

injured, thanks in part to the rationalization of trauma services, addition of transfer protocols, formal recognition of levels of trauma care, and nationalized and regionalized models of care. The prospects for the average trauma victim injured and managed within a modern trauma network are many times better than they would have been in previous decades, and are also better than they would be outside of a formalized trauma network. The formalization of these networks and coordination between Helimed and trauma centres have also allowed for changes in front-line care. One of these changes, pre-hospital plasma resuscitation, is the focus of this randomized trial led by researchers in **Pittsburgh, Pennsylvania (USA)**.⁷ The authors trialled their standard resuscitation protocol against the addition of pre-hospital administration of thawed plasma. This was a safety-and-efficacy trial that included injured patients who were at risk of haemorrhagic shock. The trial reports on the outcomes of 501 patients, of whom 230 patients received plasma and 271 received standard care. The primary outcome was mortality at 30 days, as the trial was designed to assess the effects of early plasma administration on downstream haemorrhage. In terms of the primary outcome measure, there was a superior rate of survival in the plasma group (33.0% vs 23.2% in the standard-care group); this was also seen in the nine pre-specified subgroups. When explored with Kaplan–Meier analysis, the treatment effect appeared to begin at three hours post-injury, and was maintained until the 30-day follow-up. In

terms of possible explanations for the observed effect, there was a lower average prothrombin-time ratio (1.2 vs 1.3) in the intervention group. There are no significant differences in the other common causes of death or expected serious adverse events with regard to multi-organ failure, acute lung injury and acute respiratory distress syndrome, nosocomial infections, or allergic or transfusion-related reactions. Quicker blood products in haemorrhagic shock leads to reduced mortality. Whilst there are some potential difficulties with access and logistics here, early access to blood ambulances or helicopters would seem to be a sensible approach where possible. The study was funded by the military, which makes it clear where one application of this protocol will be.

Discharged but not dissatisfied: the Edinburgh Trauma Triage Clinic

■ In state-funded systems and those with bundled payments, there is an incentive to reduce the number of patients moving through clinics, whilst in other systems there may be incentive to keep the number of patients high for funding reasons. In some parts of the world, telemedicine, Skype consultations, and other types of ‘virtual’ clinic have become very fashionable, whereas in others, triage approaches have become very common. In one of the few papers looking at these changes in detail, the **Edinburgh (UK)** trauma service report on how their changes in protocol were effective in streamlining the clinic experience for their patients.⁸ The Edinburgh

approach involves the implementation of consultant-led ‘virtual’ triage of referrals combined with the direct discharge of minor fractures from the Emergency Department. The authors then compared the patient outcomes for simple fractures of the radial head, little finger metacarpal, and fifth metatarsal before and after the implementation of the Edinburgh Trauma Triage Clinic (TTC). The authors report on a consecutive series of 628 patients, all of whom had sustained these simple upper limb injuries over a one-year period. Two patients were subsequently excluded due to death and incarceration, respectively. During the study period, there were 337 patients in the pre-TTC group and 289 in the post-TTC group. This paper reports on the clinical scores in terms of Disabilities of the Arm, Shoulder and Hand Score (QuickDASH) or Foot and Ankle Disability Index (FADI), EuroQol-5D (EQ-5D), visual analogue scale (VAS) pain score, satisfaction rates, and return to work/sport at six months post-injury. The patients were not directly seen; however, their electronic records were evaluated at three years post-injury in an attempt to exclude late complication. A cost analysis was performed. Overall, patient-reported outcomes were equivalent between the two groups, although at three years, the pre-TTC group required a total of 496 fracture clinic appointments compared with 61 in the post-TTC group. Mean cost per patient was nearly four times less after the commencement of the TTC. There is certainly some food for thought here, and appropriate use of expensive resources (such as

face-to-face fracture clinic time) is clearly important. It is worth noting that the system reported on here is an enhanced triage rather than a ‘telephone clinic’ approach, and that data related to the former should not be used to support the implementation of the latter.

REFERENCES

1. **Kammerlander C, Pfeufer D, Lisitano LA, et al.** Inability of older adult patients with hip fracture to maintain postoperative weight-bearing restrictions. *J Bone Joint Surg [Am]* 2018;100-A:936-941.
2. **Verbeek DO, van der List JP, Tissue CM, Helfet DL.** Predictors for long-term hip survivorship following acetabular fracture surgery: importance of gap compared with step displacement. *J Bone Joint Surg [Am]* 2018;100-A:922-929.
3. **Ding A, O'Toole RV, Castillo R, et al.** Risk factors for early reoperation after operative treatment of acetabular fractures. *J Orthop Trauma* 2018;32:e251-e257.
4. **Morgenstern M, Athanasou NA, Ferguson JY, et al.** The value of quantitative histology in the diagnosis of fracture-related infection. *Bone Joint J* 2018;100-B:966-972.
5. **Fahmy M, Abdel Karim M, Khaled SA, et al.** Single versus double column fixation in transverse fractures of the acetabulum: A randomised controlled trial. *Injury* 2018. (Epub ahead of print) PMID: 29843895.
6. **Wang Q, Wang Q, Wang J.** Evaluation of strategies for the treatment of type B and C pelvic fractures: Results from the German Pelvic Injury Register. *Bone Joint J* 2018;100-B:973-983.
7. **Sperry JL, Guyette FX, Brown JB, et al.** Prehospital plasma during air medical transport in trauma patients at risk for hemorrhagic shock. *N Engl J Med* 2018;379:315-326.
8. **Mackenzie SP, Carter TH, Jefferies JG, et al.** Discharged but not dissatisfied: outcomes and satisfaction of patients discharged from the Edinburgh Trauma Triage Clinic. *Bone Joint J* 2018;100-B:959-965.

Oncology

Limb-sparing resection in pelvic sarcoma: where are we?

■ The treatment of pelvic sarcoma is one of the most difficult in the

orthopaedic oncology world. In other areas of oncology, the development of limb-sparing techniques with megaprosthesis, vascularized autograft, or allograft has

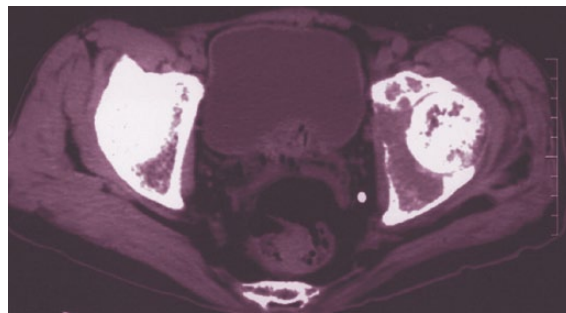
transformed the functional outcomes with similar overall and disease-free survival rates to amputation. However, it is not entirely clear where the orthopaedic literature stands

regarding treatment of pelvic sarcoma and the role, if there is any, of limb-sparing surgery. This systematic review from **Nashville, Tennessee (USA)** sets out to establish more

accurately the non-oncological complication and reoperation rates, as well as the functional outcomes, for patients after pelvic sarcoma resection and reconstruction.¹ The authors did a sterling job of trawling the literature, identifying 2350 potential studies, all of which were reviewed. The inclusion criteria yielded 22 Level-IV studies with a total of 801 patients. A wide range of reconstructive techniques were used across these studies, including allografts, allograft-prosthesis composites, saddle prostheses, custom endoprostheses, and irradiated autografts. Pooled means were calculated for five-year patient survival (55%), non-oncological complication rate (49%), non-oncological reoperation rate (37%), and Musculoskeletal Tumor Society score (65%). The authors concluded that the non-oncological complication and reoperation rates for pelvic reconstruction are high, whilst five-year survival is poor. Although functional outcomes were found to be satisfactory, they may not be better than a resection without reconstruction. The authors recommend that forgoing pelvic reconstruction should be considered, especially in patients with poor overall prognosis.

Paediatric soft-tissue sarcoma: changing practice and outcomes

■ The role of adjuvant therapies in surgical oncology has grown as understanding of tumour mechanics, optimization of outcomes and more accurate imaging, and effective chemotherapy and radiotherapy techniques have become available. In the domain of soft-tissue sarcoma, radiotherapy is now universally accepted to be an essential component for obtaining adequate local control, especially in the setting of organ- and function-preserving surgery. However, radiotherapy in children with maturing tissues of low-radiation tolerance has undesirable late effects, both in terms of local complications and



tumour neogenesis. Over the past few decades, the refinement and development of techniques that reduce the volume of normal tissues being irradiated have made radiotherapy a more accessible treatment to the paediatric population. This study from **Mumbai (India)** aimed to evaluate long-term clinical outcomes, adverse effects, and the practice of interstitial brachytherapy for paediatric soft-tissue sarcomas.² In brachytherapy, the radiation is delivered locally, rather than via external beam radiation, and is often combined with either external beam radiotherapy (as in soft-tissue sarcoma) or chemotherapy. In this study, 105 children (with a median age of ten years) were treated with brachytherapy for their soft-tissue sarcoma. The treatment strategy in all cases included wide local excision and brachytherapy with or without external beam radiotherapy. Most patients reported here (n=85, 81%) received brachytherapy alone. Local control (83%), disease-free survival (66%), and overall survival (73%) rates all looked very promising at ten years (median follow-up, 65 months). The important take-home messages from this series are that children receiving brachytherapy alone had comparable reported local control to those in whom it was combined with external beam radiotherapy (84% vs 80%). The complications observed were: wound complications (6%), subcutaneous fibrosis (25%), limb oedema (6%), and secondary skeletal abnormalities (3%). One child went on to develop a second malignancy after seven years. The authors therefore concluded,

based on their series, that interstitial brachytherapy with or without external beam radiotherapy leads to very good long-term outcomes. When used judiciously, they reported that radical brachytherapy alone resulted in excellent local control and function with minimal treatment-related morbidity.

The role of surgical margins in chondrosarcoma

■ The authors of this novel study from **Birmingham (UK)** sought to iron out some of the uncertainties surrounding surgical margin status in chondrosarcoma surgery.³ They investigated the relationship between surgical excision margins and local recurrence-free survival, and the role of local recurrence in disease-specific survival in chondrosarcoma of the limb and pelvis. Their series was based on 341 pelvic and limb chondrosarcomas that were treated over a 12-year period and included in the study on a retrospective basis. During the study itself, local recurrence developed in just under a quarter (23%) of cases. After an initial univariate analysis, pelvic location, pathological fracture, margin, and grade were deemed to be significant factors for local recurrence. Subsequent multivariate analysis revealed surgical margin and pelvic location to be positive factors for local recurrence. As would be expected, grade 1 and grade 2 chondrosarcomas were found to be negative prognostic factors for local recurrence. Univariate analysis for disease-free survival showed that the presence of pathological fracture, central *versus* peripheral location,

grade of the tumour, and development of local recurrence were all significant factors. An unusual but welcome addition, given the high numbers of dichotomous outcomes, was the addition of competing risk analysis, in which local recurrence was statistically significant for disease-free survival in grade 2 and grade 3 tumours. The authors therefore concluded that surgical margins determine local recurrence rates in all chondrosarcoma grades, but that local recurrence is only a determinant of disease-free survival in grade 2 and grade 3 tumours. They recommended that, whilst narrow resection margins are acceptable in grade 1 tumours, a minimum 4 mm margin should be the aim in all cases due to the unreliability of biopsy in predicting the final grade.

Neoadjuvant chemotherapy in non-metastatic high-grade pelvic osteosarcoma?

■ For patients with high-grade osteosarcoma, the most common treatment strategy is neoadjuvant chemotherapy followed by surgery and adjuvant chemotherapy. With this in mind, the authors of this retrospective study from **Beijing (China)** aimed to address three questions.⁴ First, does neoadjuvant chemotherapy followed by delayed surgery offer a survival benefit to patients with non-metastatic, high-grade pelvic osteosarcoma compared with immediate surgery and adjuvant chemotherapy? Second, is the timing of chemotherapy and surgery associated with a difference in the survivorship free from local recurrence and the risk of complications? Finally, is the threshold of 90% necrosis after neoadjuvant chemotherapy appropriate to distinguish responders from non-responders in patients with pelvic osteosarcoma? Their work was based on their own reported series of 112 patients with non-metastatic, high-grade primary pelvic osteosarcoma. Of these patients, 93 underwent tumour resection with chemotherapy and

so were potentially eligible. Four patients were lost to follow-up and the remaining 89 were included. Patients were allocated into two groups, depending on the timing of their surgery and chemotherapy: neoadjuvant chemotherapy followed by delayed surgery and adjuvant chemotherapy (n=56); and immediate surgery followed by adjuvant chemotherapy (n=33). The total duration, dosing regimen, and agents used for chemotherapy were similar in both groups. There was no survival benefit found in the patients treated with neoadjuvant chemotherapy followed by delayed surgery. The likelihood of successful limb salvage was comparable for the two groups, at 89% in the neoadjuvant chemotherapy group *versus* 91% in the immediate surgery group. Similar five-year local recurrence-free survival rates were also similar for the two groups (68% *vs* 67%), and there was no apparent difference in survival between patients whose tumours demonstrated more than 90% necrosis. It should be noted, however, that only four of 56 patients in the neoadjuvant chemotherapy group demonstrated 90% necrosis. This finding should therefore be interpreted with caution. The authors concluded that, whilst the treatment allocation in this series was not randomized, the authors did administer a standard multidrug chemotherapy regimen. They were unable to demonstrate a survival advantage with chemotherapy before delayed surgery compared with immediate surgery in patients with non-metastatic high-grade pelvic osteosarcoma, and suggest that the decision on chemotherapy timing should be made for reasons other than survival. Such factors include the ability to assess necrosis, considerations of anticipated margin status, and whether there is sufficient time to plan resection and reconstruction options with the patient. They recommend that a prospective trial is needed to confirm this conclusion.

Osteosarcoma and age: the Japan experience

■ The authors of this simple study from **Tokyo (Japan)** aimed to establish the effect of patient age on the clinical features, prognosis, and prognostic factors of patients presenting with osteosarcoma.⁵ Their series consisted of 1043 osteosarcoma patients, who were identified using the Bone and Soft Tissue Tumor Registry in Japan. These patients were categorized into three age brackets: those younger than 40 years old (n=760), those aged between 41 and 64 years (n=173), and those older than 65 years (n=110). There was a differing pattern of presentation and outcomes within the groups, with patients older than 65 years showing a significantly higher proportion of tumours arising in the trunk and with metastasis at diagnosis. The five-year disease-specific survival was significantly worse for patients older than 65 years with metastasis (33%) *versus* without metastasis (39%) present at diagnosis. Adjuvant chemotherapy did not significantly improve disease-specific survival in the two older groups of patients (41 to 64 years, 65+ years), although it did lead to significantly better survival in patients younger than 40 years. Clearly there is some food for thought here, with little benefit seen in adjuvant chemotherapy in the older population of osteosarcoma. This is useful information to know, whether discussing risks in a multidisciplinary team (MDT) setting or, indeed, with the patients themselves.

Reconstructing diaphyseal tumours using radiated (50 Gy) autogenous tumour bone graft

■ Whilst a well-established technique, there has been little published in recent years on autogenous irradiated bone graft reconstruction. Generally speaking, the thoughts of orthopaedic oncologists have tended to linger instead on megaprosthesis reconstruction

options in recent years. However, in diaphysis tumours where it is possible to preserve the adjoining joints after intercalary resection, the use of irradiated autogenous bone remains a potentially attractive one. The advantage of a biological reconstruction is that, if uncomplicated, it may provide a more durable alternative to megaprosthesis. From a surgical perspective, reimplanting the patient's own sterilized tumour bone is one of the more appealing biological reconstructions, as it circumvents the logistical issues involved in obtaining size-matched strut allografts. The risk of disease transmission and rejection – which, although rare, is nevertheless a possibility in bulk bone grafting – is also obviated. In their series of 70 non-metastatic patients, these authors from **Mumbai (India)** evaluated their surgical outcomes with a focus on the complications associated with bulk allografting.⁶ All patients had high-grade tumours of the limb, with diagnoses of both osteosarcoma (n=38) and Ewing's sarcoma (n=32). The minimum follow-up was three years. Patients underwent reconstruction with intercalary extracorporeal radiotherapy (ECRT) grafts, which were sterilized with 50 Gy and reimplanted back into the original position in the diaphyseal region. The outcomes reported focused on graft survival and union at the two osteotomy sites. A higher proportion of metaphyseal osteotomies (91%) united without additional intervention compared with diaphyseal osteotomies (71%). The addition of a small plate at diaphyseal osteotomy appeared to reduce the incidence of nonunion (17% *vs* 31% for metaphyseal osteotomy). There was no evidence, however, that the addition of morsellized allograft improved the likelihood of bony union. At final follow-up, 19 patients had died and two were lost to follow up. The cohort suffered seven (10%) local recurrences, all in the soft tissues, and a quarter (25%) of patients needed removal of the graft during the period of the study.

Overall five-year survival for the ECRT graft was 79%, or 84% excluding removal for local recurrence. The authors therefore concluded that reimplanting sterilized tumour bone using 50 Gy for tumour ablation was an easily applicable, oncologically safe biological reconstruction option for primary diaphyseal tumours of the limb.

Fibular epiphyseal transfer in primary sarcoma of bone

■ The difficulties of treating epiphyseal tumours in children are readily apparent. We were interested to see this paper from **Birmingham (UK)**, in which the authors describe the outcomes following proximal humeral reconstruction using a technique involving vascularized fibular epiphyseal transfer.⁷ All of the children in this study had diagnoses of primary bone sarcoma. In this small 'proof of concept' study, the authors retrospectively reported 11 patients: six with a diagnosis of Ewing's sarcoma and five with osteosarcoma. The age at the time of surgery ranged from two to eight years. The mean age at the time of surgery was five years, with a mean follow-up of 5.2 years. At both five and ten years, the overall reported survival rate was 91%, and all but one of the patients were alive at the time of the final review. There were, however, multiple complications: seven fractures, four transient nerve palsies, and two instances of patients developing avascular necrosis of the graft. The fractures all presented within one year following surgery, and all seven united with conservative management. Hypertrophy and axial growth were observed in the nine patients who did not have avascular necrosis of the graft. At final follow-up, the mean modified functional Musculoskeletal Tumour Society score was 77% and the mean Toronto Extremity Salvage Score (TESS) was 84%. The authors reported, based on this study, that vascularized fibular epiphyseal transfer preserves

function and growth in young children following excision of the proximal humerus for a malignant bone tumour. Although function is favourable when compared with other limb-salvage procedures in children, here at 360, we agree with the authors' conclusion that longer-term analysis is required to determine if this technique proves to be durable into adulthood.

REFERENCES

1. Wilson RJ, Freeman TH Jr, Halpern JL, Schwartz HS, Holt GE. Surgical outcomes after limb-sparing resection and reconstruction for pelvic sarcoma: a systematic review. *JBJS Rev* 2018;6:e10.
2. Laskar S, Pilar A, Khanna N, et al. Interstitial brachytherapy for pediatric soft tissue sarcoma: evolving practice over three decades and long-term outcomes. *Pediatr Blood Cancer* 2018;65:e27112.
3. Stevenson JD, Laitinen MK, Parry MC, et al. The role of surgical margins in chondrosarcoma. *Eur J Surg Oncol* 2018;44:1412-1418.
4. Xu J, Xie L, Guo W. Neoadjuvant chemotherapy followed by delayed surgery: is it necessary for all patients with non metastatic high-grade pelvic osteosarcoma? *Clin Orthop Relat Res* 2018. Epub ahead of print (PMID: 29912746).
5. Tsuda Y, Ogura K, Shinoda Y, et al. The outcomes and prognostic factors in patients with osteosarcoma according to age: a Japanese nationwide

study with focusing on the age differences. *BMC Cancer* 2018;18:614.

6. Puri A, Byregowda S, Gulia A, et al. Reconstructing diaphyseal tumors using radiated (50 Gy) autogenous tumor bone graft. *J Surg Oncol* 2018. Epub ahead of print (PMID: 29949650).
7. Stevenson JD, Doxey R, Abudu A, et al. Vascularized fibular epiphyseal transfer for proximal humeral reconstruction in children with a primary sarcoma of bone. *Bone Joint J* 2018;100-B:535-541.

Children's orthopaedics

X-ref For other Roundups in this issue that cross-reference with *Children's orthopaedics* see: *Wrist & Hand Roundup 6*.

Screening for the limping child: can labs help?

■ Paediatric bone and joint sepsis remains a challenging area for orthopaedic surgeons, and clinical examination is often difficult to perform. The decision to operate must respect the need to avoid the morbidity of over-intervention, and must consider the catastrophic consequences of a missed diagnosis. Kocher's criteria, although now old, are still used in many institutions. Kocher proposed a system based on temperature, weight-bearing status, white cell count, and erythrocyte sedimentation rate (ESR). There have been recent modifications including the now more common C-reactive protein (CRP). This paper from **Peterborough (UK)** postulated that, in the presence of a 'limping child', an ESR or CRP greater than ten was suggestive of a higher rate of pathology and, therefore, the authors' protocol was only to undertake an MRI of the affected limb in these patients.¹ Their paper reports the outcomes of 100 consecutive children recruited between 2010 and 2015 who had been investigated using this protocol. They used a limited MRI protocol scan to screen the limbs of the children for whom

it was hard to localize the symptoms to a specific joint. In those patients found to have a normal limb scanogram, a spinal MRI was then performed. Children under seven years old required a general anaesthetic for their MRI scan. In this reassuringly useful study, an extremely high rate of pathology was identified in these patients, with 75% having a positive scan: 64% had an infective cause (including osteomyelitis, septic arthritis, cellulitis, myositis, and discitis); and 11% had a non-infective cause (including juvenile idiopathic arthritis, cancer, or undisplaced fracture). The remaining 25% had either transient synovitis (13%) or no positive findings. ESR was found to be a more sensitive marker of infection than CRP, with ESR being raised in 97% of cases compared with 70% for CRP. For this reason, the authors suggest including ESR in the battery of initial tests rather than allowing CRP to replace it. Given the high rate of positive MRI scans and the variety of pathologies identified immediately, the authors suggest that all children with a limp or limb pseudoparalysis and an ESR > 10 or CRP > 10 should undergo MRI scanning. There is, of course, concern about the availability of MRI scanning and the need for general anaesthetic for scans in younger children. The authors do not comment about availability nor timing of scans but, here at 360, we

would take the view that acute MRI should be available in all centres treating these patients. Regarding anaesthesia, a feed and swathe may be adequate in very young babies, but, in children up to five years old, the potential risk of neurodevelopmental disorders from anaesthesia must be weighed against the risks of a missed diagnosis by clinicians. Further studies replicating these findings would be useful, but the thresholds published here seem sensible based on this evidence.

The paediatric ACL injury

■ Anterior cruciate ligament (ACL) rupture in the skeletally immature population is increasing in prevalence. Whether this is related to increased access to imaging techniques or an increased level of sports participation is unknown. The optimal management is unclear but, in those favouring early reconstruction, there is a debate about the best technique to employ. The transphyseal reconstruction, as routinely used in the adult population, risks growth inhibition through physeal damage or a tethering effect of the graft. Extraphyseal reconstructions have been popularized to reduce this risk, but they are more technically challenging and can result in a non-anatomical position of the graft. This systematic review from **Oxford (UK)** looks specifically at the long-term outcomes of

ACL reconstruction in the skeletally immature population.² While not common, these injuries are relevant to paediatric surgeons and knee surgeons with soft-tissue practices. The authors identified 18 articles that fit the inclusion criteria of skeletal immaturity, sufficient follow-up (over five years or to skeletal maturity), and patient-reported outcome measures (PROMs) at final follow-up. The mean age at surgery reported in these papers ranged from 10.3 to 15 years, and mean follow-up was from three to 13 years. Two papers detailed conservative treatments, four detailed extraphyseal or hybrid reconstruction, and 12 detailed transphyseal surgical reconstruction. They found that PROMs were significantly better in the operative group than in the conservatively managed groups, although it should be borne in mind that immobilization and rehabilitation regimens have improved in the last decade, and that current conservatively treated patients may possibly have better outcomes. Good long-term results were found in the operative groups that were deemed to have significant growth potential, with no significant difference in leg length, as well as low reported rates of re-rupture (3%) and instability (0.7%). Furthermore, there was no difference found between the reported outcome scores, leg-length discrepancy, coronal plane deformity, and re-rupture