendan D. Lewis, NL

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Preoperative Predictors for Postoperative Clinical Outcome in Lumbar Discectomy

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Purpose: Persistent radiculopathy secondary to lumbar disc herniation is a common problem that greatly compromises quality of life. In North America, lumbar discectomies are among the most common elective surgical procedures performed. There is still much debate about when conservative or surgical treatments should be offered to patients. Although the related literature is comprehensive, there are limited systematic reviews on the prognostic factors predicting the outcome of lumbar discectomy. The purpose of this review is to define the preoperative factors predicting clinical outcome after lumbar discectomy. **Method:** We conducted a computerized literature search using Ovid Medline and the Cochrane Central Register of Controlled Trials. We included randomized controlled trials or prospective studies dealing with lumbar disc surgery. The preoperative predictors had to be clearly identified and correlated with outcome measures in terms of pain, disability, work capacity, analgesia consumption, or a combination of these measures. We assessed the articles as high or low quality studies using the Newcastle-Ottawa Quality Assessment Scale, and summarized the results of High Quality Studies. **Results:** A total of 39 articles were included. The two most prominent negative predictors were Workers' Compensation status and depression according to 6 studies. Poor predictors reported in 4 articles were female gender, increasing age, and prolonged duration of leg or back pain. Lower education level, smoking, and higher levels of psychological complaints were negative predictors in 3 articles. A positive Lasègue sign was a positive predictor in 7 articles. Absence of back pain, positive patient expectations, and higher income were good prognostic factors in 3 studies. Patients with contained herniations did worse than those who had uncontained disc extrusions and sequestrations according to 4 studies. The level of herniation was not a predictive factor in 7 studies. **Conclusion:** Workers' Compensation, depression, greater back versus leg pain, increasing age, female gender, contained herniations, and prolonged symptoms predict unfavourable postoperative outcomes after lumbar discectomy. Positive Lasègue sign, higher income, uncontained herniations, and positive patient expectations predict favourable postoperative outcomes. The level of herniation is not an established prognostic factor. The results of this review provide a preliminary framework for patient selection for lumbar disc surgery.

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Pre-operative CT Imaging of the Cross-sectional Area of Perispinal Musculature as a Predictor of Posterior Lumbar Fusion Surgery Outcomes

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Purpose: Perispinal core muscle strength has been theorized to be an important component in the pathogenesis of back pain. Recent research has demonstrated a strong association between preoperative perispinal musculature, adjusted for fatty infiltration and prospective outcomes and improvements in back pain in patients undergoing lumbar laminectomy without fusion. The purpose of this study is to determine if a similar relationship exists in patients undergoing elective posterior lumbar fusion and decompression (PLFD) surgery. **Method:** A retrospective observational study of prospectively collected outcomes data was conducted in which pre-operative function and patient variables of those undergoing PLFD were derived from a functional status questionnaire and medical records. ImageJ Digital Imaging Software was utilized to measure the total (CSA) and percentage of fatty infiltration of the psoas, multifidus, and erector spinae muscles in pre-operative L4 axial CT images. Pre-operative and post-operative lateral images were evaluated for degree of post-operative adjacent level degeneration. Follow-up consisted of a functional status questionnaire. Outcomes measured were improvements in back pain, leg pain, and Oswestry disability scores. **Results:** Twenty-three patients were analyzed with a mean follow-up of 2 years (range 1 - 5 years). Outcomes improved following surgery. There were strong to moderate correlations between percentage of fat in the pre-operative posterior spinal muscles and improvements in leg pain ($r = 0.63$, $p = < 0.001$) and improvements in back pain ($r = 0.41$, $p = 0.05$). There was a moderate trend towards greater adjacent level degeneration ($r = 0.37$, $p = 0.1$) in patients with higher percentage of fat in the pre-operative posterior spinal muscles. There was a strong relationship between greater adjacent level degeneration and pre-operative disability as measured by the Oswestry ($r = 0.62$, $p = 0.03$). **Conclusion:** The results demonstrate that a potential relationship exists between pre-operative fatty infiltration of posterior perispinal muscles and post-operative outcomes, and adjacent level degeneration following lumbar fusion surgery. This suggests that perispinal muscle atrophy and conditioning may play a role in these outcomes. Results may be used for prognostication, surgical candidate selection, and interventional strategies.

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Caudal Epidural Steroid Injections for Lumbo-Sacral Radicular Pain... Does it Really Make a Difference?

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Purpose: The management of radicular pain due to lumbar or sacral nerve root compromise remains controversial. Caudal epidural steroid injections are widely employed although there is little hard evidence to confirm their efficacy. This empirical treatment still remains a matter of personal choice and experience. To investigate the clinical effectiveness of caudal epidural steroid injections (CESIs) in the treatment of sciatica and to identify potential predictors (clinical subgroups) of response to CESIs. **Method:** Prospective study. All patients with corresponding radicular pain received a course of three caudal epidural steroid injections, two weeks apart. All patients reviewed at three months interval in a dedicated epidural follow up clinic and one-year postal and telephonic follow-up. Exhaustive epidural database maintained. VAS scores documented both axial and limb pain for actual and comparative analysis. ODI and HADS were recorded prior to treatment, at three months follow-up and one year. Main outcome measures: The primary outcome measure was the Oswestry Disability Questionnaire (ODQ). The Visual analogue score (VAS) and the Hospital Anxiety and Depression Scores (HADS) were also employed in all cases. **Results:** In the largest single series to date, we report on 928 consecutive patients, with three months follow-up and 354 patients with 12 months follow-up. Fifty-eight percent were females, 24% smoked and 4.1% had ongoing litigation due to their pain. The mean age was 56 years with BMI ranging from 17 to 50 (mean=28). Ten (0.6%) patients required subsequent surgical intervention due to disc herniation. The mean VAS, ODI and HADS improved significantly at three months and one-year results were encouraging. **Conclusion:** Significant improvement in both axial and limb pain in the short and intermediate terms achieved facilitating onward referral for physical therapy. Subgroups predicting poor outcome are identified. Positive primary care feedback encourages further recruitment.

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The Treatment of Lumbar Intermittent Neurogenic Claudication Using the XStop IPD Device: A Prospective Clinical and Functional Outcome Study

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Purpose: Lumbar spinal stenosis is the most common indication for spine surgery in the elderly. XStop IPD is an attractive alternative to traditional laminectomy or laminectomy with fusion as it avoids a longer procedure and anaesthesia with significantly less blood loss. The purpose of this study is to prospectively evaluate clinical outcomes, complications and functional evaluation of symptom severity, physical function and patient satisfaction following XStop IPD procedure **Method:** Preoperative and postoperative clinical data as well as SF 36, visual analog scale and Roland Morris questionnaire data collected on 16 consecutive patients over 60 years undergoing XStop IPD at L3-4 and L4-5 levels or both levels. All patients had symptomatic lumbar spine stenosis with intermittent neurogenic claudication. Evaluations were made pre-operatively and post-operatively at 3, 6, 12 and 24 months. All patients had clinical radiographic data as well as data on

visual analog scale SF 36 and the Roland Morris back questionnaire. **Results:** Patients ages ranged from 58 to 86 years with an average age of 74.25 years. In 75 percent of patients there were two or more significant comorbidities with 18.75 percent requiring 2 level surgery. Four of the 16 patients had lumbar degenerative scoliosis with Cobb angle less than 25 degrees. 50.25% the patients had grade I spondylolisthesis. No patient had previous spine surgery. In 31.25 percent of patients there was a history of diabetes. BMI ranged from 20 to 40. Seventy five percent of patients were discharged home within 24 hours. Ninety percent of patients reported relief of their leg pain at their first follow up visit within two weeks of the surgery. There were no significant complications. One-year follow up in six patients demonstrated improvements in VAS, Roland Morris criteria and SF 36 while the remaining patients have up to nine months of follow-up clinical data. **Conclusion:** We present our early results of this prospective study. There were significant improvements in functional outcomes. We therefore recommend the use of XStop IPD for elderly patients with multiple comorbidities suffering from symptomatic lumbar spine stenosis with neurogenic claudication.

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Understanding Patient and Physician Preferences for Surgery on the Degenerative Lumbar Spine

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Purpose: Surgery for degenerative lumbar spinal conditions offers tremendous benefit for patients with moderate/severe symptoms failing non-operative treatment. There is little appreciation among referring family physicians (FPs) on factors that identify the ideal surgical candidate. Differences in preferences between patients and physicians leads to wide variation in referrals and impedes the shared decision-making process. Our purpose was to identify the dominant clinical factors influencing patient, FP, and surgeon preferences for lumbar spinal surgery. **Method:** We used conjoint analysis, a rigorous method for eliciting preferences, in a mailed survey to all orthopaedic and neurosurgeons, a random sample of FPs, and patients in Ontario to determine the importance that respondents place on decisions for lumbar spinal surgery. We identified six clinical factors (walking tolerance, duration of pain, pain severity, neurological symptoms, typical onset, and dominant location of pain) and presented 16 hypothetical vignettes to participants who rated, on a six-point-scale, their preference for surgery. Data were analyzed using random-effects ordered probit regression models and relative importance of each clinical factor was reported. **Results:** We obtained responses from 131 surgeons, 202 FPs, and 164 patients. We demonstrated that despite wide variations in overall responses, all six clinical

factors were highly associated with surgical preference ($p < 0.01$). Surgeons placed the highest importance on the location of pain (34%), followed by pain severity (19%) and walking tolerance (19%). FPs considered neurological symptoms (23%), walking tolerance (20%), pain severity (20%), and typical onset (16%) to all be of similar importance. Pain severity (29%), walking tolerance (29%), and duration of pain (28%) were the most important factors for patients in deciding for surgery. Orthopaedic (over neurosurgical) specialty was statistically associated with a lower preference for surgery ($p < 0.047$). Older patient age ($p < 0.03$) and previous surgical consultation ($p < 0.03$) were both associated with a greater patient preference for considering surgery. **Conclusion:** Different preferences for surgery exist between surgeons, FPs and patients. FPs may reduce over- and under-referrals by appreciating surgeons' importance on location of pain (leg versus back). Surgeons and FPs may improve the shared decision making process by understanding that patients place high importance on duration, severity, and walking tolerance.

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Subsidence of the Charite Total Disc Arthroplasty and Predisposing Factors

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Purpose: To investigate subsidence of the Charite total disc arthroplasty (TDA) and to identify if a discrepancy between vertebral endplate and the Charite footprint predispose to subsidence. **Method:** Between July 2001 and May 2008, 69 patients underwent a Charite TDA (DePuy Spine, Raynham, MA). They were prospectively followed at 3, 6, 12 months, and once a year thereafter. The following measurements were performed on the replaced motion segment using a lateral radiograph: 1. The anterior-posterior (AP) dimension of the end plates. 2. Amount of subsidence. 3. The distance between the TDA and the posterior and anterior borders of the vertebra bodies (to represent the extent of uncoverage of the endplate by the TDA). 4. The AP dimension of the TDA metal endplate. The ratio between the actual and radiographic AP length of the metal endplate was calculated and utilized as the correction factor for the error of magnification on all other radiographic measurements. **Results:** At L5-S1 the mean subsidence was 1.87 mm and occurred exclusively at the posterior part of the inferior end plate of L5. The mean posterior uncoverage was 3.5 mm (L5) and 0.27mm (S1). At L4-L5 the mean subsidence was 1.48 mm (L4) and 0.56 mm (L5). Posterior uncoverage of L4 and L5 vertebrae were 4.81 and 2.22 mm, respectively. Subsidence of more than 1 mm was present in all cases where the posterior uncoverage of the end plate with the TDA was more than 2 mm (odds ratio:

5.7). Subsidence was non – progressive in all cases. An anatomic mismatch exists between L5 and S1 endplates in the AP dimension; in more than half the patients S1 is shorter than L5. **Conclusion:** The radiographic measurements suggest an increased likelihood of subsidence with more than 2 mm of posterior uncoverage of the end plate by the TDA. The endplate AP length of S1 is frequently less than that of L5. Implant selection based on the smaller S1 endplate may produce worrisome uncoverage of the L5 inferior endplate leading to an increased risk of subsidence and possible catastrophic failure. TDA design should afford modularity to compensate.

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Prospective Clinical and Radiographic Results of the Charite Total Disc Replacement: Average 5 Year Follow-up

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Purpose: To report the clinical and radiographic prospective results of a consecutive series of patient with a minimum two year follow-up with the Charite Total Disc Arthroplasty (TDA). **Method:** Between 2001 and 2005, sixty patients underwent a Charite TDA (Depuy Spine, Raynham, MA) at either L4-5 or L5-S1. The primary indication for surgery was discogenic low back pain confirmed by provocative discography. Clinical assessment was carried out preoperatively and postoperatively at 3, 6, 12 months, and once a year thereafter using the Oswestry Disability Index (ODI), Visual Analogue Scale (VAS) for back and leg pain, and SF-36. Radiographic analysis included: angle of sagittal rotation, translation of the rostral vertebra onto the caudal vertebra, anterior vertical motion (AVM), middle vertical motion (MVM), posterior vertical motion (PVM), pre- and post-operative lumbar lordosis, disc height and subsidence of the TDA. The radiographic measurements were performed using the GE Medical Systems Centricity PACS Software Version 1.0. **Results:** There were 36 female and 24 male patients with a mean age of 39 (range 21-59). The mean duration of low back pain was 70 months. Twenty-five percent claimed work compensation status. The mean post-operative hospital stay was 4.8 days. A statistical significant improvement was demonstrated between the mean pre-operative ODI (50) and all post-operative intervals ($p < 0.0001$) which had declined to 27.7 by one year. Similarly, pre-operative VAS back pain (8.0), leg pain (6.1), SF-36 physical component summary score (33.5) and mental component summary score (41.8) remained improved ($p < 0.0001$) by three months (4.1, 3.1, 51.7, 62.0 respectively). One patient with an L5-S1 TDA has since undergone a posterolateral instrumented fusion. The mean pre- and post-operative lumbar lordosis was 34.58 and 53.48 respectively. The mean

sagittal rotation was 6.5 degrees at 5 year follow-up, while the mean translation was 0.83 mm. The mean AVM, MVM and PVM were 0.59 mm, - 3.96 mm and 3.69 mm respectively at 5 year follow-up. **Conclusion:** This study demonstrates satisfactory clinical results in carefully selected patients. The radiographic assessment confirmed preservation of movement at the replaced disc during flexion and extension of the lumbar spine.

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Prospective Randomised Controlled Study Comparing a DBM-CaSO₄ Composite Graft and Bone Marrow Aspirate with Autologous Iliac Crest Bone Graft in One-level and Two-level Lumbar and Lumbosacral Spinal Fusions

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Purpose: The current gold standard for spinal arthrodesis, autologous bone graft harvested from the iliac crest, has several disadvantages including donor site morbidity, blood loss, delayed wound healing, and increased operative time. Our study explores a Demineralized Bone Matrix-Calcium Sulfate (DBM-CaSO₄) composite graft with autologous bone marrow aspirate (BMA), and compares it to autologous iliac crest bone graft in lumbar and lumbosacral spinal fusions. **Method:** A total of 80 patients were recruited for the study and randomised, via a computer-generated randomisation schedule, to autologous iliac crest bone graft (control) or DBM-CaSO₄ composite graft with BMA (study) groups. Patients were evaluated at three-months, six-months, 12-months and 24-months post-operatively with questionnaires to evaluate clinical outcome (Oswestry disability questionnaire (ODI), visual analogue pain scales (VAS), and validated SF-36) and with posteroanterior and lateral x-rays of the spine to evaluate radiological outcome. **Results:** At 24-months post-operatively, there were no statistical differences seen between the two groups based on the clinical outcomes measured. Average ODI values were 27.19 for the control group versus 22.68 for the study group ($p > 0.05$). The average back VAS pain for the control group was 3.50 versus 3.51 for the study group ($p > 0.05$). The SF-36 score was 89.22 for the control group versus 91.56 for the study group ($p > 0.05$). The average operative time was 115.7 minutes for the control group versus 104.2 minutes for the study group ($p : 0.014$). Average calculated blood loss was 571.9 cc for the control group versus 438.2 cc for the study group ($p : 0.025$). The Lenke score was 1.92 for the control group versus 2.66 for the study group ($p : 0.004$). **Conclusion:** At two year follow-up, radiographic fusion was slightly higher in the ICBG. However, clinical outcomes were equivalent in both groups. Moreover, the DBM-CaSO₄ and BMA composite graft offered the advantages of decreased blood loss and shorter operative time. Therefore, the DBM-CaSO₄ and BMA composite graft represents a viable alternative to autologous iliac crest bone graft in carefully selected patients undergoing spinal arthrodesis.

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Vertebral Fracture Risk and Tokuhashi Score Validation in Patients with Metastatic Breast Cancer

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Purpose: To identify local and systemic risk factors for the development of pathologic fractures and determine the value of the Tokuhashi Score in patients with known asymptomatic lytic spinal metastases secondary to breast cancer. **Method:** A prospective cohort study was carried out on 51 patients with lytic spinal metastases secondary to breast cancer identified as having either purely lytic or mixed disease. The Tokuhashi Score, developed to estimate life expectancy for patients with symptomatic spinal metastases being considered for surgery, was calculated for each of the 51 patients. The score consists of six parameters each of which is rated from 0-2. Initial and follow up CT images and pain and function data were obtained every four months for one year. A final review of patient charts was performed two years later to determine if each patient was still alive. **Results:** Tumour burden was predominantly blastic and mixed rather than lytic. There was no progression of lytic tumour burden over the 12-month period, however there was progression of blastic tumour load. Eleven compression fractures occurred in seven patients; no burst fractures occurred during the study. No correlation between tumour burden (lytic, blastic or both) and risk of fracture was found. A weak correlation between bone mineral density and length of time elapsed from diagnosis of metastatic disease and fracture risk was found. Pain and functional data results were not related to tumour load. Tokuhashi score did correlate with survival, however actual survival in our population was far longer than that found in previous studies. Negative progesterone status was found to be negatively associated with life expectancy. **Conclusion:** Metastatic vertebral disease in breast cancer patients has a predominantly blastic and mixed appearance with current pharmacologic therapies. Pathologic fracture risk appears to be more related to bone mineral density than tumour burden in this population. Tokuhashi score does correlate with life expectancy in patients with relatively asymptomatic spinal metastases. Having a progesterone receptor negative tumour has a significantly negative impact on life expectancy.

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Validation of the Enneking Oncologic Classification in the Management of Primary Tumours of the Spine: A Cohort Study

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Purpose: Oncologic management of primary bone tumors of the spine is inconsistent, controversial and open to individual interpretation. Tumor margin violation intraoperatively increases local recurrence and mortality.

The purpose of this study is to determine whether applying Enneking's principles to the surgical management of primary bone tumors of the spine significantly decreases local recurrence and/or mortality. **Method:** A prospective and retrospective multicenter Cohort Study: Inclusion of patients undergoing en bloc or intralesional resection of primary tumors of the spine at four separate quaternary care centers, between January 1994 and January 2008. Patients were staged, using the Enneking system, prior to surgery and baseline demographic and surgical variables were recorded. Outcomes measured were disease local recurrence, or death. The results were statistically analyzed for significance. **Results:** One hundred-fifty patients with primary tumors of the spine were recruited. Average age was 47.0 (range 8 to 83). Sixty-two patients were identified to have local recurrence. A statistically significant decrease in local recurrence ($p=0.0001$) was observed in favor of en bloc resection. In patients with local recurrence there was a significant increased risk of mortality, ($p<0.0001$). There was a trend to decreased mortality in the en bloc resection group, not statistically significant ($p=0.64$). **Conclusion:** Wide resection of primary tumors of spine with reconstruction is the standard of care. Application of Enneking's principles to the spine when managing primary bone tumors significantly reduces local recurrence of the disease process, without an adverse outcome on mortality, and with acceptable HRQOL. Further cohort studies based on stringent data collection prospectively will provide a basis for more detailed study of individual tumor types.