

X-ref For other Roundups in this issue that cross-reference with *Children's orthopaedics* see: **Trauma Roundup 4; Oncology Roundup 2.**

Screw or drill and curettage for leg-length discrepancy

■ The correction of leg-length discrepancies often relies on epiphysiodesis at the appropriate time to ensure the lower limbs end up as similar in length as possible. Traditionally, epiphysiodesis was performed using drill and curettage to destroy the growth plate. More recently, cannulated screws and other techniques, such as eight-plates, have been used with the aim of improving the reliability of the procedure and having the potential advantage of correcting angular deformities accurately. Each technique has its proponents and recent studies report inconsistent findings, some favouring drill and curettage, others favouring cannulated screws. This paper from **Boston, Massachusetts (USA)** compares the use of screw epiphysiodesis and the more traditional drill epiphysiodesis.¹ In a retrospective review, they examined the outcomes of 115 patients, with a mean age of 12.6 years and median follow-up of 3.7 years. Percutaneous cannulated screw fixation across the physis under image guidance was performed in 23 patients, and compared with a cohort of 92 patients who underwent drill and curettage epiphysiodesis group. The patients were then followed up to a mean of two years with serial radiographs. The mean overall correction in each group was two centimetres; there were no differences in the mean correction ratio across groups. The median hospital stay was one day in both treatment groups. A retrospective project propensity score analysis concluded that there was negligible selection bias across the treatment groups. Operative

time was the same in each group and 22% of the transphyseal screw group required return to theatre compared with 10% in the drill and curettage group; however, this difference was not statistically significant. In the drill and curettage group, return to theatre was almost solely for a second epiphysiodesis due to over-correction or undercorrection. In the transphyseal screw group, this was overwhelmingly due to symptomatic instrumentation. There was a significantly earlier return to sports in the transphyseal screw group (mean 1.4 months vs 2.4 months). This paper is obviously limited by the retrospective nature of the investigation; however, it does add very valuable information. Overall, the efficiency of resolution of leg-length discrepancy was equivalent between the groups and the rate of return to theatre was similar. Advocates of each technique will find backup for their views. Drill and curettage is low morbidity but is irreversible and may delay weight-bearing. Transphyseal screw fixation may facilitate early activity but may also require return to theatre for persistent pain from the screw heads. Reversibility with growth returning when the metalwork is removed is another potential advantage. The true reversibility is also under scrutiny at present, as is the prevalence of angular deformities and undercorrection. A cost analysis may be useful, given the propensity for return to theatre with these procedures.

Eight-plate epiphysiodesis: are we creating an intra-articular deformity?

■ This study examines the potential morbidity from the eight-plate epiphysiodesis. The eight-plate is a technique for correction and relies on a tension band plate creating a unilateral growth arrest or pause. The method can also be temporary due to the avoidance of violating

the epiphysis itself, and may also be used to correct angular deformity with a unilateral instrumentation or a leg-length discrepancy where both sides of the physis are addressed. The working principle is tethering at the periphery of the physis, allowing the remainder to continue to grow. There is therefore a risk of introducing deformity of the epiphysis itself, and this study from **Petah Tikva (Israel)** sought to retrospectively detect and quantify deformities in their patients treated with eight-plates at the proximal tibial epiphysis.² Their retrospective study included analysis of 42 children with a mean age of ten years; 34 patients were treated for the correction of angular deformities and eight patients were treated for limb-length discrepancy. This study was performed over an eight-year period and the patients were followed up to a mean of 18 months. Various measurements were taken to assess the change in morphology of the physis, including slope angles at the lateral and medial plateau, which was referenced to the line between the ends of the physis and a tibial plateau roof angle (defined as 180° minus the sum of both plateau angles). The latter is therefore a measure of what is described as the 'volcano' deformity, where the central part of the plateau gains some length while the peripheries are restricted and is not an effect that has previously received much publicity. Where available, the non-operated physis was also analyzed for comparison purposes. The proximal tibial slope angle increased by 5° or more in half of the operative knees, and the roof angle reduced by a mean of 5° in almost half of operated cases. The slope angle change was similar in patients with leg-length discrepancy, varus angulation, and valgus angulation corrections. Perhaps unsurprisingly, the roof angle changes were more

frequent in leg-length discrepancy cases where both sides of the physis were instrumented. This study is limited by its retrospective nature and its relatively small sample size, but it does highlight a concern regarding the development of tibial deformity in cases where guided growth is required, which is potentially unique to the eight-plate method. The authors have seen fit to discontinue the use of eight-plates for the treatment of leg-length discrepancy, and this does seem prudent. However, the full clinical effect of the deformities identified here was not studied, and further information is required.

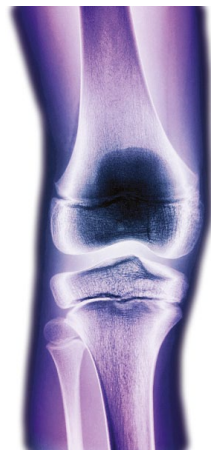
Gram stain is not clinically relevant in treatment of paediatric septic arthritis

■ The low sensitivity of the emergency Gram stain to exclude the presence of septic arthritis has been demonstrated extensively in the diagnosis of septic arthritis in the adult population. However, joint fluid is still sent for urgent Gram stain in the majority of centres when infection is suspected. Septic arthritis in children is diagnosed by a combination of clinical examination, inflammatory markers (C-reactive protein, white blood cell count, and erythrocyte sedimentation rate) with or without ultrasound or MRI, and the results of joint fluid culture. This retrospective study from **Philadelphia, Pennsylvania (USA)** sought to determine whether Gram staining was still a relevant test in the diagnosis and management of this condition.³ In this retrospective diagnostic study, the authors examined the records of 302 children, all of whom underwent joint washout for suspected septic arthritis. Patients with eventual diagnoses of osteomyelitis, pyomyositis, and the presence of foreign bodies were excluded from the study. Of the included cohort, 47 patients

(16%) had a positive Gram stain and 102 patients (34%) had positive joint fluid cultures. Six patients with positive Gram stain were found to have a negative culture, giving an overall positive predictive value of 0.87. The Gram stain was found to be particularly poor at picking up Gram-negative bacteria (only two out of 16 Gram-negative cultures were positive on initial Gram staining). Increasing age, raised white cell, and absolute neutrophil count were associated with a true positive Gram stain in this paper. The paper's authors argue that at a cost of US\$273, this test does not change the overall management of these patients, with its poor sensitivity and poor specificity reported in this paper. Patients with septic arthritis require prompt treatment and the traditional Gram stain does seem to be of limited value in aiding the decision towards operative management. The authors of this paper still recommend blood cultures and culture of joint fluid. Here at 360, we agree that a negative Gram stain should not influence the decision to wash out a suspicious joint, but other findings on microscopy, such as crystals, may of course influence this decision. The charge for Gram stain quoted is likely to overestimate the true cost in most hospitals when microscopy of the fluid is performed anyway, and so any cost benefits are likely to be marginal. Omitting the Gram stain may be defensible, but we are not sure based on this paper alone that it is necessarily wise.

Botox for spastic equinus in cerebral palsy: a prospective kinematic study

■ Botulinum toxin injection is now routinely used in children with cerebral palsy and muscle spasticity. Given in injections throughout the muscle belly, usually in fractionated dosages, it has been shown to be a safe and effective treatment for cerebral palsy spasticity. However, there is a certain art to establishing the eventual effects, as releasing spastic muscles can result in unopposed



muscle pairings. Gastrocnemius complex injections are generally aimed at reducing equinus deformity with a view to improving gait; however, the evidence for their use is far from complete. A randomized controlled trial from 2016 demonstrated no difference in the eventual outcomes for children who received regular gastrocnemius injections of Botox injections irrespective of whether the injections were given yearly or every four months. The same investigating group from **Victoria (Australia)** have gone on to investigate the kinematic effect of these injections using the same prospectively enrolled patient cohort.⁴ Measurements were taken four weeks before and four weeks after the injection using 3D instrumented gait analysis, with gait profile and gait variable scores calculated, as well as movement of the knee and ankle at midstance. The gait variable score is based on each of nine different gait variables and the gait profile score is a synthesis of all of these. The advantage of using this approach is that a minimal clinically important difference for the change in profile scores has been previously calculated. Overall, the study team were able to include the results of 37 patients in the analysis, with a mean age of 5.6 years. Ankle dorsiflexion improved significantly from 7.7° to 11.5°; however, there was no overall improvement in gait profile analysis. There was an increase in knee flexion post-injection in those patients with

spastic diplegia, suggesting a marginal descent towards crouch gait. The plantarflexor knee extension couple is a phenomenon where the gastrocnemius muscle is thought to contribute to knee extension during midstance phase. These results are concerning specifically for those with spastic diplegia, for whom crouch gait is a major complication. The study was limited by the variation in treatment, with patients having had between two and six injections previously. Additionally, the only outcome data was collected at four weeks post-procedure and so the longevity of any effect is difficult to ascertain. Larger studies are clearly required here to guide clinicians regarding the use of Botox to increase muscular range, as developing fixed contractures is also not acceptable in these patients.

Residual hip dysplasia: is there a place for the shelf?

■ The shelf procedure is one of the oldest procedures for treating acetabular dysplasia. The procedure provides increased lateral coverage, and has historically fallen in and out of favour as thinking surrounding hip dysplasia treatment has changed over the years. Over the last few decades, more demanding and complicated procedures, such as periacetabular osteotomies, have increased in their popularity and results out to 30 years follow-up have been published. While it is clear that a shelf alone is not a great treatment, its use for residual dysplasia is becoming more commonplace again. This retrospective review reports the long-term results of shelf osteotomy for residual acetabular dysplasia and hip subluxation in a cohort series from **Oslo (Norway)**.⁵ The authors sought to evaluate the outcomes of a historical cohort of patients undergoing a modified Spitzzy shelf procedure and to determine whether there is still a place for this when contrasted with periacetabular osteotomies outcomes. Procedures undertaken

over a 22-year period (1954 to 1976) were analyzed retrospectively, with clinical notes documenting pain and pre-/post-operation radiographs. The data correlated with the Norwegian arthroplasty register data to gauge rate of hip arthroplasty as an endpoint, permitting a Kaplan–Meier survival analysis to be performed. The surgical technique of a Spitzzy's shelf operation are described in the paper, consisting of a tricortical bone graft impacted into a notch just superior to the acetabulum. Patients were grouped by age, below and above 12 years of age at time of surgery, to address the possibility that younger patients have a higher rate of absorption of the shelf graft, giving poorer results. In this series, 44 patients with 55 hips were included; 37 patients had follow-up greater than ten years and so were subsequently included in the survivorship analysis. The mean time to pain postoperatively was 20 years; 80% of patients had undergone hip arthroplasty at a mean of 40 years following a shelf osteotomy and at a mean chronological age of 50 years. There was no difference in arthroplasty rates between the two age group cohorts; however, those under 12 years of age were significantly less likely to have preoperative pain. Interestingly, those patients with a centre edge index of greater than 10° were more likely to develop early postoperative pain. The author notes that these results are similar to recent reviews of the periarticular acetabular osteotomy at 30 years last year, and suggests that there is a place for the shelf procedure in the armamentarium. While this may be true, there may be a potential bias, with the chronologically earlier cohort subject to a potentially higher threshold for conversion to total hip arthroplasty given the relative infancy of the technology at that stage in history. However, we applaud the author for linking historical cohort data to registry outcome data, a technique that allows for this kind of long-term outcome.

Risk factors for paediatric ACL reconstruction failure **X-ref**

■ As sports participation and patterns of play are becoming more common, anterior cruciate ligament (ACL) rupture in the young is an increasingly prevalent problem and is relatively common in high-risk young athletes. There have been a range of interventions aimed at reducing the risk of injury, including prehabilitation, changes to participation rules, and education programmes. In recent years, however, the pendulum has swung towards favouring early surgical reconstruction when an ACL injury is sustained, with the intention of preventing further chondral and meniscal damage. It is therefore useful and instructive to consider the failure rate and risk factors for revision surgery in order to target and optimize the outcome of this treatment. This study from **San Diego, California (USA)** reports a retrospective analysis of 561 paediatric patients, all of whom underwent ACL reconstructions over an 11-year period.⁶ In this cohort, the mean patient age was 15 years with an even gender split. The authors report 54 failures occurring at a rate of 9.6%. The most important take-home message from this series is perhaps that patellar bone-tendon-bone (BTB) grafts were half as likely to fail as their soft-tissue counterparts. Overall failure rate of autograft reconstructions, allograft reconstructions, and hybrid reconstructions were 8.9%, 13.2%, and 20.0%, respectively. While the optimal choice of graft is controversial, previous studies have shown wide variation between allografts and autografts, which was not replicated here. Mean time to failure was 13 months, with hamstring grafts failing significantly earlier at 11 months than BTB grafts, which failed on average at 19 months. There was no difference in the time to failure between allografts and autografts. Although type of graft was the primary variable predictive of failure, multivariate analysis showed there was a significant effect of increasing skeletal maturity and an

anatomical tunnel-drilling technique, which were both predictive of failure. Overall, 20% of the patients were reported to have an open physis at the time of surgery and the majority of these had a transphyseal construction. However, the prepubescent athletes underwent an all-epiphyseal reconstruction. The results of the all-epiphyseal treatment in the younger patients showed no failures but, of the whole cohort, only 14 patients underwent this procedure. The 8% contralateral ACL injury rate reported during the study period is interesting but perhaps unsurprising. This study is limited by its relatively short follow-up, as later failures will be missed, but the results seem reassuring in that ACL reconstruction is a reasonable option in the paediatric and adolescent population, with patellar BTB grafts having the best short-term survivorship.

Temporary screw epiphysiodesis of the first metatarsal for correction of juvenile hallux valgus

■ Juvenile hallux valgus is not uncommon, with a quoted overall incidence in the population of 1.6%. While the majority of patients are treated nonoperatively, there is no consensus among surgeons about the optimal procedure where surgery is indicated, and most would recommend postponing operative intervention until maturity. Epiphysiodesis has been tried and, in particular, there are a number of reports of using temporary stapling and permanent destruction of the lateral epiphyseal plates of the first metatarsal. However, this paper from **Hamburg (Germany)** is the first to report screw hemiepiphysiodesis of the first ray.⁷ They therefore sought to study its efficacy, complications, potentially achievable correction, and requirements for follow-up. Indications for surgery in this series were reported as failed conservative treatment with psychological or physical problems, and all patients complained of pain.

Patients with less than two years of growth or a hallux valgus angle less than 18° were not offered treatment. A cannulated 3 mm partially threaded screw was used under image guidance. A total 22 patients were included with 39 feet; mean age was 11 years and mean follow-up was 28 months. No perioperative complications occurred, nor premature physeal closure. Two patients reported tenderness of a prominent screw head, resulting in removal of the screw. In one patient the screw broke and in a further two patients screw migration away from the growth plate was observed, resulting in no further deformity correction in one patient and increasing deformity in the other patient. A mean correction of 5.5° of hallux valgus angle was achieved at a mean correction rate of 0.2° per month. There was, however, a significant variation in the rate of correction of both hallux valgus angle and the intermetatarsal angle between individuals, making estimation of final correction difficult. This, of course, then mandates frequent follow-up to avoid overcorrection and timely screw removal where required. The mean follow-up time of 28 months limits the conclusions that can be drawn from this paper regarding recurrence but, from the data presented, this technique does seem to have advantages as a safe, technically straightforward, and minimally invasive method of treating symptomatic hallux valgus prior to skeletal maturity.

The Ponseti method and likelihood of tendon transfer **X-ref**

■ The standard treatment for idiopathic clubfoot worldwide is undoubtedly now the Ponseti method, but a common sequela is the recurrence of equinus deformity. This may be treated in younger children by resuming the use of an orthosis, but in children older than 2.5 years an anterior tibial tendon transfer to the third cuneiform is

often favoured. The rates of secondary tendon transfer are not known, usually occurring outside the follow-up period of reported Ponseti series. This study from **Los Angeles, California (USA)** sought to add to the literature and enable the accurate counselling of the families of children undergoing Ponseti treatment regarding potential need for later tendon transfer surgery. They also sought to elucidate risk factors for recurrence of equinus deformity. The authors report a cohort of 137 patients, all with idiopathic clubfoot, who were followed up for a minimum of 2.5 years. A Kaplan–Meier survival analysis was performed to determine the probability of survival without tendon transfer surgery. In this cohort, at the age of three years, the probability of undergoing a tendon transfer was below 5%, but by the age of four years this had risen to 15%. After this, the probability continues to rise to the age of six; by the age of six years, 29% of all patients had undergone a transfer. The influence of socioeconomic variables and treatment variables were included in the analysis and nonadherence with bracing reported by parents resulted in an almost seven-fold increase in the odds of undergoing surgery. Gender, severity of deformity, and prematurity did not significantly affect the risk of subsequent surgery. The effect of family income levels and parental marital status also were not statistically significant. As with most studies in this area, the true compliance with bracing cannot be known. An interesting observation of the authors was that many of the families who opted for continued bracing to treat a relapse do subsequently require a tendon transfer. Overall, although the probability of requiring a tendon transfer at age six years was 29%, in those families reporting noncompliance with bracing, there was a 42% risk compared with a 19% risk for those who were compliant with the bracing. The authors should be commended for the application of survival analyses

to this problem, which does help the evaluation of risk and hence the counselling of patient's families.

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Research

X-ref For other Roundups in this issue that cross-reference with Research see: *Foot & Ankle Roundups 4 & 5; Shoulder & Elbow Roundup 2; Spine Roundup 2.*

The effect of haemorrhagic shock and resuscitation on fracture healing in a rabbit model X-ref

■ The early management of trauma follows a defined pathway, whether the advanced trauma life support (ATLS) principles are adhered to or pathology is tackled in a simultaneous manner in the modern resuscitation room. How the management of shock influences the subsequent healing of fractures sustained by the injured patient has not been investigated until now. Recently, however, a group in **Australia** have used a rabbit model with a femoral osteotomy and intramedullary fixation to examine the effect of haemorrhagic shock and resuscitation on fracture healing.¹ This is one of those areas where animal studies can rapidly drive innovation in clinical practice. After inducing stage III shock in nine adult male New Zealand rabbits and leaving nine others with the full circulating volume, a femoral osteotomy was created and treated with intramedullary nail fixation. Fracture healing was monitored using radiological measurements and serum markers of bone formation. Four animals, however, were excluded from the study due to

postoperative complications. Despite this, this study conclusively showed that the serum concentration of osteocalcin was significantly elevated in the shock group postoperatively when compared with the normal group ($p < 0.0001$). Furthermore, study of serial radiographs showed that the callus index on both the anteroposterior ($p = 0.0069$) and lateral ($p = 0.0165$) radiographs was consistently increased in the shock group compared with the normal group radiographs from three weeks postoperatively. Overall, the presence of haemorrhagic shock and resuscitation showed larger callus formation but with delayed remodeling, emphasizing yet another benefit of the aggressive early management of shock in traumatized patients. Aside from highlighting the importance of early aggressive resuscitation, this study has value in posing the question, what is the mechanism here? If the mediators of this response could be established, then these could potentially be used to accelerate healing in those patients with significant closed injuries.

Vitamin D supplementation and infection? A mouse perspective X-ref

■ Prosthetic joint infections (PJI), which are often bacterial in nature, are a common aetiology for failure following all types of joint arthroplasty. Recent research has suggested a potential link between

vitamin-D deficiency and PJI; in fact, >65% of patients undergoing total joint arthroplasties have low total 25-hydroxyvitamin D (25D) levels. Is this a potential point for intervention, and could an argument therefore be made to encourage patients to take vitamin D supplements in an effort to reduce the risk of PJI? The authors of this paper from **Los Angeles, California (USA)** have presented an *in vivo* mouse model that shows 25D may be an important modifiable risk factor for patients undergoing total joint arthroplasty.² The authors investigated 25D₃ supplementation in a mouse model of PJI, infected with *Staphylococcus aureus*. A total of 20 mice were randomized to receive a vitamin D-sufficient diet and 40 were randomized to a vitamin D-deficient diet for six weeks prior to surgery; 20 mice in the deficient diet group were 'rescued' with one intraperitoneal dose of 25D₃ three days prior to surgery. A stainless-steel implant was then implanted into the knee joint and all knees were inoculated with *S. aureus*. Blood sampling was used to confirm 25D₃ levels three days prior to surgery and on postoperative day (POD) 0 and POD 14. The number of *S. aureus* colony-forming units (CFUs) were measured on POD 21 by culture. Myeloperoxidase and β -N-acetylglucosaminidase assays were used to quantify neutrophil infiltration and activated tissue macrophage recruitment. Results

confirmed that 25D₃ deficiency results in increased bacterial burden and neutrophil infiltration, and that repletion by a preoperative intraperitoneal dose significantly reduces this effect. CFUs measured at POD 21 were similar between the 25D₃-sufficient group and 25D₃-rescued group, both of which were significantly lower than the 25D₃-deficient group. Bacterial burden quantified by bioluminescent signal on the implant and surrounding tissues was clearly increased for 25D₃-deficient mice compared with 25D₃-sufficient mice. Of course, these results were from a mouse model and may not be applicable to humans; however, the data presented here is both interesting and encouraging. If further work in larger animal studies reveals similar results, vitamin D supplementation may in fact be a low-risk, high-reward prophylactic strategy for decreasing the risk of PJI.

Sleep in hospitalized patients

■ Nobody involved in the provision of institutional care would be surprised that poor sleep is associated with poorer healthcare outcomes, particularly on patient-reported measures. Until now, we have had little idea as to what affects the quality of sleep on general hospital wards. This unique cross-sectional study, carried out across **The Netherlands**, collected data from 2005 adult inpatients from 39 hospitals and compared their last