X-ref ***For other Roundups in this issue that cross-reference with Spine see: Children's orthopaedics Roundup 4; Research Roundups 4 & 5.***

Turn up the volume: surgical outcomes and numbers in spinal surgery

The saying goes that practice makes perfect. Using the National Joint Registry database, our arthroplasty colleagues have shown that the more often a surgeon carries out a particular joint arthroplasty, the fewer complications he or she encounters. They have also shown that there is a floor effect, with those undertaking a particular procedure fewer than approximately 40 times per year having a markedly higher complication rate. In spinal surgery, we are yet to have the benefit of such a database; until now, we have been left to speculate about the impact that infrequent performance of a procedure has on its outcome. A review team from **Karachi (Pakistan)** have stepped in to fill this obvious gap in evidence and have carried out a systematic review of the association between surgical volume and outcomes in cervical, thoracic, and lumbar decompressions, discectomies, and deformity surgery.[1] The review was undertaken using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, and a thorough literature search identified nine appropriate studies, all of which were retrospective and observational, to include in their narrative review. Meta-analysis was not possible due to the heterogeneity of methodologies in the identified studies, as well as the vast differences in reporting and data interpretation. The systematic review took into account the outcomes of over 954 000 patients from North America – no studies from outside the continent were found – and analyzed them for the complications, mortality, cost of care, length of stay, and rates of reoperation and revision surgery stratified by the volume of a surgeon's practice. Surgical practice volume was defined as very low (< 15 procedures per year), low (between 15 and 39 procedures per year), medium (between 40 and 66 procedures per year), and high (> 66 procedures per year). The authors describe how there is an increased rate of complications in lumbar procedures carried out by low-volume surgeons (odds ratio (OR) 1.42 to 1.83) compared with that of high-volume surgeons. With regard to cervical surgery, there is a higher risk of acute kidney injury, cardiac arrest, lower respiratory tract infection, sepsis, surgical site infection, and urinary tract infection with medium- or low-volume surgeons than with high-volume surgeons, although reoperation and revision rates are much the same. All procedures showed a shorter length of stay when performed by high-volume surgeons but, interestingly, fusion rates were no different between the groups. This study proves what most of us probably suspected (with the notable exception of fusion rates). What cannot yet be defined is why this is the case, and if there are minimal numbers of a procedure one should perform in order to limit suboptimal outcomes to an acceptable frequency. The authors speculate that higher-volume surgeons may adhere to evidence-based guidelines more rigorously, and may work in units where care pathways are more developed. With regard to minimal numbers, the reader is left largely to draw their own conclusions; however, a minimum of 25 decompressions, 40 discectomies, and 35 posterolateral fusions per year are quoted by the authors. This is not necessarily achievable in the United Kingdom, but is something to aim for if we want to drive for continual improvement.

Vancomycin: if some is good, is more better?

In order to alleviate the risk of wound infection, spinal surgeons have developed an affinity for introducing vancomycin powder into the wound during closure, and there have been a number of reports on the topic featured in previous issues of *360*. Although there is little doubt that the current literature supports this approach to reduce infection, the precise protocols vary, with most authors recommending the use of between 1 g and 2 g per patient, distributed along the wound. Nonetheless, according to one group, its use is not usually moderated based on patient and wound size, and, as such, local tissue concentrations can vary significantly. In some cases, this could lead to a local tissue concentration of vancomycin of more than 200 times that used in severe infections, such as necrotizing fasciitis. The group sought to disprove the hypothesis that local tissue concentrations of vancomycin may exceed the toxic doses for mesenchymal stem cells (MSCs) that are necessary for successful spinal fusion, and hence have the potential to contribute to the development of a nonunion. In this basic science investigation, the group from **San Francisco, California (USA)** tested the effect of a range of vancomycin concentrations on cell cultures of osteogenic MSCs harvested from femoral reamings during total hip arthroplasty.[2] After being exposed to vancomycin, the cell cultures were assessed for their survival, osteogenic function, and ability to maintain a homeostatic environment. In short, the higher dose of vancomycin, the lower the survival and metabolic activity of the MSCs. At 12 800 µg/ml, over 51% of cells failed to survive. In those that did survive exposure to vancomycin, the osteogenic potential is much reduced. The authors take pains to explain that this study cannot show how these findings might translate into the clinical setting, and cannot prove beyond reasonable doubt that the negative effects of vancomycin lead to nonunion in the clinical setting. Furthermore, they explain that the price of MSC death or failure may be worth paying in order to reduce surgical site infections. Nonetheless, this study suggests that, in general, we should perhaps be more thoughtful in our use of topical vancomycin, particularly in smaller patients, if we are to maximize every opportunity for fusion to occur while preventing infection. As ever, more work is needed.

Surgery and standing

Given the ever-ageing population, and the ever-rising demands of that population, adult spinal deformity (ASD) is an increasingly frequent indication for surgery. One of the many effects of coronal and sagittal spinal imbalance is the inability to stand efficiently in a stable position within Dubousset's 'cone of economy'. It has been shown that patients with ASD utilize the hip and knee to maintain adequate sagittal balance, while truncal shift is used to maintain coronal balance. In part, this inefficient muscle use is contributing to their symptoms. These patients undergo surgery with the purpose of reducing these problems; however, the effect of this surgery on standing balance has not been described before. A group from **Tokyo (Japan)** has come forward with a prospective case series of 35 female patients aged 50 years and over, with a Cobb angle of 20° or more and a C7 sagittal vertebral axis (C7-SVA) of > 5 cm. The authors followed up the patients for more than two years to observe the impact of corrective surgery on standing balance.[3] They assessed the patients' standing balance, pelvic parameters, C7-SVA, ground reaction forces

across the lower limbs, hip and knee flexion, and lower limb muscle volume pre- and postoperatively. The authors performed in-depth analyses of their series of 35 patients, using computerized force plate analysis combined with clinical assessment and an evaluation of spinopelvic parameters and radiographs. The results make for interesting reading. The patients' centre of gravity was not improved by corrective surgery, and the residual disturbance was found to correlate directly to the coronal radiological truncal shift. In the sagittal plane, the spinal tilt, pelvic tilt, and obliquity were all improved compared with preoperative values. The centre of gravity distance from the C7-SVA correlated to the lean muscle volume of the lower limbs, suggesting that more disturbance here leads to increased muscle size. There was an insignificant improvement in head-heel and head-sacrum alignment in the sagittal plane. Hip and knee flexion were reduced, and ground reaction forces were symmetrical between left and right legs postoperatively (in contrast to preoperatively). Understanding the effects of sagittal and coronal balance, and how they are altered by surgery, is a developing area within spinal surgery. In adult cases, considering the centre of gravity and consequent standing stability is key in alleviating disability in these patients. An improved understanding of the biomechanics of the spine is essential in successful surgery, although it should be noted that not all units will benefit from access to a force plate laboratory or advanced plain x-ray machines.

Spinal deformities in Romantic operas

Society's perception of chronic disease has evolved over the years, and historical texts can give an insight into how attitudes and behaviours have changed. The librettos of two famous Romantic operas that contain references to spinal pathology have been analyzed by a group from **Monza (Italy)** to improve understanding of how 19th-century society viewed deformity.[4] *Rigoletto* (1851) by Giuseppe Verdi (1813 – 1901) and *La Esmerelda* (1836) by Louise Bertin (1805 – 1877) both have central characters with a spinal deformity. The title character of *Rigoletto* is described as being deformed when he married his wife, and the absence of other features have led the authors to suggest that he may have been affected by severe idiopathic scoliosis. The libretto of *La Esmeralda* was written in French by Victor Hugo, who adapted it from his novel *The Hunchback of Notre Dame*. We learn that the main character, Quasimodo, developed a deformity in early childhood and had a combination of deafness with extensive soft-tissue and skeletal deformity, while strength and metal function were spared. It has been proposed that Quasimodo may have had von Recklinghausen's neurofibromatosis (NF-1), the diagnosis that most closely fits the description given. Although von Recklinghausen would not name his disease until 1882, there are pictorial examples in scientific literature dating back to the 13th century. Both characters are shunned by society: Rigoletto is a jester who is ridiculed by other courtiers, while Quasimodo is a bell-ringer who is imprisoned. Both characters display normal human affections: Rigoletto for his daughter Gilda, and Quasimodo for Esmerelda, a beautiful gypsy woman. However, both characters also suffer loss: Rigoletto's daughter dies still enamoured of the unsuitable Duke of Mantua, while Esmerelda falls in love with the handsome Phoebus. The authors suggest that, although 19th-century society was prepared to tackle the subject, it was not yet ready to attribute success or human value to people affected by disabilities. This is an interesting perspective on disability, deformity, and the arts, and we would thoroughly recommend this thoughtful paper to those interested in spinal deformity.

Prepare: pre-surgery physiotherapy

Undergoing a surgical procedure involves taking one step backwards, as the body undergoes surgical trauma, and then (hopefully) two steps forwards, as the patient reaps the improvements in function or the reduction in pain or deformity. What if the step backwards could be lessened or the eventual outcome improved? A group from **Linköping (Sweden)** has looked at whether 'prehabilitation' or pre-surgery physiotherapy can alleviate pain and improve function and health in the longer term.[5] Their study involved patients undergoing surgery for lumbar spinal stenosis or disc herniation who were randomized into either a pre-surgery physiotherapy group or a control group of patients who simply waited for their surgery. Outcome was assessed by the Oswestry Disability Index (ODI), as well as by looking at secondary reported outcomes of pain intensity, anxiety, depression, self-efficacy, fear avoidance, and physical activity. The results were as one might expect: prior to surgery; the physiotherapy group had better scores in all of these areas compared with patients who were in the control waiting list group. After surgery, however, the control group had caught up in all areas except for a higher activity level in the physiotherapy group. For healthcare systems with long waiting lists, this study shows the beneficial effects of receiving physiotherapy while on a waiting list. The question the study does not answer, however, is whether the step backwards is actually lessened. While in the longer term, patients' outcomes are similar, is there a shorter-term difference? Do patients return to work or achieve better function earlier or experience less pain? This study only captured data at two timepoints post-surgery – three months and one year – so this potential difference between the groups could have been missed. We are delighted, however, here at *360*, to see a good-quality study investigating the effect of rehabilitation strategies on outcomes.

Can you measure physical function in patients with low back pain? X-ref

Low back pain (LBP) is among the most prevalent maladies of the modern human, and the most common cause of job-related disability. There are anthropological studies that argue that bipedal gait and unintended longevity make low back pain an inevitable part of the human biology. In fact, it is far from inevitable, but treatments are somewhat difficult to assess. Part of the difficulty in assessing treatments and treatment efficacy is that the evaluation of physical functioning is often made using patient-reported outcome measures (PROMs), which need to be complemented by physical functioning tests. Of course, how well patients with back pain will perform in physical function tests is not known. This study from **Wilrijk (Belgium)** provides a comprehensive overview of all physical functioning tests in patients with LBP, and reports on their test-retest, interrater, and intrarater reliability – important for clinicians who use these tests regularly in their armamentarium.[6] Rather than harvesting novel data, the authors of this study undertook a systematic computerized search of four different databases and used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to select and evaluate studies for inclusion in their review. Despite the importance of the question, the authors found that

there were very few clinical studies that reported the reliability of physical functioning tests in patients with low back pain. Overall, 20 eligible studies were found and 38 clinical tests were identified. Good test-retest reliability was concluded for the extensor endurance test, the flexor endurance test, the five-minute walking test, the 50-foot walking test, the shuttle walk test, the sit-to-stand test, and the loaded forward reach test. Only the Biering–Sørensen test demonstrated an overall good inter-rater reliability. None of the identified clinical tests could be considered to have good intrarater reliability. The authors call for future research that will investigate thoroughly the clinimetric properties of these clinical tests.

Low back pain and femoral geometry

■ The study from **Bari (Italy)** aims to assess the relationship between femoral anteversion, low back pain, and spinopelvic parameters in patients with severe primary unilateral hip osteoarthritis.[7] It is a relatively common presentation for patients to experience both low back pain and hip pain, both in the presence of degenerative disease. It is sometimes difficult to tease out which should be treated first, although there is almost universal agreement that the two conditions are linked. In a cohort of patients undergoing total hip reconstruction, this study seeks to identify the precise link between the two conditions, and brings us all one step closer to identifying the pathology behind the so-called 'hip-spine syndrome'. The study is based on the results of 91 patients, all with primary hip arthritis. All of the patients underwent a CT scan preoperatively and were divided into those with and without concomitant low back pain. The full gamut of radiological parameters was collected, as were clinical scores in the form of the visual analogue scale (VAS), Harris Hip Score (HHS), Oswestry Disability Index (ODI), Roland–Morris Disability Questionnaire (RM), and 36-Item Short-Form Health Survey (SF-36). The authors report that patients with severe primary unilateral hip osteoarthritis and low back pain exhibit a different femoral anteversion between the two hips, with a more anteverted femoral neck observed at the arthritic hip. This asymmetry was found to be strongly related to back pain, thus a new connection between hip and spine pathology has been discovered. This explains, in part, why patients with simultaneous hip osteoarthritis and back pain experience relief of both pathologies once a total hip arthroplasty is performed.

REFERENCES

1. Malik AT, Panni UY, Mirza MU, Tetlay M, Noordin S. The impact of surgeon volume on patient outcome in spine surgery: a systematic review. *Eur Spine J* 2018 (Epub ahead of print) PMID: 29344731.

2. Chu S, Chen N, Dang ABC, Kuo AC, Dang ABC. The effects of topical vancomycin on mesenchymal stem cells: more may not be better. *Int J Spine Surg* 2017;11:12.

3. Yagi M, Ohne H, Kaneko S, et al. Does corrective spine surgery improve the standing balance in patients with adult spinal deformity? *Spine J* 2018;18:36-43.

4. Andreotti M, Caruso G, Massari L, Riva MA. Spinal deformities in Romantic operas. *Spine (Phila Pa 1976)* 2017 August 29. (Epub ahead of print) PMID: 28858188.

5. Lindbäck Y, Tropp H, Enthoven P, Abbott A, Öberg B. Prepare: pre-surgery physiotherapy for patients with degenerative lumbar spine disorder: a randomized controlled trial. *Spine J* 2017 (Epub ahead of print) PMID: 29253630.

6. Denteneer L, Van Daele U, Truijen S, et al. Reliability of physical functioning tests in patients with low back pain: a systematic review. *Spine J* 2018;18:190-207.

7. Piazzolla A, Solarino G, Bizzoca D, et al. Spinopelvic parameter changes and low back pain improvement due to femoral neck anteversion in patients with severe unilateral primary hip osteoarthritis undergoing total hip replacement. *Eur Spine J* 2018;27:125-134.

Trauma

X-ref *For other Roundups in this issue that cross-reference with Trauma see: Children's orthopaedics Roundups 2, 6 & 7; Foot & Ankle Roundup 1; Research Roundup 2; Shoulder & Elbow Roundup 6; Wrist & Hand Roundups 1, 5 & 6.*

Suture button *versus* single syndesmotic screw for syndesmosis injury X-ref

■ There has been a resurgence of interest in the ankle syndesmosis, with recent papers looking at accuracy of reduction, functional restriction, and range of motion following syndesmosis injuries. This interest has paralleled the development of the TightRope syndesmosis device (Arthrex, Naples, Florida), which allows a 'flexible' fixation of the syndesmosis using an endobutton and a knot through traditional drill holes. Although there is much low-quality evidence making the argument that this is a reasonable approach, there is little in the way of high-quality evidence comparing TightRope and traditional screw treatment. These investigators from **Oslo (Norway)** undertook a randomized controlled trial to compare the clinical and radiographic results between patients, all of whom had a syndesmotic ankle injury, who underwent stabilization with a TightRope *versus* treatment with a single four-cortical syndesmotic screw.[1] The investigators enrolled 97 patients aged between 18 and 70 years old. Treatment allocation was via randomization; 48 patients received a TightRope device and 49 patients received treatment with a syndesmotic screw. The primary outcome measure was the score on the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale assessed to a final follow-up of two years. Secondary outcome measures were the Olerud–Molander Ankle (OMA) score, visual analogue scale (VAS), and EuroQol-5D (EQ-5D) Index. CT scans of both ankles were obtained at two weeks, and at one and two years postoperatively. The patients were followed at six weeks, six months, one year, and two years. Two years of follow-up were completed for 90% of the patients (46 in the TightRope group and 41 in the syndesmotic screw group). The median AOFAS score at two years was higher in the TightRope group than in the syndesmotic screw group (96 *vs* 86; $p = 0.001$), as was the median OMA score (100 *vs* 90; $p < 0.001$). The TightRope group reported less pain during walking at two years than the syndesmotic screw group. There was no difference between groups with regard to pain at night or during daily activities at the final two-year follow-up; however, the TightRope group had a higher median EQ-5D Index score at two years (1.0 *vs* 0.88). Around half of the patients in the syndesmotic screw group had a persistent radiographic malreduction of over 2 mm between the injured and uninjured ankles, which resulted in symptomatic recurrent syndesmotic diastasis in seven patients in the screw group. Although this is a relatively small randomized controlled trial, the investigators of this study conclude that patients treated with a TightRope do better over a two-year follow-up period, based on their AOFAS scores, OMA