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Walking out of the curve: thoracolumbar kyphosis in achondroplasia **X-ref**

■ Achondroplasia occurs in both familial and sporadic patterns, and brings with it a wide range of orthopaedic pathologies that warrant investigation, consideration, and, in some cases, management. Progressive thoracic kyphoscoliosis is one such pathology, and is often monitored with a view to intervention at some point during a patient's early years. As with all deformities that progress sporadically, a comprehensive understanding of scoliosis in this setting is essential in managing these complex patients. Fortunately, a group from **Baltimore, Maryland (USA)** have reported on a series of 60 patients, all of whom were assessed by a senior orthopaedic surgeon in a tertiary referral centre over a 16-year period, to bring a measure of clarity to the issue.¹ Demographic, radiological, and thorough clinical assessments were regularly made throughout the patient's childhood in an effort to understand the natural progression of the deformity and any associated pathology. The results of this cohort make for interesting reading. At walking age, and at one year after walking age, 15% and 58% of patients had spontaneous resolution of their deformity, respectively. Only 30% of patients had persistent deformity at final follow-up at around nine years after presentation. These persisting deformities were associated with apical vertebral translation, apical wedging, and developmental motor delay. The main author of this paper, Michael C. Ain, MD, has achondroplasia and a wealth of experience in the management and surgery in these patients. As such, this paper is an important contribution to healthcare providers who take care of children with skeletal dysplasias. It may not be sufficiently powered, but it provides a natural history of thoracolumbar kyphosis and factors leading to its persistence in children with achondroplasia, and it gives guidance in regard to treatment.

The arrival of the robots

■ Robots are slowly but surely infiltrating many aspects of modern life, and have all but replaced humans in many roles within the high-technology industry. Their presence is not quite ubiquitous in the operating theatre, but robots are increasingly taking the knives out of human hands. The

theoretical advantages to using robots in surgery are evident to us all: greater precision, the ability to avoid human error, lower operating time, less radiation exposure to the surgeon/team, and so on. Robots do, however, also bring their own limitations, including the increased complexity of operating the machine, constraints inherent in the system, and the potential for malfunction and breakdown. As with every new form of technology, the advantages are clear, but innovation always brings new potential problems. With this in mind, a group of authors based in **Miami, Florida (USA)** set out to investigate the current status of robotics in spine surgery.² So far, a number of small studies have shown a decrease in length of stay for patients operated on using minimally invasive methods in combination with robotic assistance. Regarding reduction of radiation exposure, only a few studies have shown a positive effect of robots. However, it is obvious that the fluoroscopy time will shorten as surgeons acquire more experience in using such aids. The accuracy of pedicle screw placement using robots tends to dominate the freehand technique, resulting in comparable or lower complication rates in the robotic groups. The authors call for further studies investigating this topic and emphasize that, for stronger conclusions, more surgeons with higher numbers of robotic surgeries will be needed. So, on balance, robots are not quite there yet. In order for a health-economic benefit to be shown, more data is required, and perhaps more work on innovative ways to utilize robotic surgery. It is important to remember that while the 'robotic age' in surgery may be dawning, surgical robots are currently aids to surgery, and appropriate training and familiarity with the technique is still very much essential.

Clinical impact of corrective cast treatment for early onset scoliosis

■ Bracing in scoliosis is a long-established treatment, particularly in early onset disease. An alternative to these orthoses would be corrective casts, which, although technically difficult to apply, are infinitely customizable to the patient. In order to establish the relative benefit of these treatments, a group from **Nagoya (Japan)** present us with this interesting paper, which assesses how a combination of casting and bracing compares with brace-only therapy in patients with early onset scoliosis (EOS).³ The authors used data taken from two hospitals, each of which

implemented a different strategy in the conservative treatment of early onset scoliosis. One unit treated patients with an alternating casting and bracing technique, while the other focused solely on bracing. There were no differences in the two groups with regards to diagnosis, gender, age at the first visit, curve magnitude, or the duration of treatment. Excluding those patients with congenital scoliosis, the study showed that in the cohort of 58 EOS patients, repetitive casting suppressed scoliosis progression better than only bracing. Second, patients had better compliance in the casting group and were unable to influence the time of cast application as they could with bracing (presumably because they can't take the cast off). Third, it was noted that brace therapy did not control the overall curve progression as effectively as casting did. The authors conclude that, given great variability in the aetiology of EOS, it is reasonable to take a more of a tailored approach. Based on the data presented here, perhaps casting should be considered more frequently. Clearly there are disadvantages in terms of patient acceptability, and technical expertise is required to apply the casts, but a comprehensive conservative treatment approach should at least consider the use of casting for selected patients.

Albumin/doxycycline injections for aneurysmal bone cysts in the mobile spine

■ This study, emerging from **Beijing (China)**, set out to validate the safety and efficacy of a minimally invasive non-surgical treatment for aneurysmal bone cysts (ABC) of the spine.⁴ The treatment of ABCs of the spine remains controversial, with a number of options available to the surgeon: surgery, embolization, radiotherapy, injection, and medication, as well as a range of different combinations of these modalities. In this comparative study, a percutaneous injection was used as an alternative to open surgery in patients who presented with ABCs and minimal, or no, neurological deficit (Frankel D or E). Patients were excluded if significant spinal instability was evident, and a control group had conventional surgery. Overall, 14 patients were treated with percutaneous injection, which comprised of a mixture of doxycycline and albumin. Doxycycline was used due to its inhibitory actions on matrix metalloproteinases, angiogenesis, and osteoclasts, while albumin serves as an excellent carrier. The remaining 11 patients were treated with

conventional surgery. The authors note no difference in the rates of complications or recurrences of the ABC in the group treated with injection compared with the surgery group. All patients showed a full neurological recovery and most showed a complete reduction in their spinal pain. In the surgery group, patients equally improved and outcomes were comparable. The authors concluded that this treatment could well serve as a valid alternative to surgery, especially in lesions within the mobile segments of the spine with uncompromised stability. This represents a promising early treatment, although a larger study will be needed to establish the complication profile. With only 14 patients in the percutaneous injection arm, it is difficult to draw strong inferences as to the safety of this treatment.

Eat before you fuse

■ Anterior lumbar interbody fusion (ALIF) is a common procedure in spinal surgery. ALIF is used to address deformity, to improve fusion rates, and, in some cases, for neural decompression. Although it is a safe procedure, the risk of complications has been reported as being up to 26%. Several factors have been proposed as risks for encountering complications; however, nutrition is one that has previously been neglected when considering anterior surgery. It is generally recognized that a serum albumin of < 3.5 g/dl represents sufficient malnutrition for complications to occur in orthopaedic surgery in general. In this study, a group from **New York, New York (USA)** has sought to establish whether there is a relationship between low serum albumin and complications in anterior lumbar fusion surgery.⁵ The group designed a population-based study to explore the relationship between serum albumin and complications. This registry-based study included 1275 patients who underwent anterior lumbar surgery and had preoperative serum albumin assessment from the American College of Surgeons National Surgical Quality Improvement Programme (ACS-NSQIP) database. Patients were all aged 18 years or more, and were excluded if surgery was urgent, if they showed signs of pneumonia or sepsis preoperatively, if they were pregnant, or if they had had surgery in the preceding 30 days, as all of these factors are known to either increase complication rates or affect albumin concentrations. Outcomes were assessed at 30 days postoperatively and were correlated with preoperative albumin. The authors show that a preoperative serum albumin of 3.5 g/dl or less is significantly associated with a length of stay greater than five days, wound complications, pulmonary complications, urinary tract infection,

transfusion requirement, sepsis, and readmission. Furthermore, a multivariate analysis shows that albumin is an independent predictor of these problems in a model including a range of potential confounders. This study shows that patients are five times more likely to develop sepsis or a urinary tract infection with a low albumin level, and are 2.5 times as likely to stay more than five days following surgery. These findings are similar to those seen in posterior surgery. However, it is worth noting some of the flaws with this methodology. First, the coding for anterior surgery in the ACS-NSQIP database included lateral surgery, and these were inseparable during the analysis. Hypoalbuminaemia may have also been a surrogate marker for another, undiagnosed illness that may have confounded the findings. Nevertheless, this study makes it clear that patient nutrition warrants attention in the build-up to spinal surgery, as part of an extensive work-up.



Coronal imbalance under the spotlight

■ Scoliosis surgery aims to prevent development of a deteriorating imbalance in the spine, and to improve this balance wherever possible. It has been well established that sagittal imbalance has the greatest effect on patient-reported outcomes, and this has received a lot of attention in the literature in recent years. However, coronal imbalance must not be ignored, as failure to improve this has a negative effect on patient satisfaction, pain, function, and quality of life. Unfortunately, achieving coronal balance can be very difficult, with factors including body mass index, osteoporosis, and L4 and L5 tilt reported to contribute to residual deformity. This group from **Toronto (Canada)** conducted a study aimed at finding the key factors that influence coronal curve correction in patients with long spinal fusions for adult spinal deformity.⁶ Of the 47 patients who were included in the study, all had undergone surgery by a single surgeon in a single centre. Patients underwent long segment

fusion to the pelvis over a ten-year period between 2005 and 2015. Patients were followed up for at least six months with scolliograms, CT, casenote review, and questionnaires. Coronal imbalance was defined as when a plumb line from C7 was found to be lying outside 40 mm from the sacral vertical line. Overall, 32 patients were found to be balanced. Residual L4 and L5 tilt was closely associated with residual coronal imbalance. All patients showed improvements in their coronal balance, with no significant differences in the maximum Cobb angle or correction achieved. Both groups also showed a similar improvement in their sagittal parameters. Surgical techniques, osteotomies, and the implants used had no significant effect on achieving coronal balance. This study suggests that achieving neutral tilt in L4 and L5 seems to be a key factor in attaining coronal balance. Although this study is single-centre and single-surgeon, it contributes to the surgical strategy in delivering the optimal outcome for these complex patients.

Revision spinal surgery: when once is enough

■ Revision spinal surgery is not much fun for anyone involved. It is, unfortunately, increasingly common, with up to 70% of procedures carried out for adult spinal deformity encountering a complication. The purported rate of revision surgery in these patients lies somewhere between 9% and 45%, with higher rates being encountered in series reporting longer follow-up. As a result, multiple revisions are now on the rise; however, we do not know what impact multiple revisions has from the patient's perspective. With this in mind, a group from **Plano, Texas (USA)** have explored the relationship between the number of revision procedures and final outcomes in 137 patients undergoing surgery for adult spinal deformity.⁷ The patients, who all underwent surgery in a single unit between May 2010 and December 2013, were divided into three groups. Group 1 encompassed patients who had undergone one previous operation, group 2 had undergone two previous operations, and group 3 had undergone three or more previous operations. The authors assessed radiological and clinical outcomes using the visual analogue scale (VAS) and the Oswestry Disability Index (ODI). The groups were equal in size, with a mean of four previous spinal operations. There were no differences in the underlying diagnoses between each of the groups. Group 2 and 3 had a worse coronal balance than group 1, and group 3 had the worst pelvic incidence–lumbar lordosis (PI–LL) mismatch and ODI. There were no differences in the frequencies of major or minor complications,

and no differences in the subsequent number of operations. This study suggests that multiple revision surgeries could be leading to worse coronal balance, sagittal balance, and overall function. The study's small series, its focus on a single centre, and its retrospective methodology limit the conclusions that can be drawn from the data, but it provides more information that we can communicate to patients before they submit to the theatre table.

Staged surgery for tandem cervical and lumbar spinal stenosis: which should be treated first?

■ Coexisting lumbar and cervical stenosis is common, and planning a treatment strategy is challenging. Surgical decompression is often staged, but two important questions remain: which stenosis should be addressed first, and is it possible to decompress just one to alleviate a patient's symptoms? Researchers from **Tauyuan (Taiwan)** retrospectively analyzed data from 47 patients, all of whom underwent staged decompression of either cervical or lumbar spine first, and then compared their outcomes.⁸ Group A underwent lumbar decompression first, and group B underwent cervical decompression first. Patients in both groups were followed up for two years and were observed to see if they developed symptoms from the untreated stenosis. One patient in group A (9%) made a full recovery compared with 25 patients (67%) in Group B, indicating that the need for second-stage surgery is significantly higher for patients who underwent lumbar spine surgery first. Patients who underwent initial lumbar decompression reported worsening of the modified Japanese Orthopaedic Association score and Nurick's grade, both of which are scoring systems for myelopathy, whereas both scores improved for patients who had initial cervical decompression. Although this study had small patient numbers and

was retrospective in design, the message is clear: initial cervical decompression is associated with a lower chance of second-stage surgery, whereas initial lumbar decompression risks worsening the symptoms of cervical stenosis.

Iliac screws may not be necessary in long segment constructs

■ There is an increased risk of metalwork failure with long spinal constructs at the lumbosacral junction, due to the weak fixation offered by S1 screws in the cancellous bone of the sacrum in combination with the long working lengths and related adverse lever arm. To counter this, fixation to the pelvis with iliac screws is often performed, but this is associated with increased morbidity, including prominent metalwork, and is reported to cause mechanical complications in up to 35% of patients. A group from **Phoenix, Arizona (USA)** have reported their biomechanical cadaveric study to assess the influence of iliac screws and interbody fixation type on range of movement, sacral screw strain, and rod strain.⁹ Overall, 14 cadaveric lumbar spines were instrumented between L2 and S1, and underwent mechanical loading in flexion, extension, lateral bending, axial rotation, and compressive loads. The instrumentation consisted of a variety of configurations involving L2-S1 pedicle screws and rods/additional iliac screws, and then with either anterior lumbar interbody fusion (ALIF) or transforaminal lumbar interbody fusion (TLIF) interbody cages between L5 and S1. Multiple strain gauges were placed on the pedicle screws and rods. The key findings were that iliac screws were protective of sacral screw strain, but increased rod strain at the lumbosacral junction. Constructs involving an ALIF without iliac screws resulted in similar sacral screw strain to constructs with TLIF and iliac screws, albeit with significantly less rod strain.

When iliac screws were inserted, ALIF reduced iliac screw strain, but TLIF did not. The message for surgeons is that while iliac screws protected against S1 screw failure, they increased the lumbosacral rod strain, which may lead to failure. ALIF appeared to protect against iliac-screw rod strain and may also remove the need for it.

REFERENCES

1. **Margalit A, McKean G, Lawing C, Galey S, Ain MC.** Walking out of the curve: thoracolumbar kyphosis in achondroplasia. *J Pediatr Orthop* 2018;38:491-497.
2. **Ghasem A, Sharma A, Greif DN, Alam M, Maaieh MA.** The arrival of robotics in spine surgery: a review of the literature. *Spine (Phila Pa 1976)* 2018;43:1670-1677.
3. **Kawakami N, Koumoto I, Dogaki Y, et al.** Clinical impact of corrective cast treatment for early onset scoliosis: is it a worthwhile treatment option to suppress scoliosis progression before surgical intervention? *J Pediatr Orthop* 2018;38:e556-e561.
4. **Liu X, Han SB, Si G, et al.** Percutaneous albumin/doxycycline injection versus open surgery for aneurysmal bone cysts in the mobile spine. *Eur Spine J* 2018. (Epub ahead of print) PMID: 30470879.
5. **Ukogu CO, Jacobs S, Ranson WA, et al.** Preoperative nutritional status as a risk factor for major postoperative complications following anterior lumbar interbody fusion. *Global Spine J* 2018;8:662-667.
6. **Lewis SJ, Keshen SG, Kato S, Dear TE, Gazendam AM.** Risk factors for postoperative coronal balance in adult spinal deformity surgery. *Global Spine J* 2018;8:690-697.
7. **Hu X, Lieberman IH.** Revision adult spinal deformity surgery: does the number of previous operations have a negative impact on outcome? *Eur Spine J* 2018. (Epub ahead of print) PMID: 30382430.
8. **Luo CA, Kaliya-Perumal AK, Lu ML, et al.** Staged surgery for tandem cervical and lumbar spinal stenosis: which should be treated first? *Eur Spine J* 2018. (Epub ahead of print) PMID: 30328532.
9. **Hlubek RJ, Godzik J, Newcomb AGUS, et al.** Iliac screws may not be necessary in long segment constructs with L5-S1 anterior lumbar interbody fusion: cadaveric study of stability and instrumentation strain. *Spine J* 2018. (Epub ahead of print) PMID: 30419290.