

incidence of 84%. This was higher in the trauma group at 96%, compared with the elective arthroplasty group at 72%. The authors reported mainly low-grade Brooker classes, with 61% of the HO being class I. Most of the disease was observed at the posterolateral aspect of the elbow, followed by the anterior aspect and along the collateral ligaments. Overall, the presence of HO did not significantly affect range of movement within either the trauma or elective groups, which was well maintained at a flexion arc of 93° and 97°, respectively.

The elbow-specific outcome scores were not significantly affected by a higher class of HO, and showed good improvement in all groups. The authors do not therefore advocate routine prophylaxis, and instead suggest consideration of this on a case-by-case basis.

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Spine

X-ref For other Roundups in this issue that cross-reference with *Spine* see: *Children's orthopaedics Roundup 8; Research Roundup 2.*

A pain in the neck

■ Neck pain is a common and disabling condition. When combined with back pain, it can be difficult to treat and has significant ramifications for patients' quality of life, affecting both working and driving. The related psychological and sensorimotor symptoms are often also associated with a phobia of cervical movement, which combines to form a potent disabling condition. Targeting these symptoms through directed therapy would be a sensible strategy to improve a patient's quality of life; if this can be conservative in its nature, then there is much to be gained. The difficulty has always been in settling on the ideal conservative programme, and then proving if it works or not. This study from **Queensland (Australia)** brings technology into the fray by evaluating the use of therapies that utilize virtual reality (VR) or laser projection against a control group to assess their impact on the Neck Disability Index (NDI), cervical motion, visual analogue scale (VAS)

score, and kinesiophobia at four weeks and at three months.¹ The authors tested their interventions using a randomized controlled trial methodology to compare conservative therapy, virtual reality, and laser projection with outcomes assessed at over three months of follow-up. Patients were included in the trial if they were aged 18 years or over with at least three months of neck pain, a reduced peak cervical movement velocity, and a VAS score of 20 mm or more. The study here describes patient allocation using a flowchart, which describes how 141 patients were evenly distributed between the three arms within phase one (which finishes after four weeks of therapy), followed by a further randomization of the control group after four weeks between the VR and laser groups with reassessment at three months. The authors describe that the control group, who received no specific therapy, showed no improvement over the investigation period; however, the VR and laser projection groups showed marked improvement in every domain. Between the two interventions, VR exceeded the improvement seen in laser projection ($p < 0.05$ in all cases). The number needed to treat using

these therapies, in order to show a ten-point improvement in the NDI (the minimally important clinical difference for this scale), is ten patients. So, we have an interesting study investigating a difficult-to-treat condition that supports the early adoption of new technology in managing this difficult problem. However, as always, there are some limitations. There is a reported 15% dropout from the interventions and a 29% loss to follow-up at three months. Furthermore, there are limitations with the technology at this stage, particularly with VR, which can, and does in this study, cause disorientation and motion sickness. These therapies have enormous potential, which can be tailored to the patients' ability, provided they are willing to try new technology. We are sure that in conditions like this, where the pathology is driven at least in part by self-reinforcement, such technology may become increasingly useful.

To navigate or not to navigate?

■ Navigation is increasingly being used in spinal surgery and is even beginning to be considered essential by some units to help in accurately instrumenting the spine

and avoiding complications such as incorrect level and misplaced hardware. Accurate pedicle screw insertion is key to maximizing kyphosis and rotation correction during scoliosis surgery, and has the advantage of preventing catastrophic complications. However, some potential users are cautious in defining the benefits of navigated surgery. These suspicions have led a group from **Yamanashi (Japan)** to conduct an observational cohort study with the aim of investigating the influence of the O-arm on pedicle perforation and pedicle screw deviation, and to identify the risk factors for screw perforation.² The authors conducted an observational study of 404 screws inserted into patients undergoing surgery for adolescent idiopathic scoliosis (AIS), and used postoperative CT to examine screw trajectory and establish the incidence of pedicle perforation. These findings were then correlated with the order of screw insertion, the presence of previous screw perforation, and the distance of the screw from the navigation reference frame. The authors found that no patients required revision surgery and none suffered any complications. The mean number of screws inserted per patient was nine,

with a mean of 8.9 screws inserted per 'spin' of the O-arm. Each patient required a mean of two O-arm spins (1 to 3). Following surgery, 34.8% of patients were found to have pedicle perforation on postoperative CT scan, with this being a significant perforation in 26.1% of patients. There was no tendency for perforation to occur at any one particular level of the spine. There was a higher perforation rate after the eighth inserted screw and if there was previous perforation ($p < 0.01$). Furthermore, there was a significant increase in pedicle perforation at vertebrae within three levels of the reference frame and in younger patients (with smaller pedicles and immature spinous processes). These figures are similar to those in the existing literature examining pedicle screw insertion, which show up to 20% perforation with freehand techniques, 7% in navigated screws, and 29% when fluoroscopy is used. The authors make several recommendations to limit pedicle perforation: careful fixation of the reference frame using a double clip if possible, maintaining vigilance for any movement of the reference frame, repeating the O-arm 'spin' if any deviation of screw trajectory is suspected, and only inserting eight screws per spin. Although using an O-arm seems to be beneficial, it is clearly not the be-all and end-all of pedicle screw insertion. However, for AIS patients, we now have some guidelines to help manage its use and mitigate the risks of pedicle perforation and subsequent complications. It seems that, given the reported reductions in pedicle screw perforations, it is only a matter of time before the utilization of the O-arm is mandatory in pedicle screw use.

Osteotomies and neuromuscular scoliosis

■ Neuromuscular scoliosis is a challenging condition to treat, and curves are typically progressive and resistant to conservative treatment. As the curve progresses, it commonly leads

to pelvic obliquity and subsequent sitting imbalance, pain, and functional impairment. Surgery aims to achieve a well-balanced spine atop a level pelvis, most often using posterior corrective instrumentation with or without osteotomy. Osteotomy is a dangerous and complex procedure and has been previously associated with significant risk; however, it offers the potentially attractive option of larger and more permanent corrections. In this study from **Ankara (Turkey)**, the authors conduct a retrospective analysis to compare the radiological and clinical results of posterior subtraction osteotomy (PSO) with multiple posterior column osteotomies (PCO) when used to correct a neuromuscular scoliosis.³ Patients were included in the study when they had a diagnosed neuromuscular scoliosis with pelvic obliquity that required surgical correction using posterior instrumentation that included the pelvis. The patients were all reliant on a wheelchair for mobility preoperatively and the authors had access to at least one year of follow-up. The two cohorts reported in this series were a historically matched case series. The clinical algorithm at use in the originating centre was that patients underwent a traction film under general anaesthetic; if the pelvic obliquity corrected by $< 50\%$, they then underwent PCO. This surgical strategy was later modified to PSO with the aim of increasing the improvement in pelvic obliquity. As would perhaps be expected with a complex procedure from a single centre with stringent inclusion criteria, there were just 22 patients in this study. The authors reported on 12 patients who underwent PSO and ten who underwent PCO. All patients also underwent instrumentation from the upper thoracic spine down to the pelvis. The mean number of PCOs per case was five, and the mean age of patients reported here was 15.7 years, with cerebral palsy and spinal muscular atrophy representing the most common underlying diagnoses. No significant difference was found in the degree of major curve correction



between the two osteotomy techniques; however, pelvic obliquity was better corrected by PSO ($p = 0.001$). No difference in intraoperative complications was found, and the operation duration and length of stay were found to be the same. This simple study shows that PSO is equivalent to PCO when it comes to the coronal curve; however, PSO probably has the edge when it comes to correcting pelvic obliquity. The cohort is small, with short follow-up, and the data contain no patient-reported outcome measures. Nevertheless, given the lack of any volume of better data, this study is useful for supporting decision-making in these difficult cases.

Compensatory lumbar curves in thoracic adolescent idiopathic scoliosis

■ A common rationale for treating a primary thoracic scoliosis is to obtain correction of the compensatory lumbar curve and reduce the long-term effect of asymmetrical loading on the facet joints and discs, and thus prevent potential degenerative changes and low back pain. What happens, though, if the compensatory curve is left untreated? Does the compensatory curve progress and become a structural curve? Does it become symptomatic even if the thoracic curve was small enough to be left untreated? The authors of this study, from **Niigata (Japan)**, have investigated the natural course of the compensatory lumbar curve.⁴ They performed a retrospective, long-term analysis of

patients who had a primary thoracic curve $\geq 30^\circ$ with a Lenke lumbar modifier A or B that was treated with either observation or bracing, and who were 30 years or older at the time of the survey. The authors identified nearly 150 patients who would have fulfilled the inclusion criteria for this study, but only 34% ($n = 51$) attended for contemporary follow-up and, as such, this report is based on these 51 patients, who were divided into two groups, A or B, based on the lumbar modifier. The authors went on to further subdivide these groups depending on whether L4 tilted to the right (R) or left (L). In group B, L4 tilted to the left in all cases. As expected, the thoracic curves progressed in all cases, but the compensatory curves progressed only in group B. Coronal alignment, measured by C7 translation, and L4 tilt shifted to the right in both AR and AL groups, but there was no change in the B group. Therefore, the resulting C7 translation and the L4 tilt were greater in the AR group (median, 11° , 18.6 mm). When other parameters were considered, Modic changes were greater, at L4/5 in the AR group, and the visual analogue scale for low back pain and the Oswestry Disability Index were high in the AR group compared with the expected incidence. Although this study had a small number of patients, it suggests that progression of the lumbar curve depends on the Lenke lumbar modifier and the direction of the L4 tilt. This is potentially valuable information when deciding upon intervention and trying to predict the likelihood of curve progression.

Concurrent and overlapping surgery in idiopathic scoliosis

■ As surgical services continue to be placed under stress, and as the role of trainees and surgical assistants is increasingly under the spotlight, we were delighted to see this paper from **San Francisco, California (USA)** that explores parental perspectives regarding trainee participation and

simultaneous surgery using a simple survey methodology.⁵ The authors set out to establish if patients or their parents were routinely informed of the role played by surgical assistants during operations as part of the consent process, and if this was important. A total of 31 consecutive parents of children undergoing scoliosis surgery were questioned about their attitudes to simultaneous surgery and trainee roles. The investigators explained to the parents that parts of an operation were either non-critical (exposure and wound closure) or critical (instrumentation). Also, in order to improve theatre utilization and increase the number of operations performed, the lead surgeon and the surgical trainee could work independently in two separate operating theatres, with the trainee being unsupervised. The cases could be “overlapping”, where “non-critical” parts of an operation were performed at the same time, or “concurrent”, where the “critical” parts of two operations occurred simultaneously. The parents were questioned about which scenarios they found acceptable, as well as their understanding of the roles and seniority of surgical trainees. Parents had difficulty distinguishing between the levels of seniority of surgeons (resident vs fellow vs attending) but all were able to define a medical student. Parents also thought that a trainee would be present (mean likelihood score 86) in the operating room but were much less certain that the trainee would actually be operating directly (mean likelihood score 59). From the survey, it was clear that parents, on average, “strongly agreed” with the need to be informed about overlapping or concurrent surgery. Parents also, on average, “disagreed” with the concept of both overlapping and concurrent surgery, and with surgical trainees operating unsupervised even for non-critical parts of the operation. Parents had similar views with regard to anaesthesia trainees and simultaneous anaesthesia

scheduling. This survey draws attention to the fact that the role of trainees is not often highlighted during the consent process and that greater transparency is required. There is the potential for adverse outcomes during unsupervised parts of any procedure and there is increasing scrutiny, particularly in the United States, by the public, government, and other funders of health care of practices that are seen to prioritize increasing case load and profit. The authors suggest that there should be a “national conversation”, given the “discordance” between parental expectations and current practice.

Bariatric surgery or spinal surgery first?

■ Obesity rates are increasing, and patients with obesity are more likely to have degenerative changes in their spine with low back pain. Some studies suggest that up to 80% of patients undergoing elective spinal surgery are either overweight or obese, and it is recognized that these patients have greater rates of complications following surgery. In the United States, there has been a corresponding increase in bariatric surgery to treat patients with a high body mass index (BMI), particularly in those with obesity-related complications, such as type II diabetes, hypertension, and cardiovascular disease. With this in mind, a study from **San Francisco, California (USA)** piqued our interest here at 360.⁶ The authors of this retrospective, registry-based study aimed to investigate the effect of bariatric surgery prior to lumbar fusion to see whether there are reduced complications. The study population comprised 157 000 patients from several state databases. Baseline data and outcomes, including 30-day medical complications, surgical complications (nerve injury, infection, revision), death, readmission, and length of stay, were collected as part of the study. Patients who were undergoing lumbar spinal surgery were placed into three groups: those with

a history of bariatric surgery (BS) and obesity; those with severe obesity (BMI > 40 kg/m²); and those of a normal weight (BMI < 25 kg/m²). When compared with the severely obese group, the BS group had significantly fewer medical complications (including respiratory complications) and infections (including urinary tract infections), lower rates of acute renal failure, and reduced length of stay following lumbar spinal fusion. When the BS group were compared with the normal weight group, there were no differences in medical complications, but the BS group had a significantly higher rate of infection, reoperation, and readmission. The results suggest that, whilst bariatric surgery may not completely reverse all the deleterious effects of obesity, it does reduce medical complications following lumbar spinal fusion surgery. Surgeons should therefore consider a bariatric referral prior to lumbar fusion surgery in the obese population.

Cervical spine degeneration over two decades

■ So much in spinal surgery is not known, particularly when discussing the cause of a range of pathologies. Consequently, ‘best-fit’ theories have been the mainstay of explanation for things such as mechanical back pain and other ‘MRI non-specific’ pathologies. The cause of cervical pain without any clear radiculopathy has been described in the textbook as originating from degeneration of the cervical spine; however, many clinicians have their doubts about this as a reasonable explanation. A research team in **Tokyo (Japan)** describe their excellent longitudinal study, which aimed to describe in detail the long-term degenerative changes in the cervical spine.⁷ Their study utilizing MRI of the cervical spine in a previously normal cohort of patients describes the relationship between the progression of cervical degenerative changes and the development of clinical symptoms. The results of this long-term study

are based on a series of 193 subjects from an original cohort of 497. The patients underwent a contemporaneous MRI scan in addition to answering questions about the presence or absence of cervical spine-related symptoms. Over the time period of the study, the degenerative changes in the cervical spine had progressed in 95% of the subjects and there was a marked decrease in signal intensity of the intervertebral disc at all intervertebral disc levels. Just over half of the patients (60%) demonstrated this change in intensity and it was not related to age. The authors also, of course, commented on more hard-and-fast structural changes, and established that the rate of change was related to increasing age and accelerated at the C5-C6 vertebrae. In terms of clinical relatable symptoms, there was only really progression of foraminal stenosis, which was apparently related to any significant symptoms with an increased incidence of upper limb pain (odds ratio, 4.71). The findings obtained in this research are valuable, in that this kind of detailed long-term follow-up study, which describes the natural changes occurring in the cervical spine that are related to clinical symptoms, lays the foundation for more detailed research in the future.

Effect of tranexamic acid in adult spinal deformity surgery

■ Given the size and nature of spinal deformity surgery, there have been historically significant attempts to minimize blood loss and maintain normal clotting through the procedure. Over the years, strategies employed have included hypotensive anaesthesia, autologous blood transfusion, meticulous surgical technique, and the use of advanced clot analysis such as thromboelastography (TEG) and thromboelastometry (TEM) to correct clotting abnormalities. In more recent years, the effects of tranexamic acid on reducing haemorrhage have been the

focus of much study both within and without spinal surgery. The authors of this study from **Seattle, Washington (USA)** set out to identify the effect of antifibrinolytics such as tranexamic acid on the clotting cascade during significant surgical haemorrhage.⁸ The authors aimed to characterize the effects on the fibrinolytic system. The precise mechanism of surgical coagulopathy often seen during scoliosis surgery is unclear, and the authors hypothesized that, as tranexamic acid is known to reduce intraoperative bleeding, then it may be at least part of the key to the puzzle. Tranexamic acid affected the fibrinolytic cascade, specifically both clot dissolution and consumption of fibrinogen. The addition of tranexamic acid during a surgical procedure may impede the derangement in D-dimer and fibrinogen

kinetics. In this relatively small, case-matched study of 17 patients within a tranexamic acid cohort and 17 patients in a usual care cohort, the authors undertook a retrospective analysis of their intraoperative haemostatic data, surgical time, estimated blood loss, and transfusion records. In line with other series, the authors established that there was significant improvement in estimated blood loss (932 vs 1800) and packed red blood cell transfusions (1.5 vs 4.0). These differences were reflected in the recorded clotting measures, with the rise of D-dimer attenuated from 8.3 µg/ml to 3.3 µg/ml, and a reduced consumption of fibrinogen (98.4 vs 60.6); both of these changes were statistically significant. The use of tranexamic acid in high-risk surgery is becoming more and more commonplace. Although a small series, this report

has the advantage of demonstrating efficacy in the clotting cascade, and specifically in inhibiting fibrinolysis, which is an important mechanistic consideration.

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