treatment of primary osteosarcoma. From a treatment perspective, patients underwent excision and reconstruction in combination with a multidrug protocol of neoadjuvant chemotherapy. The series had more distal femoral lesions (67%) than proximal tibial lesions (33%), and the patients were followed up to a mean of 53 months with a minimum known oncological follow-up of one year. There was a 71% survival at five years' final follow-up, and 67% at eight years. Deaths were due primarily to metastasis (n=33), and ten patients suffered local recurrence during the course of the study. Overall complication rates were rather high, as previously reported in other series, with 51 complications occurring in 45 patients. The overall prosthesis survivals were 78% at five years and 55% at eight years, with 59 surviving prostheses at the end of the observation period. Of the 21 implant failures, five were due to untreatable infection, eight to aseptic loosening, four to local recurrence, three to structural failure, and one to soft-tissue failure. The MSTS score gave a 76% functional level. This is a very similar series to the Danish series, with a reported 45% failure rate at eight years, although the authors were able to demonstrate slightly poorer survival in the proximal tibia than in the distal femur.

Core needle biopsy reliable in radiolucent bone tumours?

The core needle biopsy (CNB) is a widespread and accepted method of diagnosis of solid bone tumours where a reasonable core of tissue can be expected to give an accurate and reliable diagnosis. When interpreted in conjunction with clinical and radiological findings, it is the gold standard for treatment planning. However, there is less widespread acceptance of CNB in the diagnosis of aneurysmal bone cysts (ABCs), most likely due to concerns of safety with attendant complications and its reliability in ruling out malignant diagnoses such as telangiectatic osteosarcoma. Being sure that a tumour is benign (ABC) or malignant (telangiectatic osteosarcoma) is important. The authors from **Santa Monica** and **Los Angeles, California (USA)** report a retrospective study of their pathology database for ABC and telangiectatic osteosarcoma, and included those patients who underwent a CNB and then proceeded to definitive surgical resection with final histopathological diagnosis.[9] A surprisingly high total of 81% of CNBs were effective, and, based on eventual results and further investigations, 93% of CNBs (n=55/59) were determined by the study team to be accurate. Diagnostic CNBs had a sensitivity and specificity of 89% and 100%, respectively, and there were no reported complications within the series. Within the constraints of the numbers available, there was no difference in efficacy or accuracy between CNBs performed in-house and those referred from outside. This study suggests that core needle biopsy is essentially safe and reasonably accurate if sufficient material is obtained. There seem to be few downsides to adopting CNB as part of the diagnostic work-up for these patients.

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Children's orthopaedics

X-ref ***For other Roundups in this issue that cross-reference with Children's orthopaedics see: Spine Roundup 6; Research Roundup 1.***

Supracondylar fractures and BOAST 11 X-ref

In maintaining standards in modern surgical practice, outcome, system, and process measures have become used increasingly often. The British Orthopaedic Association Standards for Trauma (BOAST) have been a laudable development in trauma care in the United Kingdom and have undoubtedly improved standards of care across a range of injuries. The principle of the BOAST guidance is to provide auditable standards against which to measure the performance of individual care or systems at any scale. BOAST 11 addresses quality standards for care of supracondylar elbow fractures. These relatively common injuries are most commonly managed by general orthopaedic surgeons, despite their relative complexity. At points in the pathway, such as the initial assessment in the emergency department, some of the most junior medical staff are involved in care. This is important, as experience, training, and level of supervision can affect the quality of the assessment made. Neurovascular injury can mandate urgent surgery, and delayed surgery or missed injuries may, of course, have serious consequences. Guidelines only improve care if they are successfully implemented, and this collaborative group based in **Bristol (United Kingdom)** have performed a simple but effective multicentre audit to establish how closely the guidance on assessment is followed.[1] Specifically, the study team evaluated implementation of BOAST 11 standard one, which requires a documented assessment of the limb performed on presentation that must include the status of the radial pulse, digital capillary refill time, and the individual function of the radial, median (including the anterior interosseous), and ulnar nerves. This

may sound relatively elementary to experienced surgeons, but the results across a total of 433 patients with Gartland 2/3 fractures in eight hospitals may be surprising to some. Overall adherence to the standard was between 201 (46%) and 232 (54%) for the motor and sensory function of the individual nerves specified, 318 (73%) for radial pulse, and 247 (57%) for digital capillary refill time. The investigators introduced a patient assessment proforma after this initial audit cycle, as their suggested intervention, and then undertook another audit. During the second audit loop, adherence to the BOAST standards improved to between 72 (71%) and 80 (78%) for motor and sensory function of the nerves, to 84 (82%) for radial pulse, and to 82 (80%) for digital capillary refill time. Of the 102 case notes reviewed in stage two, only 44 (43%) used the quality improvement proforma; when the proforma was used, adherence improved to between 40 (91%) and 43 (98%) on all metrics. Here at *360*, we commend the authors for highlighting and addressing this poor performance. We would all do well to remember the clinical and medicolegal importance of a careful examination and documentation in this high-risk area of practice.

Magnetically controlled growth rods in the treatment of early onset scoliosis X-ref

■ The correction of early onset scoliosis presents additional complexity compared with later corrections, as the remaining growth of patients under ten years of age makes multilevel fusion an inappropriate intervention. Traditional growing rods have been the mainstay of treatment, but their foremost drawback is the need for repeated operations for their lengthening, which have their own associated risks. Magnetically controlled growth rods (MCGRs) offer an alternative treatment option. The proponents of MCGRs point to the potential to obviate the need for multiple anaesthetics, reduced loss of time from school, and the obvious potential benefit of a more continuous growth approach. However, MCGRs may induce problems of their own, including pain during the lengthening process. Although now used in widespread practice, there is only really evidence to support their use from small case series. No previous clinical trials have been performed in the United Kingdom for this device, so we are pleased to report that the National Institute for Health Research have funded a study performed by a collaborative group based in **Oxford (UK)**.[2] The group undertook an observational prospective cohort study of children with early onset scoliosis, who were followed up for a minimum of two years. From a surgical perspective, growing rods were inserted in a standard manner as deemed appropriate by the treating surgeon, with distractions performed on a three-monthly basis. Ten children were recruited to the study: five boys and five girls with a mean age of 6.2 years (2.5 to 10). The mean coronal Cobb angle improved from 57.6° (40° to 81°) preoperatively to 32.8° (28° to 46°) postoperatively, and was 41° (19° to 57°) at two years. In this small series, there were five children who suffered an adverse event, with four requiring return to theatre, but none were related to the devices themselves. There were no reported neurological complications or infections and none of the devices failed. Comparison with other studies with respect to the correction of Cobb angles is difficult, given the small sample size and the heterogenous group of patients; however, the incidence of complications does seem equivalent. The study confirms that the reduced number of trips to theatre associated with MCGRs brings with it the potential for economic and psychosocial advantages. As the authors observe, early onset scoliosis remains a challenge to treat and this study provides further evidence for debate in this area.

Fibular epiphyseal transfer for sarcoma of the humerus X-ref

■ Limb salvage surgery following tumour resection frequently presents complex reconstructive difficulties. While entoprosthesis and amputation are options that may often offer benefits over limb reconstruction in the adult population, these are not ideal in the paediatric tumour population, where the preservation of future growth adds further challenges in maintaining quality of life and limb function. In the adult population, undergoing resection of the proximal humerus for sarcoma endoprostheses is the go-to option for a reliable and durable outcome. In the paediatric humerus, with 80% of growth coming from the proximal epiphysis, a significant limb-length discrepancy can result. Expandable prostheses have a high rate of complications and somewhat mixed reports of longevity. Vascularized transfers have the advantage of more predictable growth and the prevention of premature physeal closure when compared with non-vascularized grafts. Although technically challenging, there are some decided advantages to this procedure, and we were very interested to read this study from **Birmingham (United Kingdom)**, which fills an evidence gap regarding the medium-term outcome of these rare procedures.[3] These authors have quantified the medium-term outcomes of hypertrophy of the graft, the mean annual growth of the transferred fibular epiphysis, and the medium-term functional outcomes of the neoglenofibular joint. A total of 11 patients were analyzed who underwent this procedure for a primary bone tumour of the proximal humerus between 2004 and 2015; six had Ewing's sarcoma and five had osteosarcoma. The mean follow-up was 5.2 years but one patient had died from recurrence prior to the one-year postoperative follow-up. Unsurprisingly, there was a significant complication rate, including seven fractures, four transient nerve palsies, and two patients who developed avascular necrosis of the graft. All the fractures presented within the first postoperative year and united with conservative management. One patient had further operations for a slipped fibular epiphysis of the autograft. Hypertrophy and axial growth were assessed in the nine patients who did not have avascular necrosis of the graft, demonstrating a mean hypertrophy index of 65% and mean longitudinal growth of 4.6 mm per annum. These patients also achieved a mean shoulder abduction of 57° (10° to 100°), forward flexion of 63° (20° to 90°), and external rotation of 19° (0° to 40°), which is commendable. Despite its technical demands, this technique is therefore promising, and we will be interested in the longer-term follow-up of these patients into adulthood.

Lateral condylar fractures of the humerus in children X-ref

■ Surgical management of displaced fractures of the lateral condyle of the humerus in children are relatively common, although controversy surrounds the precise indications for surgery. If surgery is decided upon, there is another question to be addressed: should it be performed with K-wires or with screw fixation? Each method has its potential advantages and proponents, and in order to investigate

which method is superior, researchers from The Royal Children's Hospital, **Melbourne (Australia)** and The Hospital for Sick Children, **Toronto (Canada)** retrospectively reviewed two cohorts of patients treated surgically over a ten-year period from 2005 to 2014.[4] In the timeframe of the study, 336 patients were identified. The mean age at the time of injury was 5.8 years (0 to 15), with a male/female patient ratio of 3:2. A total of 243 (72%) had a Milch II fracture and the fracture was displaced by >2 mm in 228 (68%). Considerably more patients underwent K-wire fixation (235; 70%) than screw fixation (101; 30%). In terms of outcomes, the authors report that there was a significantly higher rate of nonunion with K-wire fixation, but there were no differences in reduction parameters (measured by Baumann's angle radiographically and carrying angle clinically) or the rate of major complications between the two groups. Immobilizing the elbow for more than four weeks also conferred no clear benefit with either technique. In the short term, no observed complications were seen when fixation crossed the lateral ossific nucleus, and screws were routinely removed at three months. However, because the patients in this series were not followed up in the longer term, the authors sensibly advise that screw fixation across the ossific nucleus should be avoided. Although a third of the patients had a fracture that was displaced by less than 2 mm, which is a commonly adopted threshold for fixation, regression analysis showed no correlation between displacement and complication rates, including nonunion. Despite the increased rate of nonunion in the K-wire group, the authors cite work suggesting that, within 16 weeks following the injury, nonunions can be treated in a relatively straightforward manner with percutaneous screw fixation alone. Furthermore, this strategy – with K-wire fixation first and percutaneous screw fixation if nonunion ensues – used less total operating resources than initial screw fixation without affecting the outcome. With a bail-out option in place if a nonunion does result with K-wires, the choice of technique still seems to be justifiable if that is the surgeon's preference.

Early closed bone graft epiphysiodesis following unstable SCFE X-ref

■ Although avascular necrosis (AVN) is a recognized and serious complication in slipped capital femoral epiphysis (SCFE) patients, there is not a universally recognized standard for AVN surveillance following *in situ* pinning for SCFE. This paper from **Cleveland, Ohio (USA)** sought to compare the different postoperative algorithms employed by two of their surgeons in order to cast light on the matter.[5] The authors report a large number (n=50) of unstable SCFE hips in 48 patients, all of whom were retrospectively identified and underwent pinning *in situ* for their unstable slip over a 14-year period. One group of patients underwent an MRI scan of the hip between one and six months postoperatively, while the other group was followed using serial plain radiographs only, the regime of which was unspecified. MRI screening revealed AVN in seven of 17 hips (41%) at a mean of 2.5 months postoperatively, while plain radiographs recognized AVN in six of 33 hips (18%) at a mean of 6.8 months. The authors suggest that early detection of AVN development followed by a suitable intervention within four months postoperatively, namely a closed bone graft epiphysiodesis, can alter the course of AVN and delay the degenerative process of the head. However, it is worth noting that the numbers in the study are small and the sources of potential bias are multiple. It may be that the authors are correct, and that routine MRI scanning postoperatively would detect early AVN, the disease course of which could be successfully modified with a closed bone graft epiphysiodesis. While the data presented here cannot really be used to unequivocally support this assertion just yet, and further research is required, this study has successfully raised the question.

Congenital coxa vara: operative or conservative X-ref

■ Congenital coxa vara (CCV) is a rather rare condition and studies with a sizeable cohort of patients are infrequent in the literature. This study from **Dallas, Texas (USA)** is therefore a welcome addition to the evidence base.[6] Patients were retrospectively identified who had been treated in a single tertiary centre over a 30-year period, up to and including 2010. Despite the size of the centre, only 46 hips (32 patients) fulfilled the criteria to be included in the study. Within this cohort, there were isolated cases of CCV, cases associated with a congenital short femur and mild limb length difference <4 cm, and patients with associated skeletal dysplasia. In terms of interventions, a valgus derotational osteotomy of the proximal femur was performed in 27 hips (59%), while the other 19 hips (41%) were treated nonoperatively. There is clearly some bias here, however, as patients were selected for surgery based on the clinician's view that they would benefit, and so they potentially represent the more severe end of the spectrum. Patients were recalled for additional follow-up x-rays, modified Harris Hip Score, and gait analysis. Radiographic parameters were examined for inter-observer reliability and multivariate analysis was performed to identify risk factors for recurrence after surgery. In the nonoperative group, long-term outcomes were variable, with 21% of these patients showing spontaneous resolution to a neck-shaft angle of >120°, but this worsened over time in 26% of patients. No risk factors for this progression were identified; this included the Hilgenreiner-epiphyseal angle (HEA). This is interesting, as it was thought previously that resolution was likely with a HEA <45°. In the operative group, initial deformity was greater compared with nonoperative patients, but radiographic outcomes were similar at follow-up. Most nonoperative hips had normal growth rates (80%), but, in contrast, 56% of operative hips showed a decreased rate. At the final long-term follow-up visit, rather worryingly, 72% of patients demonstrated a significantly abnormal gait, and half had fair or poor functional outcomes scores. Multivariate analysis revealed that there were no significant predictors of recurrence of deformity, including associated diagnoses or preoperative deformity. The authors conclude that valgus derotation osteotomy improves radiographic and clinical outcome scores in severe deformity, but recurrence was not uncommon, with 21% requiring a further osteotomy. Many patients seem to have persistent gait abnormalities and functional impairment at long-term follow-up, regardless of prior treatment. While the authors have done well to assemble a cohort of this size, a multicentre study would be useful in order to boost numbers and seek to identify prognostic factors that could improve the relatively poor results achieved in these patients.

Scoliosis: a 20-year retrospective X-ref

■ It is often instructive to review the history of our practice, which reveals how it has evolved, where changes have been made, where mistakes and blind avenues have yielded no improvements, and where developments may be made in future. However, despite the potential to learn from the past, we rarely see retrospective articles like this one from **New York, New York (USA)**, which provides an interesting historical overview spanning 20 years of adolescent idiopathic scoliosis (AIS) surgery.[7] The authors interrogated a multicentre database of over 1800 operatively

managed patients with AIS, mainly from the United States but also from Canada and the United Kingdom. Surgeries were performed between 1995 and 2013 and, by dividing this period into quartiles, trends were analyzed. Some obvious trends were confirmed; anterior spinal fusion was frequently used in the first two quartiles of the study but essentially disappeared as a standalone procedure for the treatment of thoracic and thoracolumbar curve types. The use of pedicle screws as the anchor of choice increased from 0% of cases in 1995, rising to 96% in the last quartile. Thoracoplasty use showed a steady decline, dropping from a peak of 76% of cases to a low 20% of cases in the last quartile. A significant decrease in the reported rate of major complication rate was also seen, with a rate of 19% in the first quartile and 5% in the last. There was also a greater use of antifibrinolytic medication, less blood loss, shorter operative times, and shorter length of stay. Improvements in quality-of-life score outcomes were also evident over the study period, indicating that better outcomes are being achieved. Looking to the future, the authors conclude that the role of fusionless and minimally invasive techniques, improving operative efficiency, and resource utilization are all areas ripe for further study. Overall, this is very encouraging reading. AIS is still a major procedure, but one in which major complications now affect 1:20 patients rather than 1:5, an improvement that has been achieved through the development of improved implants and the optimization of perioperative care.

Results of casting in severe curves in infantile scoliosis

X-ref

■ In this study, authors from the Shriners Hospital in **Greenville, South Carolina (USA)** present their own results with casting children with severe infantile scoliosis.[8] Although bracing is gaining traction in older children with lesser curves, casting has always retained a niche in certain infants who present with curves that are difficult to treat operatively. This study examines the effects of casting in severe infantile curves (50° to 106°), as well as how comorbidities such as a syrinx or associated genetic syndromes affected outcomes. The authors present the largest contemporary series of such a treatment in their report of 44 children with an initial curve of 50° or more, all of whom were aged three years or under at the start of casting; the minimum follow-up was three years. The authors utilized the Mehta casting technique in all cases. Curve resolution was obtained in 35% of the idiopathic cases (9/26), while, perhaps unsurprisingly, only 17% (3/18) of those with a syrinx or associated genetic syndrome achieved resolution. Of those who did not have resolution of their curves, 14 were maintained over the entire follow-up and 13 improved by 15° or more. This study has demonstrated that curve resolution is possible in children who start casting at least up to three years of age, despite the curve being over 50°. The authors were not able to demonstrate a subgroup that did not have substantial benefits. Even in the oldest children and largest curves, curve resolution and significant delays in the need for surgery are possible using serial casting. Although the technique itself is demanding of patients, parents, and clinicians, it clearly has a place in selected patients where surgery may be avoided at a later stage.

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Research

The team approach to safety in paediatric spinal surgery

X-ref

■ One of the huge challenges created by short rotas – of all types of theatre staff – is the loss of flexibility in planning and staffing theatre teams for lists. It is well recognized that team working is beneficial for improved outcomes, and teams that rarely consist of the same group of people, or that are thrown together at the last minute, may perform relatively poorly. This paediatric spinal surgery team from **Vancouver (Canada)** were finding that their operating theatre nurses, paediatric anaesthetists, and neuromonitoring technicians were being assigned *ad-hoc* to the theatre on the day of surgery according to immediate availability.[1] They report on their solution to this problem, which could find application in almost any area of orthopaedic surgery. They established a specialist Paediatric Spinal Surgical Team (PSST) to ensure that only a consistent core group of staff worked together, and retrospectively reviewed two years of cases that lasted 120 minutes or more before and after implementation to establish if there was any measurable clinical improvement. The report focuses on the outcomes of 407 patients reported over a period straddling the implementation of the PSST. There were 130 patients pre-PSST and 277 post-PSST. The groups were essentially comparable, with no significant differences in age, gender, body mass index (BMI), preoperative Cobb angle of the major curve, and the number of levels measurable between the two groups. There were, however, statistically significant improvements in almost all of the measured process and outcome measures. The group reported fewer surgical-site infections, shorter mean operating time, shorter length of stay, less requirement for allogenic blood transfusion, and a lower incidence of unplanned staged procedures between the two groups. As the authors point out,