X-ref ***For other Roundups in this issue that cross-reference with Children's orthopaedics see: Hip Roundup 6; Foot & Ankle Roundup 5; Oncology Roundup 5; Research Roundup 6.***

All-epiphyseal the future of paediatric ACL reconstruction?

Paeds, knee

■ Paediatric anterior cruciate ligament (ACL) injuries are on the rise, and, particularly in the adolescent population where sport is getting more competitive, training is getting more demanding, and athletes are performing to a higher level, there is a change in the patterns of injuries presenting to paediatric orthopaedic clinics. In particular, there has been a shift towards a more adult pattern of presentation - in particular a rise in ACL injuries rather than tibial spine fractures. The difficulty, of course, is that an ACL-deficient knee in a growing child poses problems, with both potential interruption of the growth plate and also change in kinematics as the knee itself grows. We are therefore left with the spectre of growth arrest on the one hand and a risk of significant early arthrosis on the other. One potential solution for this is the 'all-epiphyseal' ACL reconstruction. This paper from **Philadelphia, Pennsylvania (USA)** presents a single-centre retrospective case series of 103 patients (mean age 12.1, range 6.3 to 15.7).[1] Follow-up was available for the purposes of this study to a mean of 21 months after the surgery, and the authors report an 'all-epiphyseal' approach to ACL reconstruction with the aim of avoiding damage to the growth plate. The series was (as all retrospective series are) a heterogeneous group of patients, including 81 hamstring autografts, 19 allografts and three hybrid constructs. The authors extracted data on potential complications following surgery, specifically the development of leg-length discrepancy, angular deformity, re-rupture, infection, knee range of motion and arthrofibrosis. In addition, surgical factors such as age, BMI, graft type, size and concomitant injuries were assessed for association with re-rupture. The rate of growth disturbance reported with this technique was < 1%, however, the re-rupture rate was not insignificant at 10.4%, with no definable predisposition in terms of demographics or technique. The complication profile included < 1% rate of arthrofibrosis, superficial infection, prominent hardware and persistent instability. This study would be of interest to general paediatric orthopaedic surgeons and knee surgeons. The all-epiphyseal ACL reconstruction appears to have a low rate of growth disturbance, an acceptable complication profile and a re-rupture rate of 10%. This compares favourably with the other reported series in the literature describing other techniques of ACL reconstruction and perhaps we should be thinking about developing the skills required for an all epiphyseal reconstruction.

Conservative or operative treatment of humeral shaft fractures in children?

■ Even the most displaced of humeral fractures can be treated non-operatively, and indeed that is the recommendation of the standard texts. The authors of this paper from **Montpellier (France)** and **Torino (Italy)** ask the question: is this the correct management of these injuries?[2] There are few contemporary series examining modern fixation options such as flexible nails to conservative treatment in a comparative series. This retrospective three-centre cohort includes a review of 36 consecutive children, all treated for displaced humeral shaft fracture. The patients are followed up to one year following treatment with: a conservative method, Desault bandage (n = 10 patients); external fixation (n = 11 patients); and elastic stable intramedullary nailing (n = 15 patients). Outcomes were assessed using a combination of pre-operative and post-operative radiographs, and functional scoring with the QuickDASH score.As one would expect, the surgical treatments provided a better radiological outcome, however, there was no real discernible difference in clinical outcomes. All of the patients had returned to previous activities within six months following completion of fracture treatment. The complications (other than displacement) were confined to the operative group, with two cases of re-fracture, and one each of infection and neurological injury. Although the abstract curiously states "*Surgery is not contraindicated in children with displaced humeral shaft fractures*", the study demonstrates no advantage with surgery compared with this type of conservative management, and illustrates a low but not insignificant complication profile with surgery. The chief advantage of the surgical group was the rapid return to mobilisation which was significantly quicker than that seen in the non-operative group. This said, there was a price to pay in terms of risks of complications for that ability to get the patient going quicker.

Paediatric cervical spine clearance X-ref

■ The evaluation of the paediatric spine in trauma is an awkward task. Children suffering injury are often difficult to assess, can suffer from spinal cord injury without radiological abnormality (SCIWORA) and their conditions are difficult to investigate, with CT scanning associated with significant lifelong risks of tumorigenesis. Given the tricky nature of this clinical evaluation, one might expect major centres to have developed consistent guidelines for the evaluation of the traumatically injured paediatric spine. However, this study from **Philadelphia, Pennsylvania (USA)** suggests that there is a worrying lack of consistency in the assessment and management of the child with a significant neck injury at trauma receiving centres.[3] This study is based on the results of a ten-question electronic survey circulated to members of the Pediatric Cervical Spine Study Group to identify imaging and protocols used in the management of the paediatric cervical spine. The majority (21) of 25 institutions surveyed were level 1 trauma centres, and this study demonstrated a wide variability in personnel and imaging availability. Less than half had a written, standardised paediatric cervical spine clearance protocol in place. The study group aims to produce a consensus document, agreeing guidelines for the initial evaluation of the cervical spine in the paediatric trauma population. In general, these survey-type papers do not 'float our boat' here at *360*. They are often simple papers conceived to fill the research sections of registrars' or residents' CVs with the minimum of fuss. However, we can't help thinking that the authors of this simple paper really do have a point given the complexity of the decision making and the importance of getting it right, it does seem worrying that less than 50% of the centres surveyed had protocols in place for paediatric spinal clearance. This paper will hopefully provide a timely reminder to us all to ensure that our centres establish a suitable protocol.

Significance of the lateral humeral line for evaluating radiocapitellar alignment in children X-ref

■ Injuries of the paediatric elbow are a frequent occurrence, and fracture clinics are full of patients

referred due to a 'positive fat pad sign' who do not appear to have any tangible injury. The use of normal radiographic lines can be helpful in both excluding and diagnosing injury and represent a potentially easy and structured way to evaluate the radiographs of the injured elbow. The radiocapitellar line (RCL) has long been one of the basic techniques in evaluation of potential elbow injuries, providing the simple rule of thumb that if the radiocapitellar line bisects the capitellum on all views, there is unlikely to be a displaced fracture. Nonetheless, in the last couple of years, this age-old rule of thumb has been questioned by various authors in terms of its reliability and accuracy, especially in the anteroposterior (AP) view. Several previous studies have emerged, and there is a general acceptance now that the RCL less commonly "bisects the capitellum on all views". When picking these apart, it seems that the factors that determine the line's accuracy are eccentric capitellar ossification, patient age, forearm positioning, anatomic landmarks and, of course, the old issues with observer bias. Be that as it may, until this point there has not really been a viable alternative that is easy to assess and has reliable accuracy. The authors of this study from **San Diego, California (USA)** provide the readers with an alternative method of assessing the RC joint in the coronal plane, the "lateral humeral line".[4] They defined this as a line drawn along the edge of the most lateral ossification of the lateral condyle (or epicondyle, if present), parallel to the long axis of the distal humeral shaft. They tested the diagnostic accuracy of their line with 37 AP radiographs of children coupled with MRI scanning images for gold standard evaluation. The lateral humeral line was found to pass on the lateral edge, or lateral to the radial neck, on all of the AP radiographs and MRI studies of the patients without fractures. In the three children with confirmed fractures, the lateral humeral line passed through the radial neck, and the authors conclude that this line should complement the RCL, especially by limiting the effects of patient age or eccentric ossification on evaluation.

Femoroacetabular impingement in asymptomatic adolescents X-ref

One of the 'new diseases' of the new millennium is that of femoroacetabular impingement (FAI). The identification of morphological changes that may predispose to labral tears, localised pain and functional restriction has been met with both a positive and negative response. Proponents of FAI point to the lack of understanding of hip pain and particularly early degeneration. Arguing that the cam lesions in particular (but also pincer lesions) may be associated with secondary degenerative change leads to the logical conclusion that treatment of these morphological abnormalities may halt the disease process in the hip and prevent subsequent osteoarthritic change in later life. The difficulty in proving or disproving this concept is that the natural history of the disease is not really known and neither is the prevalence of the characteristic radiographic changes in the general population.This article from **Dallas, Texas (USA)** sets out to address one of these issues.[5] The authors reviewed the reformatted CT images of the pelvis and hips of children presenting for reasons other than hip pain and pathology. This was undertaken with the aim of establishing the incidence of femoroacetabular impingement morphology in adolescent patients who are thought to be otherwise asymptomatic. The study team measured the angles and lateral centre-edge angles (LCEA) in 558 patients (1116 hips), all of whom were asymptomatic adolescents (mean age 14.4 years). The incidence of CAM deformity ($\angle \geqslant 55°$) was 16.8% (23.9% males, 9.9% females). This represents a finding similar to that in the adult. Surprisingly, over 30% had an LCEA $\geqslant 40°$, indicative of a pincer lesion, and 6% had a mixed morphology. Pincer and mixed morphology occurred equally in males and females. This is an important paper in that it sets out the baseline prevalence of 'abnormal' hip morphology in an asymptomatic cohort of patients. To complete the picture, a longitudinal cohort study is needed, where the long-term incidence of hip pain can be established in those with and without hip pathology.

Kocher criteria and osteomyelitis

The Kocher criteria was proposed as a way to predict hip septic arthritis, and due to simplicity and accuracy has found widespread utility in evaluation of the painful paediatric hip throughout the world. The strength of the system is its simplicity and, when combined with an ultrasound examination (as it often is), it can be considered the gold standard in many centres. One of the unknowns about the Kocher criteria is the ability of these criteria to identify underlying osteomyelitis in the hip. These authors from **Houston, Texas (USA)** sought to establish the utility of the Kocher criteria in evaluating suspected osteomyelitis of the paediatric hip.[6] The study team used 71 consecutive patients with suspected septic arthritis and three or four positive Kocher criteria treated over a six-year period. The authors established that in patients with three or four Kocher criteria, the incidence of osteomyelitis was 47.9%, as compared with a 22.5% (n = 16) incidence of septic arthritis. Although the relative proportions of septic arthritis and osteomyelitis will vary by region due to the patient and microbiological demographics, one does wonder; if osteomyelitis is more, or as frequently positive, as septic arthritis in this cohort, perhaps routine evaluation should include MRI to ensure cases of osteomyelitis are not missed.

Percutaneous management of radial head fractures X-ref

The percutaneous management of radial neck fracture reduction has become the gold standard of care in the majority of centres and is favoured over open techniques as it avoids stiffness and other complications such as pseudoarthrosis and osteonecrosis. A paediatric trauma group in **Barcelona (Spain)** compared the functional results of percutaneous surgery with those of open surgery in the treatment of paediatric displaced radial neck fractures to see if this really is gold standard.[7] Their series included 51 children, all with radial neck fractures with more than 30° of angulation or overall 30% displacement (modified Judet grades 3, 4[a], 4b). In common with many retrospective series, treatment was a mixed bag with seven managed with closed reduction and casting, 27 the Métaizeau technique, and 17 were undertaken using the Métaizeau technique and open reduction. The outcomes were all assessed using the Mayo Elbow Performance score. These authors present a well planned treatment algorithm and report no significant differences in the final functional results, nor in complications between closed and open reductions. There is some value in the observation that open surgical reduction was not associated with poorer functional results, as is often thought. The authors were only able to identify initial fracture displacement as an independent predictor of functional outcome. Clearly, for lots of reasons, percutaneous fixation remains an attractive option, however, if there are no other options then surgeons performing an

open reduction should not worry unduly that they are compromising the long-term outcomes of their patients.

Combined pelvic and femoral osteotomies in Perthes' disease

Patients with Legg-Calve-Perthes' (LCP) disease are usually treated conservatively. Although a range of operative options are described, given the natural history of the majority of patients is one of complete resolution with expectant management, patients end up with a period of supervised neglect. That said, of course there are severely affected patients or those with progressive potentially destructive changes in the femoral head. For these patients there are a range of interventional operative options, but most involve rather significant surgery with a not insignificant risk profile. This study from **Hamburg (Germany)** investigated the outcomes of patients treated with combined pelvic and femoral osteotomies with the aim of containment of the hip.[8] The authors report the outcomes of 69 patients with LCP who underwent the described combined pelvic and femoral osteotomies. The mean age at index surgery was just shy of eight years, with follow-up to around ten years. Outcomes were assessed using the Harris Hip Score, Stulberg classification and the sphericity deviation score. The mean Harris hip score at the time of follow-up was 90, and just short of 40% of patients achieved a Stulberg class I hip at final follow-up. The authors conclude that more invasive procedures did not give much benefit to patients with LCP when compared with the historic series of either upper femoral osteotomy alone or pelvic osteotomy alone. In those cases not amenable to conservative management, it would seem that the best course of action at the moment is to choose technically simple and less invasive procedures for treatment of LCP.

REFERENCES

1. Cruz AI Jr, Fabricant PD, McGraw M, et al. All-Epiphyseal ACL reconstruction in children: review of safety and early complications. *J Pediatr Orthop* 2017;37:204–209.

2. Canavese F, Marengo L, Cravino M, et al. Outcome of conservative versus surgical treatment of humeral shaft fracture in children and adolescents: comparison between nonoperative treatment (Desault's bandage), external fixation and elastic stable intramedullary nailing. *J Pediatr Orthop* 2017;37:e156-e163.

3. Pannu GS, Shah MP, Herman MJ. Cervical spine clearance in pediatric trauma centers: the need for standardization and an evidence-based protocol. *J Pediatr Orthop* 2017;37:e145-e149.

4. Souder CD, Roocroft JH, Edmonds EW. Significance of the lateral humeral line for evaluating radiocapitellar alignment in children. *J Pediatr Orthop* 2017;37:e150-e155.

5. Li Y, Helvie P, Mead M, et al. Prevalence of femoroacetabular impingement morphology in asymptomatic adolescents. *J Pediatr Orthop* 2017;37:121-126.

6. Nguyen A, Kan JH, Bisset G, Rosenfeld S. Kocher criteria revisited in the era of mri: how often does the kocher criteria identify underlying osteomyelitis? *J Pediatr Orthop* 2017;37:e114-e119.

7. Gutierrez-de la Iglesia D, Perez-Lopez LM, Cabrera-Gonzalez M, Knorr-Gimenez J. Surgical techniques for displaced radial neck fractures: predictive factors of functional results. *J Pediatr Orthop* 2017;37:159-165.

8. Mosow N, Vettorazzi E, Breyer S, et al. Outcome after combined pelvic and femoral osteotomies in patients with Legg-Calvé-Perthes disease. *J Bone Joint Surg [Am]* 2017;99-A:207-213.

Research

X-ref ***For other Roundups in this issue that cross-reference with Research see: Foot & Ankle Roundup 7; Wrist & Hand Roundup 3; Trauma Roundup 8.***

Vitamin D levels and revision arthroplasty X-ref

It never ceases to amaze us here at *360* how orthopaedics, and orthopaedic research in particular, run in trends and fashions. Just at this point in time, vitamin D is very much in vogue for the retrospective registrar paper. Although not all of this research is valuable, and there is a danger of poor study design and a 'me too' attitude, there is certainly some worth in these investigations as vitamin D deficiency is easily correctable medically. This retrospective review from **Charleston, South Carolina (USA)** of 126 patients undergoing revision joint replacement surgery sets out to compare a number of different outcome measures between patients with normal pre-operative vitamin D levels and patients with low vitamin D levels.[1] Although there was not a huge number of patients here, the authors' first finding was that patients whose levels were low were at statistically increased risk of periprosthetic joint infection (PJI). As such, the authors undertook a regression analysis; this therefore allowed them to control for PJI itself, following which they still discovered an increased risk of all complications at 90 days, and a higher all-cause 90-day re-operation rate. The take home message from this straightforward paper is that vitamin D deficiency should be considered a pre-operative modifiable risk factor in this patient cohort. Although the authors did not demonstrate a non-causal relationship, and a number of other variables might also warrant further consideration, this is a simple test for a simple problem that may potentially reduce morbidity and cost following revision surgery, and, as such, it merits closer scrutiny.

What is the effect of age on risk of revision?

It is widely acknowledged that not only are primary joint replacement rates increasing in the general population, but there is a specific increase in the number of patients younger than 60 years who are undergoing these procedures. The authors of this study from **Oxford (United Kingdom)** highlight that this is a topic of concern as joint registries have shown that the ten-year revision rates in this group are much higher than for older patient groups.[2] The majority of surgeons quote the joint registry data for longevity because other studies with longer follow-up are usually less representative, being restricted to specific prostheses, small populations or single-surgeon series. There is a gap in knowledge about the true effect of age and its influence on joint replacement longevity. This novel study published in *The Lancet* aims to determine the lifetime risk of undergoing a revision procedure after primary total hip arthroplasty (THA) or total knee arthroplasty (TKA), with data obtained from the Clinical Practice Research Datalink (based on computerised primary care medical records of a patient population of 6.5 million from 433 contributing representative UK practices) and the Office for National Statistics. From the database, the authors identified 63 158 patients who underwent a THA, and 54 276 who underwent a TKA. A total of 15% of patients were aged between 50 and 60 years, and the estimated lifetime risk of revision increased with decreasing age at the time of primary operation. In patients of 70 years, the lifetime risk of revision was between 4.4% and 7.7%. In patients aged between 60 and 70 years at the time of their