

their treatment. Does this leave the potential to miss significant ligamentous soft-tissue injuries that can afflict the thoracolumbar junction, rendering it unstable? A group from **Wonju (South Korea)** have reported their own retrospective case series examining the utility of plain radiographs in identifying clinically significant ligament complex injuries that would influence the surgical treatment of trauma victims.⁸ They propose the interspinous distance ratio (ISDR) as a sign of ligamentous instability; they define this as the ratio of the distance between the spinous processes of the injured vertebra and the subjacent or superjacent vertebra, and the interspinous distance at an adjacent motion segment. They then go on to measure the ISDR in 153 patients who underwent spinal stabilisation for trauma. Patients were excluded if they showed any signs of tumour, infection, vertebral fragility fractures or fractures to the adjacent thoracic or lumbar motion segments. The mean age of patients was 47 years, and L1 was the most commonly injured vertebra. When measured using a plain lateral radiograph in the right down decubitus position, an ISDR of 120% was clinically detectable and yielded a sensitivity of 81%, specificity of 76% and an accuracy of 79%. This compares rather favourably with

the published figures for a 1.5T MRI scanner of sensitivity 79.2 to 100 and specificity of 56 to 100. Perhaps the most useful application of this technique is likely to be in the indeterminate injuries previously defined by Alexander R. Vaccaro, rather than in those patients whose injury (or lack of injury) is clear. In either case, this technique is an extra tool in the detection of significant thoracolumbar spinal injuries.

Simple but great: where to put fusion cages?

■ Sometimes a paper crosses our desks here at 360 that addresses a question that we can't believe has not been answered before. This paper from **Auckland (New Zealand)** is one such study.⁹ In it, the authors describe where to put paired interbody fusion devices, to reconstitute lumbar lordosis. We know that most lumbar pathologies are associated with regional hypolordosis, and that reconstructing the sagittal profile of the lumbar spine is important in maximising functional outcomes. An analysis of 83 patients treated with a single-level posterior lumbar interbody fusion (PLIF) with posterior instrumentation has been undertaken, and the patients' self-reported pain and disability recorded, with a view to describing the optimal position of paired polyetheretherketone (PEEK) interbody fusion devices. The results suggest that cages should be

positioned with their midpoint anterior to the midpoint of the vertebral endplate. This is somewhat at odds with those who have avoided this location due to the risk of cage subsidence. To support their stance, the authors showed that positioning the cages accordingly led to an increase of nearly 6° in lordosis maintained at one year, with persisting improvements in patient-reported pain and disability scores. The maintenance of the cage's centre of rotation position anterior to halfway along the superior endplate of the inferior vertebrae was moderately correlated to the lordosis gained. When considered alongside posterior osteotomy and instrumentation, this was likely to lead to a much greater anatomical correction of lumbar lordosis. Groundbreaking? Seemingly not, yet these findings have not been described before. This new information, however, may explain why unilateral facetectomy in transforaminal lumbar interbody fusion (TLIF) techniques does not universally improve patient outcomes, and why wide posterior osteotomy with anterior cage placement is most likely to improve patient symptoms. Sometimes the simplest studies are the best, and certainly this paper has a direct bearing on our clinical practice.

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Trauma

X-ref For other Roundups in this issue that cross-reference with **Trauma** see: **Hip Roundup 7; Wrist & Hand Roundups 4, 7 & 8; Children's orthopaedics Roundup 3 & 7.**

Shortening and healed mid-shaft clavicular fractures X-ref

■ There have been a good number of randomised trials now looking at shortening and the clinical outcomes of shoulder function following

clavicular fractures, and, in particular, the beneficial effects or otherwise of clavicular fracture fixation on eventual shoulder function. Although the studies themselves appear to be somewhat conflicting on first glance, the results are actually remarkably similar, with the differences in conclusion essentially being based on differences of reporting and interpretation of these remarkably similar results. What is different is the perception of

malunion and nonunion as a study event, and how these are dealt with. It is very timely, therefore, to see this study from **Edinburgh (UK)** evaluating the impact of clavicular shortening on patient outcome.¹ Essentially, this study is questioning the widely held view that non-operative treatment with shortening can negatively impact upon outcome. The data used in this study were collected as part of a multicentre

prospective randomised controlled trial of open reduction and plate fixation compared with non-operative treatment for acute displaced mid-shaft clavicular fractures. The investigators studied as a cohort the 48 patients who were randomised to non-operative treatment and had healed by one year. Of note, 17% of patients (16/105) in the original study who were treated non-operatively developed a nonunion, 13 patients



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were lost to follow-up, and 28 did not undergo a CT scan and were excluded from their analysis, leaving these 48 reported patients. Clavicular shortening relative to the uninjured clavicle was measured using 3D CT. This adds significant strength to this study as prior studies are limited by their use of conventional radiographs only, which has been shown to be unreliable for assessing clavicular length. In addition to the imaging data, clinical outcomes were measured with the Disabilities of the Arm, Shoulder and Hand (DASH), Constant, and Short Form Health Survey (SF-12) scores, as well as with level of patient satisfaction, which were assessed at six weeks, three months, six months, and one year following injury. The mean of the shortening of the injured clavicles was 11.3 ± 7.6 mm, with a mean proportional shortening compared with the uninjured side of 8%. Proportional shortening did not significantly correlate with the DASH ($p \geq 0.42$), Constant ($p \geq 0.32$), or SF-12 ($p \geq 0.08$) scores at any point during follow-up. There was no significant difference in the mean DASH or Constant scores at any follow-up timepoint when the cutoff for shortening was defined as 1 cm ($p \geq 0.11$) or as 2 cm ($p \geq 0.35$). Initially, there was no significant difference in clavicular shortening between satisfied and unsatisfied patients ($p \geq 0.49$). The authors concluded that there was no association between shortening and functional outcome or satisfaction in patients with healed displaced mid-shaft clavicular fractures up to one

year following injury, and their data would certainly support this. This paper really has added some new information to the debate; if shortening doesn't leave functional deficit, perhaps we are being somewhat hasty in fixing all of these fractures.

Figure-of-eight harness versus anterior plate X-ref

■ In recent years, the figure-of-eight harness has fallen out of favour among surgeons and patients due to the fussy nature of the braces, in part, and perhaps also in part due to the rise in operative intervention. It is, however, an intervention that has not yet been tested against operative intervention – all of the other studies were simple conservative management with a sling rather than a brace. Reasoning that the figure-of-eight brace might give a similar functional outcome to plate osteosynthesis, and that the jury is still very much out on which is the best treatment method, a research team in **São Paulo (Brazil)** designed a randomised controlled trial to establish the comparative outcomes between the figure-of-eight harness and anterior plate osteosynthesis.² The investigators enrolled a total of 117 patients in their prospective randomised controlled trial and assessed the primary outcome measure of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire administered at six months. Secondary outcome measures including pain scores, radiological findings, cosmetic satisfaction scores, complications, and time to return to previous work and activities were also recorded and reported. Participants were assessed at six weeks, six months, and one year. The investigators were unable to establish any statistically significant difference in the DASH scores between the two groups at any timepoint (six weeks, six months, and one year). They also found no difference in pain levels measured with a visual analogue scale (VAS), time to return to previous activities, or dissatisfaction with the cosmetic result. While all fractures in the operative

group healed, seven patients (14.9%) developed nonunion after figure-of-eight brace treatment. The authors concluded that their study failed to demonstrate a functional difference between those patients treated non-operatively and those treated with open reduction and internal fixation. This study really does little to add clarity on its own to what is becoming an increasingly complex question: which clavicular fractures should be fixed? However, the data will be useful in meta-analysis – at the moment, it does appear that more and more studies are siding with non-operative treatments.

How effective is ultrasound in treating nonunions? X-ref

■ Nonunion, whether caused by infection or other biological factors, is a great treatment challenge. From long bone to small, it is easy to see the vast amounts of healthcare resource, clinician time, investigations, and eventually often surgical time, devoted to the assessment, diagnosis and treatment of nonunion. That, of course, is only the tip of the iceberg; the hidden costs of lost economic productivity, care burden, and, in the case of the tibia and femur, sometimes even amputation result in a vast societal and human penalty. It is no wonder, therefore, that when the ultrasound devices became available commercially with the promise of low cost and reduction in nonunion rates, there was a lot of interest from clinicians and patients alike. However, this initial excitement has not entirely been reflected in the outcomes of the various studies available. The evidence for the most widely available device that offers low-intensity pulsed ultrasound (LIPUS) is somewhat contradictory. The most common device available commercially (Exogen; Bioventus LLC, Durham, North Carolina) has mixed evidence and we were delighted to see a systematic review and meta-analysis of published papers from **Halifax (Canada)** that describe nonunions treated with LIPUS.³ The study team undertook a meta-analysis of randomised and

non-randomised controlled trials and were able to identify 13 papers reporting the outcomes of 1441 nonunions treated with LIPUS. Although this multinational team showed a success rate of over 80% with LIPUS, we are somewhat sceptical here at 360. Including non-randomised trials in meta-analysis does not, of course, iron out the inherent methodological flaws of those studies. The Cochrane review on the matter, and the most recent randomised study (interestingly sponsored by the manufacturer), both show no apparent difference in outcomes. The fact that the effect was more apparent in those with a hypertrophic nonunion suggests that there may be a time element in this, especially with the definitions used for this meta-analysis; delayed union may have a role to play with those treated by LIPUS likely to fail in many cases.

Thromboprophylaxis in trauma X-ref

■ Anticoagulation in trauma patients is a rather contentious practice, and there are differences in practice and guidelines within healthcare systems, let alone internationally. However, there has been some significant suspicion globally of the results of studies funded by the pharmaceutical companies that use the presence of any venous thromboembolism (VTE) as a surrogate marker for clinically relevant deep vein thrombosis (DVT). There has, as this review team from **San Francisco, California (USA)** point out, been a change in endpoint of interest to clinically relevant thrombosis (CVTE) which is usually defined as proximal DVT or embolic disease (most often pulmonary emboli).⁴ The review team undertook a well-structured systematic review and meta-analysis with the aim of evaluating the evidence for thromboprophylaxis for both VTE and CVTE. Although their initial search threw up 1502 studies, just five studies reporting the outcomes of 1181 patients were suitable for inclusion in the analysis, which was the now standard random-effects

model. The authors established what perhaps one may expect when using VTE as an endpoint, that administration of low-molecular-weight heparin was associated with a relative risk reduction of 0.696, a clinically relevant reduction. However, when examining the CVTE endpoint, this difference disappeared, with a relative risk of 0.87 (95% CI 0.12 to 3.87). Looking at things from a slightly different perspective, this means that, statistically speaking, 31 patients would need to be treated with chemoprophylaxis to prevent one VTE, while 584 patients would need to be treated with chemoprophylaxis to prevent one CVTE. The authors conclude that “routine postoperative anticoagulation after surgical management of an isolated fracture of the tibia or distal bone is unlikely to provide a clinical benefit”. We would wholeheartedly agree, here at 360.

Does waiting risk the radial nerve? X-ref

■ Diaphyseal fractures of the humerus are a topic of much debate. Orthopaedic surgeons the world over are aware of (and many agree with, though some don't) the seminal work by Gus Sarmiento on functional bracing, a technique that yields acceptable results in the majority of fractures, both with and without radial nerve palsy. However, there are reports of an incidence of up to 20%, even in expert hands, of nonunions with functional bracing, and therefore evidently a large number of humeral fractures will end up with surgery, even if the default position is conservative. Radial nerve palsy, of course, then becomes the chief concern. If the radial nerve isn't injured at the time of initial injury, will it survive the surgery? Further, are there any modifiable risk factors for poor outcomes such as timings of surgery? If there were, we would perhaps have some guidance as to when it is safest to intervene. Surgeons in **Boston, Massachusetts (USA)** present their own candid series of 325 patients, all managed with plate fixation of the humerus and with a pre-operative

intact radial nerve.⁵ Overall, 7.7% of patients developed an iatrogenic radial nerve palsy and the majority of these (n = 22/25) recovered in their entirety. One was lost to follow-up and the others required intervention for their nerve injury. To cut a long story short, when undertaking a multiple variable analysis and dividing patients into time cohorts (< 4 weeks, 4 to 12 weeks, and > 12 weeks) from injury to surgery, there was no link between delay to surgery and incidence of radial nerve palsy, and, given the size of this series, these authors are probably in a position to make that association. There were, however, other independent risk factors identified on multivariable analysis, which were: more distal location of the fracture and revision fixation. Given the lack of association between delay to surgery and incidence of radial nerve palsy, it is not unreasonable, based on the evidence in this series, for surgeons to continue to manage humeral fractures initially non-operatively and only intervene when it looks like patients are progressing to a nonunion. It appears that all that is lost is time as the risks of iatrogenic nerve injury are no higher when surgery is delayed.

Post-traumatic stress and major injury

■ It is well documented that post-traumatic stress disorder (PTSD) does exist, and can occur following any major life-changing event. Despite the known association, there is precious little written about PTSD in the setting of either orthopaedic injury or traumatic brain injury (TBI). These authors from **Dallas, Texas (USA)** have set out to fill this gap in knowledge with their own longitudinal series of patients, all with orthopaedic injuries.⁶ The authors collated depression and PTSD scores at regular intervals prospectively throughout the patients' stay, and out to 12 months post-operatively, and then sought to establish any association with TBI. Their cohort consisted of 214 patients, of whom 21% had sustained a concomitant TBI

and orthopaedic injury. The remainder had orthopaedic injuries only. There was a significant association between PTSD and depressive symptoms reported at 12 months and six months post-injury and TBI in this series. There is evidently a lot of work to be done here. These authors have clearly identified a higher risk of both PTSD and depressive disorder following trauma in patients with both orthopaedic and head injuries. To say that support for these patients, from a psychological perspective, borders on the rudimentary is something of an understatement in the majority of trauma units. However, the first step to solving a problem is recognising that there is one, and this team from Dallas have ably underlined the frequency of the problem here.

A no-transfusion hip fracture service: pipe dream or possibility? X-ref

■ Despite the cost (which is the usual focus of articles on blood transfusion), there are a number of other potential drawbacks to blood transfusion in the peri-operative period. It has a profoundly immunosuppressive effect, and may be associated with peri-operative complications. Researchers in **Seoul (South Korea)** have published an interesting propensity score-matched series that goes some way to unpicking the trade-offs of risks and benefits for blood transfusion.⁷ The authors were somewhat fortunate in that their population contained a number of patients who did not consent to blood transfusion, even if it were deemed necessary. These were matched using a propensity scoring method to 50 matched pairs of patients. Clinically, the non-transfusion group were treated with erythropoietin and iron as an alternative to transfusion. Perhaps unsurprisingly, the post-operative haemoglobin levels were statistically significantly different between the two groups (11.0 vs 10.5 g/dL). By two weeks, haemoglobin levels had completely recovered in both groups and

there was no overall difference in complication rates or length of stay. In this matched cohort, there were really no differences to see between the groups in terms of length of stay or complications. However, we do need to remember how these studies are constructed, and although propensity scoring does account for some biases, it does not substitute for either randomisation or underpowered studies. Given the complication rates in surgery, are we really to believe that a matched cohort of 50 pairs of patients is appropriate for drawing conclusions about events with an incidence of around 1%?

Lisfranc: screw, plate or both?

■ There is no doubt that the Lisfranc injury is a catastrophic injury to the foot, with significant fractures also associated with deformity, ligamentous instability, soft-tissue disruption and even vascular injury and compartment syndrome. Like all injuries, however, there is a spectrum of injury patterns and a variety of treatments offered. The mainstay of treatment for these injuries is the position screw, dorsal plate or a combination of them both. The trauma team in **Victoria (Australia)** undertook a retrospective review of their case series to establish if there were any differences detectable in success rates or outcomes between these three competing strategies.⁸ The authors report a sizeable series of 50 patients, all of whom underwent surgical fixation for a Lisfranc joint injury over a six-year period. Outcomes were reported using both the American Orthopaedic Foot and Ankle Society (AOFAS) Midfoot Score and the Foot Function Index (FFI). The message which the authors present here is a rather simple one. There were no differences in functional outcomes, metalware failure or need for revision with either of the fixation strategies. However, there was a significant difference in functional outcomes seen with accuracy of reduction, which was reflected in both scores. So, it seems yet again

that it doesn't really matter what implant or combinations of implant are in use – it's simply the quality of the surgery that matters.

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Oncology

Allograft augmented with intramedullary cement after resection of a diaphyseal tumour

■ Surgeons in Mount Sinai Hospital, **Toronto (Canada)** have reported their own experience of augmented plate reconstruction with allograft following resection of diaphyseal tumours.¹ The technique in question involves the use of intercalary allograft and subsequent cement augmentation to create a cement plate fixation construct following tumour excision. This offers a flexible alternative to a megaprosthesis in the limb salvage situation. Although a well recognised technique, there are few long-term studies reporting survival or functional outcomes, and we were delighted here at 360 to read this report of nearly 50 patients, all managed using this technique. This study team reports a prospective cohort series of 46 patients with intercalary allografts augmented with intramedullary cement and fixed using compression plating. Outcomes were evaluated for long-term functional status using the Musculoskeletal Tumor Society (MSTS) scoring system and the Toronto Extremity Salvage Score (TESS). The most common diagnoses were osteosarcoma (n = 16) and chondrosarcoma (n = 9), with the usual pattern of tumour location (femur in 21, the tibia in 16 and the

humerus in nine). At a median follow-up of 92 months, overall survival of the allograft was an impressive 84.8%. A total of 15 patients (33%), however, had experienced at least one complication. Five allografts were revised for complications and one for local recurrence. The authors concluded that intercalary allografts augmented with intramedullary cement and compression plate fixation provide a reliable and durable method of reconstruction after the excision of a primary diaphyseal bone tumour. While it is unlikely that there will ever be a single benchmark in limb salvage and tumour reconstruction, given the variety of defects, primary diagnoses, and patient and surgeon expectations, this study does support the use of augmented intercalary allograft with cement and plate fixation. This technique is certainly one that has a place in modern orthopaedic oncology.

Non-vascularised fibular grafts for reconstruction of segmental and hemicortical bone defects following meta-/diaphyseal tumour resection of the limbs

■ One of the difficulties faced by tumour surgeons in limb reconstruction is that a relatively poor vascular supply causes difficulties with local flaps, and therefore causes restriction in the range of reconstructive

options available. One option used is that of a fibular graft, either vascularised or not. It is certainly a matter of opinion whether or not vascular reconstruction is necessary in this setting, and if indeed this makes a difference in the long term. However, use of the vascularised option does, to a certain extent, dictate surgical availability, as the pedicle must be reconstructed with a suitable anastomosis. We were delighted to see this series of patients from **Basel (Switzerland)**.² The authors report 36 patients, all of whom were treated with non-vascularised fibula for segmental (n = 15) and hemicortical reconstructions (n = 21) after bone tumour resection (15 malignant, 21 benign) in the limbs. At a final mean follow-up of 8.3 years, union was achieved radiologically in 94% of patients, and 85% showed apparent hypertrophy at the graft-host junction. The overall complication rate was somewhat high at 36%, with four patients (11%) developing local recurrence. The authors report a relationship between the development of mechanical complications (fracture, delayed union/nonunion) and a defect size of ≥ 12 cm. Encouragingly, the dual functional outcome was highly satisfactory (mean MSTS score 86%). The authors here concluded that non-vascularised fibular reconstructions should be considered a valuable

alternative treatment option for patients with hemicortical defects or segmental reconstructions of less than 12 cm in which no additional neo-/adjuvant treatment is necessary. Reporting here a combination of segmental and hemicortical defects makes interpretation of these results somewhat more challenging than the average paper. Only six of the 36 cases received adjuvant therapy (which is on the low side for malignant tumours), hence their comment (based on their experience of six cases) that "this is a valuable addition 'only' in patients in which no additional neo-/adjuvant treatment is necessary". This may be a bit overstated from the data. An important recommendation the authors do make, however, is that "Taking our own results into account, we therefore strongly recommend the use of vascularised fibula grafts for segmental bone defects of 12 cm or greater." This can serve as a useful guideline in clinical practice.

Pasteurised autograft-prosthesis composite reconstruction may not be a viable primary procedure for large skeletal defects after resection of sarcoma

■ Among various types of composite biological reconstruction agents, pasteurised autograft-prosthesis composite (PPC) is popular when allograft is unavailable. The