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Pedicle screw designs in spinal surgery: much ado about nothing?

■ Pedicle screw designs have evolved with the aim of improving the primary pull-out strength, and one of the major innovations has been varying thread patterns. Little is published about the revision pull-out strength of pedicle screws when they are replaced *in vivo*. The authors of this study from **Singapore** have compared three common thread types: a single thread with a single helical thread; a dual thread with a double helical thread along the entire screw length; and a mixed thread that has a double helical thread over the proximal core of the screw, with a single helix distally.¹ Screws of each design were inserted into a polyurethane foam in a set sequence. First, a 6.5 mm screw was inserted into the block and the primary pull-out strength was measured. Second, a 6.5 mm screw was inserted, removed, and reinserted, then the revision pull-out strength was measured. Third, a 6.5 mm screw was inserted and removed, then a 7.5 mm screw of the same design was inserted and the revision pull-out strength was measured. As would be expected, dual-thread screws had a significantly greater pull-out strength compared with mixed and single-thread screws. Mixed screws had a significantly lower revision pull-out strength compared with both single-thread and dual-thread screws. When revision screws were upsized with a 7.5 mm screw, there was no significant difference between the screw types, although the dual-thread screws still had the greatest pull-out strength. The study has limitations; the high-density synthetic bone does not have the same bone structure as vertebral bodies and is not representative of osteoporotic bone. Mixed-thread screws were designed to improve insertional torque and thus mechanical stability in the pedicle, which is responsible for 60% of the pull-out strength of the pedicle screw. This study, however, effectively shows that mixed screw designs had the poorest pull-out strength of all designs and revision screws needed upsizing to give equivalent strength.

Fusing to the pelvis: usually better than not in neuromuscular scoliosis X-ref

■ The aim of surgical treatment for neuromuscular scoliosis is a level pelvis that provides sitting balance. The dilemma for surgeons is whether to fuse to the pelvis to achieve this or to leave the

L5-S1 space mobile. Fusion to the pelvis is required for large deformities with pelvic obliquity, but this involves greater dissection and increases potential blood loss, operative times, and rates of infection. On the other hand, a mobile lumbosacral joint may assist with ambulation and transferring. If the pelvis is not initially fused, the pelvic obliquity may progress and require subsequent inclusion into the fusion. The authors of this study from **Los Angeles, California (USA)** used data from four large-volume centres to perform a review of 285 patients over a 12-year period comparing patients who underwent pelvic fusion at their initial procedure (271 patients, index group) with patients who had pelvic fusion performed as a revision procedure (14 patients, revision group).² Their results showed that, prior to initial surgery, both groups had a similar Cobb angle with no significant difference in pelvic obliquity. Similarly, there was no difference in intraoperative outcome measures (such as estimated blood loss and intraoperative time) between the index group and the revision group at the time of revision. Cobb angle correction was better in the index group (59.2%) compared with the revision group after the initial procedure (31.2%). Overall Cobb angle correction was better in the index group compared with the correction achieved after the second procedure in the revision group, but there was no difference in correction of pelvic obliquity. The rate of revision surgery was 24.2%, and the most common causes were infection (15.4%) and implant failure (9.1%). For these reasons, a smaller percentage of patients underwent reoperation in the index group than in the revision group (22.9% vs 50.0%). As the title suggests, the authors push the argument for initial pelvic fusion. Although the groups are different in size, they conclude that index pelvic fusion led to half the reoperation rate compared with pelvic fusion at revision. Interestingly, the operative time and blood loss were similar between the index and revision procedures, and the authors suggest that returning for revision surgery is a large undertaking, with potential progression of the underlying neuromuscular condition making further surgery more complex or even impossible.

Achieving the best outcomes following fusion for lumbar degenerative conditions

■ The authors of this study from **Louisville, Kentucky (USA)** have investigated which prognostic factors predict the best outcome following a fusion for lumbar degenerative conditions.³ As

we all know, there are a few patients who achieve complete symptom remission following any operation. However, in degenerative conditions, the chances of making a complete recovery are usually poorer than in other pathological processes. These investigators built on previous studies that defined a best outcome as a postoperative Oswestry Disability Index (ODI) of 20 or less and pain numerical rating scale (NRS) of 2 or less following surgery as thresholds, equating to patients being unlikely to seek additional medical care or require additional healthcare resources. In this longitudinal cohort study, 396 patients were included from a single hospital. The variables analyzed including age, sex, body mass index, American Society of Anesthesiologists (ASA) grade, number of surgical levels, surgical time, preoperative ODI, preoperative back and leg pain, worker's compensation status, surgical approach, smoking, and the principal diagnosis. At one year postoperatively, 74 patients (19%) were assigned to a 'best outcomes' group, as classified by the authors. This group was compared with the remaining patients. The patients who achieved the minimal symptom level were older, had a lower preoperative ODI, and had lower preoperative back pain. They were more likely to have a diagnosis of spondylolisthesis or disc herniation, and were less likely to have a diagnosis of adjacent segment disease or mechanical disc collapse. In terms of intraoperative factors, they underwent fewer surgical levels and had shorter operative times. Stepwise forward regression analysis indicated diagnosis, age, baseline ODI, and number of levels as predictive variables. This study is useful for surgeons when selecting good surgical candidates or counselling patients on the effectiveness of surgery and the chance of symptom resolution and postoperative satisfaction. It also highlights the difficulties in achieving an excellent result when there is such a collection of symptoms and diagnoses.

Sonication and spinal infections X-ref

■ While the diagnosis of infection around spinal prostheses can be very straightforward, in most cases it is not entirely clear-cut, especially when associated with implants. The rate of infection in instrumented spinal procedures is thought to be as high as 20%, and the consequent effects on morbidity, mortality, and hospital care are obvious. Identifying the causative microbe is essential to the complete and economic care of a patient; however, simple tissue sampling may be insufficient to isolate a pathogen. In this interesting study, a team from

Berlin (Germany) evaluated the role of sonication of removed spinal implants in identifying the bacteria responsible for clinical infection.⁴ The authors then compared these results with those previously published. Sonication aims to shake loose the sessile bacteria from the biofilm on retrieved implants removed for infection, and makes their culture and identification possible. There have been mixed reports on the diagnostic benefit of sonication. The authors took 118 patients who had their hardware removed over an 18-month period and collected both tissue samples and sonicate fluid. They showed that, overall, 29.6% of patients had evidence of implant infection. Infections were more common in those who had their metalwork removed within one year of implantation. In those with confirmed infection, hardware was removed for implant failure or wound healing problems, whereas adjacent segment failure was more often the reason in aseptic patients. The authors found that soft-tissue samples alone showed a sensitivity of 65.7% and sonicate fluid alone showed a sensitivity of 94.3%. When a recent course of antibiotics had been administered, the figures changed to 57.1% and 100%, respectively. These results are in concordance with previously published work and give an interesting perspective on the diagnosis of spinal implant infection, suggesting that sonication of implants is a powerful tool in diagnosing infection in these often long-term patients.

Lordosis is key during TLIF

■ When kyphosis is tackled surgically, often in the setting of degenerative disease, the restoration of proper sagittal balance is critical in avoiding symptoms caused by the abnormal biomechanics applied to the thoracic and cervical spine, and to the lower limbs. When planning correction, it is difficult to determine the amount of lumbar lordosis that needs to be built into the applied construct. We do not yet have an accurate understanding on how the amount of lordosis applied to the construct influences medium- to late-term outcomes. Transforaminal lumbar interbody fusion (TLIF) is a common technique used to restore lordosis in degenerative deformity correction and fusion procedures. A group from **Ljubljana (Slovenia)** have carried out a prospective cohort study looking at the functional and radiological outcomes of patients undergoing single level fusion with TLIF in addition to a posterior construct for degenerative spine disease at five years postoperatively.⁵ The group reviewed the outcomes of 57 patients undergoing the procedure at a single centre and examined the relationship between their radiological outcomes and their Oswestry Disability Index (ODI) scores at five years postoperatively. The

authors found that an increase in sagittal vertical axis was common and correlated with an elevated ODI score. Patients with a higher pelvic incidence (PI) were found to have a greater difference between ideal and measured lumbar lordosis than those with a lower PI. However, patients with low PI showed higher ODI scores when lumbar lordosis was not corrected to the ideal position, in contrast with those patients with a higher PI at five years postoperatively. This study is limited by being unable to account for the biomechanics of the cervical spine or lower limbs in both compensating for imbalance and contributing to disability, and so these conclusions are unlikely to represent the whole story. The results are perhaps counterintuitive, but certainly this study highlights the major potential pitfall of interbody fusion when lordosis is incompletely considered. As a result, the clinical message from the authors is that anteriorizing TLIF cages is key to preventing these suboptimal outcomes.



Comparing the efficacy of methods for immobilizing the cervical spine

■ Cervical immobilization is a controversial topic, with some trauma systems continuing to employ triple immobilization, and others choosing to use alternative systems for caring for a potential cervical injury. However, in-line stabilization continues to be commonplace, and a variety of devices are employed in establishing this. In this innovative study from **Iowa City, Iowa (USA)**, the authors used a simulated motion platform to assess the efficacy of a selection of immobilization systems in preventing cervical movement during emergency transfer.⁶ The authors measured the motion that an urgently transferred patient would be subjected to in both a road ambulance and helicopter in various conditions using sensors in the vehicles during real journeys. These data were then fed into a motion simulator,

which was able to replicate the motions and vibrations in six directions. The group then chose four different immobilization systems and applied them to 16 healthy volunteers, and used inertial measurement devices to see which system most effectively immobilized the cervical spine. The group found that a simple collar, a vacuum mattress with collar, and a long spinal board (LSB) were all better than a simple trolley and straps in limiting cervical spine rotation. Lateral flexion was most effectively limited by a LSB; however, flexion and extension were not significantly limited by any immobilization system when compared with a simple trolley and straps. The group noted that the test subjects were fit and healthy average-sized male patients, and that results might not be generalizable; however, they suggest that a LSB might be the most practical solution for cervical immobilization, given its speed of application and ease of use. This study does not contribute to the debate around whether immobilization has an impact on patient outcomes, but does show that where this philosophy is followed, LSBs still have a role.

Predicting SSI after instrumented thoracolumbar spine surgery in adults

■ Surgical site infection (SSI) can be a catastrophic event in the surgical management of spine patients. Any predictive model that facilitates establishing the likelihood of infection will be useful in the care of these complex patients and would help to identify modifiable factors that could be addressed. In this topical study from **Maastricht (The Netherlands)**, the authors collected data regarding potential predictors of SSI in 898 adult patients, all of whom underwent instrumented posterior fusion of the thoracolumbar spine.⁷ Logistic regression of these data was used to develop and validate a model for prediction of SSI using a range of potential covariates after instrumented spine surgery. A total of 60 patients were diagnosed with SSI. After testing each of the potential covariates, the authors developed a predictive model that relied on age, body mass index, American Society of Anesthesiologists (ASA) score, degenerative or revision surgery, and non-steroidal anti-inflammatory drug (NSAID) use. All of these appeared to be independent predictor variables for the risk of SSI. Subsequent statistical testing shows that the model demonstrates good discriminative ability. The use of a patient-specific model will allow individualized risk assessment and counselling, and may guide practical interventions to reduce SSI in this patient cohort.

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Trauma

X-ref X-ref For other Roundups in this issue that cross-reference with Trauma see: **Foot & Ankle Roundups 2 & 8; Wrist & Hand Roundups 1 & 3; Shoulder & Elbow Roundups 1, 2 & 8; Children's orthopaedics Roundup 8.**

Is one screw a screw too few? X-ref

■ A recent prospective randomized controlled trial from **Calgary (Canada)** examined a simple but previously unanswered question: are two screws needed for fixation of the medial malleolus or will a single screw suffice? A total of 140 patients were initially enrolled and randomized to receive either one or two screws for fixation of the medial malleolar component of their ankle fracture. Outcomes were assessed out to 24 months postoperatively. The 36-Item Short-Form Health Survey questionnaire (SF-36) was used as the primary outcome, with the Ankle Hindfoot Scale and radiological assessment as secondary outcomes. Of the 140 patients, 127 completed the 24-month follow-up. There were 14 patients who were initially randomized to receive two screws in whom the fragment size was felt to be too small by the operating surgeon; these patients crossed over to the single-screw group. In the final analysis, there were 75 patients in the single-screw group and 52 patients in the two-screw group. However, the authors were unable to find any differences between the two groups in the SF-36 physical functioning score. There were also no differences found in the secondary outcome measures or in operating room times. The investigators concluded that single-screw medial malleolar fixation was as safe and effective as standard two-screw fixation. While this trial has some methodological flaws, and has evidently been undertaken on a relatively small budget (the use of sealed envelope randomization, for example), it also has some real strengths and answers a previously unexplored and important question: is it adequate to fix the medial malleolus with a single

screw? On the basis of this trial, it would seem so. The authors have also helpfully established that the addition of a second screw does not appear to have any disadvantages, nor does this significantly impact on operating times. Here at 360, we would therefore suggest that either approach is fine, and that fixation can happily be tailored for the ease of the surgeon in response to the fracture in front of them.

Screw fixation or hemiarthroplasty X-ref

■ A group of investigators from multiple centres in **Norway** examined the treatment of elderly patients with non-displaced femoral neck fractures.² Their trial started from the hypothesis that those treated with a hemiarthroplasty would have superior function over those treated with screw fixation alone. While the prevailing wisdom is to fix those fractures that are deemed to be 'stable' *in situ*, usually with cannulated screws, there is some evidence that hemiarthroplasty has a higher complication rate in the perioperative period. However, evidence also exists suggesting that fixation *in situ* is associated with a higher complication rate and that this may be associated with poorer long-term outcomes from revision surgery. In this multicentre randomized controlled trial, patients were treated with either screw fixation or hemiarthroplasty. The primary outcome measure was the Harris Hip Score and secondary measures were: mobility, as measured by the timed 'up and go' (TUG) test; numerical pain score; and quality of life, as assessed by the EuroQol (EQ)-5D. It should be emphasized that the focus of this trial was on eventual function, not on perioperative complications. The authors recruited 219 patients, all with minimally displaced femoral neck fractures, who were randomly allocated to receive either a hemiarthroplasty or fixation. Outcomes were assessed at 3, 12, and 24 months postoperatively. The authors recruited 111 patients allocated to fixation and 108 patients allocated to hemiarthroplasty over a three-year period. The

investigators found no significant difference in hip function as measured by the mean Harris Hip Score (74 (SD 19) vs 76 (SD 17)); however, faster TUG tests were reported, on average, in the hemiarthroplasty group (16.6 seconds vs 20.4 seconds). There was a higher rate of revision surgery in the screw fixation group (20% vs 5%). The authors concluded that hemiarthroplasty was not superior to screw fixation but was associated with better mobility and fewer reoperations. This trial is interesting in that the authors report slightly superior outcomes and a lower reoperation rate (both secondary outcomes for this study), favouring the hemiarthroplasty group. The reported reoperation rate of 20% for the screw fixation group is in line with other reports in the literature, such as the FAITH (Fixation Using Alternative Implants for the Treatment of Hip Fractures) trial. However, the 24-month follow-up for hemiarthroplasty is a very short follow-up interval, and it is certain that this trial is underpowered for adverse events such as infection, revision due to acetabular wear, and periprosthetic fracture.

The posterior malleolus fragment determines syndesmotic stability X-ref

■ There has been a great deal of interest in trauma circles surrounding the role of the posterior portion of the syndesmosis, which is both stronger than the anterior and tight in dorsiflexion in ankle stability. This has led to interest in treating posterior malleolar fractures with open reduction and internal fixation (ORIF), rather than using simple reverse-lag screws or ignoring the fracture all together. Although there are some series to support this approach, most are rather small. Here at 360, we were therefore delighted to read this large retrospective study from **Munich (Germany)**, in which the authors reviewed 236 patients with trimalleolar fractures in an attempt to evaluate the various management strategies.³ The authors divided their group to compare ORIF, closed reduction and internal fixation (CRIF),