relate to surgical intervention? Is the die cast at the time of injury? Surgeons from **Rome (Italy)** have reported their study of 41 patients, all with an MRI-proven rotator cuff tear.[13] Although the study was retrospective, the authors were able to identify two subgroups: those who had undergone rotator cuff repairs and those who had not. Outcomes were assessed using a range of shoulder outcome measures and an interval MRI scan at 50 months following diagnosis. The authors established that there were better results in terms of fatty infiltration of the muscle belly in the operative group with no progression of fatty changes, while the non-operative group had significant increases in tendon retraction and tear size. Although this doesn't establish causation, it does provide some evidence to suggest that tendon repair is able to prevent secondary muscle degeneration.

Anterior plating stronger in the clavicle? X-ref

Historically, clavicle fractures have been plated with a superior approach. Though sigmoid-shaped, the flat surface of the superior aspect of the clavicle allows for easy application of the plate without multiplanar contouring. There is, however, an incidence of metalwork failure. Some fracture patterns are less amenable to superior plate placement; following failure of fixation the best surgical fixation option may be an anterior plate. These authors from **Baltimore, Maryland (USA)** explore the benefits or otherwise of anterior plate placement in lateral clavicle fractures.[14] They designed a cadaveric study that tests the hypothesis that reorientation of the plates to move the screw line away from the axis of the deforming forces would improve the biomechanical strength of the construct. The authors used six pairs of fresh frozen cadavers and undertook standardised osteotomies with superior and anterior plating, prior to mounting them on an Instron machine and loading with 375 N at 1 Hz for 2000 cycles. Following this, sequential loads to failure were tested. There were significant differences in all measures of biomechanical stability, with the most marked difference being in load to failure (587 N *vs* 375 N) in favour of anterior plating. The authors found that anteriorly plated distal third clavicle fractures have superior strength and durability when compared with fractures plated superiorly in a cadaver model. Clearly there are some limitations to this study. There are few clinical studies, however, from which to base treatment decisions, and their findings are important.

Optimising treatment in olecranon bursitis

As a mostly non-operative diagnosis, olecranon bursitis has been somewhat neglected on the research front over the past decade, with little progress made in treatment despite the comparative frequency of presentation. We were delighted to see this randomised controlled trial from **Seoul (South Korea)**, testing three treatments: compression bandaging and NSAIDs *versus* steroid injections *versus* aspiration.[15] They report the outcomes of 133 patients randomised to one or other treatment and reported at four weeks' follow-up. Outcomes were assessed as resolution at four weeks and median time to resolution. Sadly this study did not detect any differences between the three interventions, although the study was only powered to detect a 30% difference. The authors sensibly suggest that this study should be regarded as a pilot, and a large study capable of detecting a greater difference should be undertaken.

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Spine

X-ref ***For other Roundups in this issue that cross-reference with Spine see:*** *Children's Orthopaedics Roundup 4; Research Roundup 4.*

Cement or screws? X-ref

All spinal surgeons have felt the grip of disappointment when reviewing post-operative radiology and spying loose pedicle screws or loss of correction - an effect heightened in osteoporotic fracture. The potential likelihood for revision surgery and all its accompanying misery leads us to despair. However, help could be at hand. A team from **Göttingen (Germany)** has conducted a cadaveric investigation into the effect of cement-augmented pedicle screws on the fatigue strength and cyclical failure of pedicle screws used in short and long segment fixation in osteoporotic fractures, compared with non-augmented screws in long fixation.[1] Although their investigation was cadaveric, should it be successful there may be important messages in this study for clinical work in the osteoporotic spine. In their study of thoracolumbar spines, the authors instrumented with either short (single vertebra) or long (two vertebrae) fixation, with one side being augmented

with cement, and the other left unaugmented. These were compared with a pair of vertebrae fixed without any augmentation at all. Specimens were then cyclically loaded with between 50 N and 100 N to simulate walking in a hydraulic testing device. Unfortunately, cement augmentation adds little to the fatigue strength and cyclical failure of pedicle screws in osteoporotic bone. In the short fixation group, augmented screws showed a greater fatigue strength of 17% and a higher number of cycles to failure than the unaugmented group, a story that was not replicated in the long fixation group. However, long non-augmented fixation showed a 76% increase in fatigue strength when compared with short segment non-augmented fixation. So, the old adage of 'if some is good, more is better' seems to apply to fixing osteoporotic fractures. Fix well, fix long, and the rest will likely take care of itself. There may be a place for augmented screws in other situations, but based on this evidence, perhaps osteoporotic fractures is not it.

Unpicking proximal junction kyphosis

Proximal junctional kyphosis (PJK) is a consequence of spinal fusion, and compromises the sagittal balance of the spine with all its subsequent effects. It occurs in about 30% of spinal fusion patients, and can result in the need for further intervention. The question, however, is *why does it occur*? Despite a number of studies investigating risk factors for the phenomenon, it is still relatively poorly understood. Here at *360* we were delighted to see a group from **Shijiazhuang (China)** tackling this issue extremely effectively and bringing clarity to this enigmatic condition.[2] The study team conducted a meta-analysis with the aim of establishing the risk factors for PJK. The team were able to include the results of 2215 patients reported from 14 different studies in their meta-analysis, following an appropriate and extensive literature search. They established that there is a significant association between PJK and fusion surgery: an age of > 55 years at time of surgery; fusion including S1, T5-T12; kyphosis exceeding 40°; low bone mineral density; and an SVA greater than 5 cm. Gender, combined anterioposterior surgery, use of a pedicle screw at the cranial most fixation point, hybrid instrumentation and thoracoplasty showed no association. While this study doesn't cover paediatrics, and potentially leaves several synonyms excluded from the search, the paper nonetheless quantifies the associations of PJK with differing types of fusion procedure. Being a meta-analysis, it suffers from the flaws inherent in the source studies, however, perhaps a more important weakness emerges – difficulties with clearly establishing the underlying diagnosis on the incidence of PJK. More work is likely needed here.

Diagnosing lumbar spinal stenosis

Lumbar spinal stenosis (LSS) is seen in every clinic. Waiting rooms are overflowing with flexed-leg patients in pain, awaiting our remedies. Somewhere between 9% and 47% of adults suffer with LSS, particularly those over 65 years of age. Yet the clinical features that reliably describe a diagnosis of LSS have not been identified, and perhaps equally importantly, a reliable, international definition has not been reached from which to work. A team from **Calgary, Alberta (Canada)** has reported the results of their Delphi exercise to create a definitive and agreed list of clinical features that make up an LSS diagnosis.[3] Although Delphi exercises are time-consuming and not exactly the most interesting of research methods, they are essential in areas of contention such as this, and an agreed definition can help in improving time to diagnosis, cost-effectiveness and treatment. There were 279 clinicians involved in the Delphi process, with representation from an array of professions and countries. The Delphi process ran over five rounds covering three phases, encompassing views from orthopaedics, neurosurgery, vascular surgery,

physiotherapy and radiology. Finalised by a task force focus group in 2015, the International Society for the Study of the Lumbar Spine agreed a list of seven 'history items' which, if present, are 80% likely to give a reliable LSS diagnosis: leg and buttock pain when walking; flexing forward to relieve symptoms; relief when riding a bicycle or using a shopping trolley; motor or sensory disturbance when walking; normal and symmetrical foot pulses; lower extremity weakness; and low back pain. Although an inventory of symptoms is not exactly revolutionary and consists of a range of well-identified but potentially general features, the study does a sterling job of convincing us that a reliable clinical diagnosis is possible. Can it replace radiology? Clearly this is unlikely, but every study that helps us narrow down a diagnosis early in the presentation is helpful. Perhaps the most useful place for a study such as this is in primary care. With the pressure to avoid referral and the use of 'triage' centres, the addition of carefully constructed symptom inventories is going to become increasingly essential in ensuring the correct patients make it to the specialist waiting room.

Are high-heeled shoes a whole body problem?

The perils of high-heeled shoes are well known to the trauma and foot and ankle fraternities, with high expectations of function from their wearers and a surprising number of fractures to their name. The problems with the spine caused by wearing them for long periods are well known to committed high-heelers, however, they are still a bit of a mystery to the medical fraternity. It is thought that high heels can exacerbate hallux valgus in predisposed individuals; they certainly aggravate hallux rigidus and they can also markedly increase the incidence of back and neck pain when compared with the general population. A study team from **Zurich (Switzerland)**[4] has set the investigation into the effect of high heels on the sagittal balance of the spine firmly in their sights. The study aims to evaluate the spine and whole body balance in young women who were not regular high heel wearers. The team used postural analysis to investigate the effects of high heel wear on a complete range of spinal parameters including C7 vertical axis, cervical lordosis, lumbar lordosis, pelvic tilt and sacral slope, none of which changed with the addition of high heels. However, there was a significant increase in knee and ankle plantar flexion. In a subgroup of patients who did not compensate with as much knee flexion, the compensation occurred with increased cervical lordosis (Δ 5.8° ± 10.7° *vs* 1.8° ± 5.3°). The authors have suggested that an explanation may well be that as high heel wearers age, the changes in knee flexion and the resultant cervical lordosis needed to maintain sagittal balance might explain the differing patterns of reported neck, back and knee pain. Clearly the treatment for committed high heel wearers wanting surgical perfection is footwear advice and careful discharge, however, what this study can tell us about sagittal plane spinal balance and how it interacts with the limbs is hugely important in understanding the dynamic balance of the limbs and spine in a range of pathologies.

Is spinal imaging associated with cancer? X-ref

Patients with adolescent idiopathic scoliosis are subjected to multiple radiographic investigations from initial diagnosis, and during surgical intervention and subsequent follow-up. The association between radiation and neoplasia is without question,

and there is also evidence to suggest that children may have greater radiation sensitivity than adults for certain tumours. Researchers from **Middelfart (Denmark)** have performed a retrospective analysis in an attempt to answer the question of whether paediatric scoliosis treatment, and the adherent radiation involved, is associated with cancer.[5] The team looked at an historic cohort of 215 patients, all of whom underwent treatment for adult idiopathic scoliosis 25 years previously. The study team started by analysing the total radiation exposure during treatment and follow-up for all patients, who received an average of 16 radiographs during the course of their treatment. This gave a mean additional radiation dose of 2.4 to 5.6 mSv per year, equating to between six and 12 months of background radiation. Follow-up was via questionnaire with 83% responding, giving a study population of 170 patients. The overall cancer rate in the cohort was 4.3% (n = 9), around five times the incidence of the age-matched Danish population, with breast and endometrial cancer being the most common. The patients who developed cancer did not have apparent greater lifetime risk factors for malignancy such as smoking, although one patient had breast cancer (BRCA) genes 1 and 2 present, and was excluded from the analysis. This study is a stark reminder to clinicians to limit the use of radiographs and CT where possible, and to explore the use of navigation techniques in order to minimise radiation exposure.

O-arm in the paediatric spine X-ref

Given the potential problems with radiation doses in the younger population, we were delighted to see this paper from the Mayo Clinic, **Rochester, Minnesota (USA)** and **Taipei (Taiwan)** looking at one potential strategy to reduce the exposure of the patient to radiation with the new 'O-arm' (Medtronic, Inc., Louisville, Colorado) navigation system.[6] The benefits of the O-arm for the surgeon are clear, offering improved pedicle screw accuracy with a reduced need for implant revision and less radiation exposure to theatre personnel. However, there is increased radiation exposure for the patient, which is far from ideal in the paediatric population given the number of radiographs that are taken during the course of their treatment and a potential susceptibility to certain tumours. The group has developed a low dose paediatric protocol, with a radiation dose similar to fluoroscopy which they compared with adult protocols, assessing image quality and radiation dose. Of course with imaging-based protocols, a reduction in radiation exposure can be associated with a reduction in image quality. The study team reports the results of 37 paediatric patients undergoing posterior instrumentation of the spine. The patients underwent 68 scans between them, using one of three protocols – default, institutional or a lower 'paediatric' protocol setting. There were dramatic differences between the protocols, with the 'default' setting resulting in a mean effective dose per scan of 4.65 mSv, compared with 2.37 mSv (institutional) and 0.65 mSv (paediatric) for the other protocols. This translated to significant reductions in dose per surgery of 1.17 mSv (paediatric), 3.83 mSv (institutional), and 12.79 mSv (default). The image quality was found to be satisfactory in all cases, although quality was poor for one patient whose weight was over 100 kg. The radiation dose was one tenth of the default manufacturer's setting, and was equivalent to 37% of the annual radiation exposure in the US. This study highlights the capability of the O-arm in the paediatric population and also the potential to lower the radiation dose in smaller adults.

Can Risser stage predict effectiveness of bracing? X-ref

Bracing in the paediatric spine is a controversial proposition, with concerns over both effectiveness and compliance. Even proponents of bracing utilise it for lower magnitude curves, and usually argue that it is most effective when compliance is good. Surgeons in **Dallas, Texas (USA)** have published an article with the intention of establishing if the Risser stage has any bearing on the eventual need for surgery when scoliosis is treated with bracing as the primary treatment.[7] They report the outcomes of 168 patients with scoliosis curves of between 25° and 45°, all followed prospectively. All patients presented with a Risser stage of 0, 1, or 2 at the time of brace prescription. The authors monitored compliance of brace use with thermal monitoring. The majority of patients were Risser 0 (n = 120), and in this group 44.2% either progressed beyond 50° or required surgery. In the higher Risser stages, the risks of progression or surgery were negligible in this study. The take home message from this study is that if attempting to brace Risser stage 0 patients with adolescent idiopathic scoliosis, at least 18 hours a day of bracing is needed and is likely to be successful for patients with a closed triradiate cartilage. In patients with an open triradiate cartilage, it is likely only to be effective with curves of less than 30°, with more than 18 hours of wear each day. For the most part this study confirms the status quo, with bracing being reasonably effective in patients with smaller curves and greater skeletal maturity.

Reversible neurophysiological events really are reversible

In a straightforward and reassuring study, investigators in **Philadelphia, Pennsylvania (USA)** have reported their experience with intra-operative neurophysiological monitoring of scoliosis correction.[8] Their study reports the outcomes of 676 patients divided into two cohorts: those who did have an intra-operative drop (n = 36) and those who did not. An event was defined as a 50% or greater drop in either somatosensory-evoked potentials or in transcranial motor-evoked potentials. These patients that experienced an event were characterised by a pre-operative larger deformity, longer operation duration, more levels of instrumentation and a higher blood loss with a greater volume of autologous blood transfused. With a return of normal potentials, 34 of the 36 patients had their surgery completed with a similar correction to those patients who did not experience an event. The eventual outcomes measured using the Scoliosis Research Society (SRS)-22 outcome scores were comparable between the two groups. Intra-operative monitoring should be considered the standard of care for scoliosis patients, and this paper illustrates the value of this technique, allowing 34 of the 36 patients to undergo their corrective surgery without compromise to their outcomes.

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