ROUNDUP360

Trauma

✕ *For other Roundups in this issue that cross-reference with Trauma see: Hip Roundup 1, 4, 5 ; Foot & Ankle Roundup 1 & 8 ; Shoulder & Elbow Roundup 6 & 9; and Children's orthopaedics Rondup 1.*

Predicting nonunion? The art of foresight in tibial fractures

■ Nonunion of the tibia is a relatively uncommon, but life-changing event. There has never been quite such interest in nonunion as in the aftermath of BMP discovery. Patients, researchers and clinicians alike have been clambering on the band wagon, requesting, investigating and using BMPs respectively. However, one overlooked piece in the jigsaw is the re-evaluation of the original problem necessitating their use. Exactly who is likely to get nonunions, and how common is it? Researchers from **St Louis (USA)** took a fresh look at the problem, asking how good surgeons are at predicting a subsequent nonunion based on clinical radiographs. The research team designed a cunningly simple study to establish the diagnostic accuracy of clinicians at predicting nonunion. They assembled a serial cohort of patients, all with tibial fractures treated with a tibial nail. The study team constructed a clinical vignette summarising the history for each patient, including their demographics (age, gender, weight), the mechanism of injury, and comorbidities (past medical history, smoking status). The clinical vignette and radiographs were presented to a group of three fellowship-trained trauma surgeons. The surgeons were presented with 56 consecutive patients with incomplete healing at three months and in all of whom their eventual union status was known. The surgeons were able to achieve a diagnostic accuracy for subsequent nonunion of 74%, achieving 62% sensitivity and 77% specificity, respectively. The surgeons were even better at predicting nonunion in patients with diabetes, with an accuracy of 88% (presumably due to the high association between diabetes and nonunion). The surgical teams identified lack of callus formation and mechanism of injury as the strongest predictive factors for nonunion. In patients with no callus formation they had a diagnostic accuracy of 89%.[1] This is a refreshing paper, and one we enjoyed here at 360. It appears that in this age of over-investigation and the increasing complexity of modern medicine, the tried and tested 'clinical review' at three months not only remains the gold standard but provides high rates of accuracy. We would, however, inject a slight note of caution. Careful reading of the paper reveals that 43% of the patients were actually operated on by the 'predicting' clinicians. Combined with a case vignette and radiograph there must certainly be some element of recall bias here.

Compartment syndrome in double

■ In a pair of compartment syndrome papers in JOT this month, researchers from all over North America re-examine some of the evidence surrounding compartment syndrome. The technique of fasciotomy has been revisited by researchers in **Vanderbilt (USA)**. Is there any difference between the single or dual incision approach, given the potential advantages (less disfiguring scars, lower infection rates) and disadvantages (incomplete release, and potential soft-tissue damage) associated with the single incision? While fasciotomy is not necessarily amenable to a randomised controlled trial, with low event rates and controversies surrounding the diagnosis, much information can often be gained from retrospective case comparisons of interventions such as this. The study team undertook a retrospective case-controlled review of all patients undergoing fasciotomy for their tibial fracture over a 12-year period. Although the centre treated 2756 fractures during this period, only 175 (6.3%) underwent fasciotomy for compartment syndrome. These were a mixed cohort with respects to treatment: 60 underwent IM nailing (36 single incision and 24 dual incision) and 81 underwent plate fixation (59 single incision, 22 dual incision). These treatment allocations were arbitrary, and at the discretion of the treating surgeon. However, there were no differences in any recorded demographic variables between the groups, suggesting that the groups were reasonably well matched. The treatment characteristics did not vary greatly between the two groups and neither did the number of debridements, requirement for skin coverage, infection or nonunion rates. The authors conducted a post-hoc power analysis (not strictly valid) which does suggest that the study reaches a B level of 20% for nonunion and 7% for infection.[2] While this paper is not quite gold standard evidence, it does suggest that the hypothesised benefits of single incision fasciotomy are not supported by the only comparative paper on the topic. However, given the current evidence, with no differences in any complication rate, it is perfectly acceptable for surgeons to perform whichever technique they feel most comfortable with.

■ Next up in JOT's foray into compartment syndrome is a short paper dealing with the difficult to diagnose entity of compartment syndrome around a tibial plateau fracture. Although widely recognised as a complication, there are often difficulties in diagnosis, as pain on passive stretch in the foot is often absent and due to the tight low volume fascia compartments in the peri-articular area, meaning that the onset can be rapid and catastrophic. A research team in **Atlanta (USA)** hypothesised that the appearances of radiographs at presentation would be predictive of the likelihood of compartment syndrome and could be used to raise the index of suspicion. The investigators identified a number of radiological factors indicative of high energy injuries and designed a study to establish if they were diagnostic of compartment syndrome. The patient cohort included 162 tibial

plateau fractures in 158 patients in which there was an 11% rate of compartment syndrome. Radiographs taken on presentation were analysed to assess the direction and degree of initial femoral displacement, along with the amount of tibial widening. The researchers used univariant analysis to establish that tibial widening, femoral displacement and fracture classification grade were associated with an increased incidence of compartment syndrome. The investigators constructed a logistic regression model to establish the effects of each variable. This suggested that Schatzker grade and femoral displacement were strongly associated with incidence of compartment syndrome whereas tibial width was not.[3] In what is a relatively straightforward study, the authors present a simple but important take-home message: "easily obtained radiographic parameters correlate with the occurrence of compartment syndrome". The only caveat being that these findings are based on just 15 positive patients!

Research: Octogenarian RTCs: not as bad for you as you might think

As of 2008, more than seven million automobile drivers in the US were aged 80 years and older, and surprisingly in this age group motor vehicle collisions (MVC) are the second most common mechanism of injury, following falls. Researchers in **Wichita (USA)** set about evaluating the one year post-discharge mortality in octogenarians involved in an MVC. The research team established the cause of death and risk factors predictive of mortality. This careful ten-year retrospective review (Level IV evidence) set out to establish patient demographics, injury severity and patterns, hospitalisation details, and post-trauma outcomes predictive of one year mortality. Like many such studies, determining the exact cause of death for patients who died within 12 months of hospital discharge can be tricky, and relies on state death databases and hospital records, when patients did not necessarily have a post mortem examination. The authors aimed to determine if there was a relationship between injury severity and pattern to the one year post-discharge mortality. Impressively, the authors were able to include a total of 199 patients in this study, with a mean age of 84.2 and Injury Severity Score (ISS) of 9.3. Unsurprisingly in this age group, the one year mortality was quite high at 11.1% (22 patients). In around half of these the cause of death was directly related to trauma (n = 9) and likely related in a further third (n = 7). The remaining six patients died of unrelated causes. Patients who were more severely injured (ISS > 15, p = 0.004) and those admitted to the intensive care unit (ICU) (p = 0.0051) were more likely to die within one year of hospital discharge and although not significant, the authors note a trend towards a higher mortality in patients with pneumonia. However, rib, hip, and pelvic fractures, spinal cord injuries, intubation upon hospital arrival, and need for mechanical ventilation were not associated with a higher post-discharge mortality rate.[4] The results of this study show that although many believe that the majority of very elderly senior citizens involved in a MVC die within one year of discharge, this is untrue. The only predictors of mortality within one year of discharge are injury severity, ICU admission, and ICU length of stay.

Does HIV status affect decision making in open tibial fractures?

The human immunodeficiency virus (HIV) affects over 33 million people worldwide. HIV suppresses cell-mediated immunity by reducing the CD4 lymphocyte count and increases the host susceptibility to Gram-positive infections. Open tibial fractures are not uncommon and are usually treated with primary stabilisation. Chiefly to maximise early return to functional activities, implants are often inserted at the initial debridement with no increased rates of infection. While closed plaster or external fixation treatment yields similar long-term results, the long union times and higher rate of malunion have almost universally persuaded surgeons to treat open tibial fractures with stabilisation. This carefully researched balance between complications, early return to function and long-term deformity may be altered in patients with HIV who are more susceptible to infections. Authors in **Liverpool (UK)** set out to establish where the balance of risks and benefits lie in the management of open tibial fractures. The researchers compared the rates of early (within 30 days) post-operative infections in HIV-positive and HIV-negative patients presenting with open tibial fractures managed with surgical fixation. The wounds of 84 patients (65 male and 19 female, mean age 34.8 years) with 85 fractures (28 HIV-positive and 56 HIV-negative) were assessed for signs of infection using the ASEPSIS wound score. A total of 57 fractures (17 HIV-positive and 40 HIV-negative) treated with external fixation were assessed using the Checkett score for pin-site infections. The remaining 28 fractures were treated with internal fixation. This study showed no significant difference in the early post-operative wound infection rates between the two groups (10.7% (n = 3) *versus* 19.6% (n=11), relative risk (RR) 0.55 (95% confidence interval (CI) 0.17 to 1.8, p = 0.32)). Additionally, no difference was found in pin-site infection rates between the groups (17.6% (n = 3) *versus* 12.5% (n=5), RR 1.62 (95% CI 0.44 to 6.07, p = 0.47)).[5] The authors concluded that, based on their study, the idea that HIV-positive patents are at a higher risk of early surgical site or pin-site infections is not true. We are, therefore, inclined to agree with the authors' suggestion that the patient's HIV status (CD4 count > 350 cells/μl) should not influence the management of open tibial fractures.

Flap timing and related complications: truth or fiction?

The management of open tibial fractures requiring soft-tissue reconstruction (Gustilo type IIIB and above) remains a challenge for orthopaedic and reconstructive surgeons alike. Most hospitals and healthcare systems have guidelines that include a combined approach including rapid soft-tissue coverage. There are large numbers of studies which have reported increased complication and infection rates with delayed soft-tissue coverage, however, some commentators have criticised these studies as they do not control for confounding factors that may be associated with both delay in coverage and complications. A study group in **Baltimore (USA)** hypothesised that the timing of flap coverage of open tibial fractures is actually not predictive of complications following open fracture fixation. They designed a study to examine if, after controlling for known risk factors for flap failure, there was a time dependent component in prediction of flap failure. The authors designed a retrospective review including all tibial fractures requiring flap coverage at their institution between 2004 and 2009. Patients requiring a delayed flap for wound breakdown

or infection were excluded from the study, leaving a total study population of 69 patients treated for acute tibial fractures (45 tibial shaft, 17 plateau, and 12 pilon fractures). The study was designed with the primary outcome of flap complications in mind. These were further defined as infection or any other flap-related adverse outcome requiring operative management. The authors undertook a logistic regression analysis and stratified outcomes by reconstruction timing (the first seven days after injury and then the subsequent days). In this study the authors demonstrated no increased risk of infection on days one through seven. For each day past day seven, the odds of complications, and infection in particular, increased by 11% and 16%, respectively ($p < 0.04$). This study showed that even after controlling for known risk factors for complications, including injury severity, a delay in coverage beyond seven days after injury is associated with a daily 16% increase in infection risk. Thus, they recommend an aggressive approach to soft-tissue coverage in open tibial fractures, especially within the first seven days.[6] This paper adds to our current understanding of infection and complication rates following open-fracture, and the point surrounding confounders and selection bias is well made. However, it is important to remember that the numbers in this study are relatively modest, and by refining on a day-by-day basis the nature of the statistics and the event rates is such that the authors were unlikely ever to find many differences in the first seven days of reconstruction timings. For us here, this paper completely supports the current policy of rapid soft-tissue coverage - how 'rapid', really needs to be quantified further. There are insufficient patients presented to confidently say that seven days is a safe cutoff for soft-tissue reconstruction and we would urge a larger (perhaps registry-based) study to further clarify this issue.

How displaced is that GT? Proximal humeral fractures under the spotlight

It is surprising that for one of the most common fractures (and the second most common upper extremity fracture), we still face difficulties in decision making surrounding proximal humeral fracture management: when to fix, when not to fix and when to replace remain extremely difficult questions to which many do not know the answer. At first glance, the picture is clearer in the case of the isolated greater tuberosity fracture. Displacement of greater tuberosity (GT) fractures has been shown to affect shoulder mobility and strength as the insertion of the supraspinatus is compromised. Conventional wisdom teaches that displaced greater tuberosity fractures should be fixed in patients with no contraindications. However, this is where things become more tricky. The GT displaces postero-superiorly in line with the pull of supra-spinatus, and measuring the displacement of the GT on plain radiographs remains a problem with errors having been quantified of up to 13 mm. Investigators in **Montreal (Canada)** have attempted to address all of these problems with their newly described GT ratio for measuring fracture displacement on radiographs. The authors describe this measure and validate it through correlation with computed tomography (CT) and surgical decision making. A retrospective review of radiological shoulder trauma series was performed between 2007 and 2010 to identify all cases of isolated GT fractures with both radiographs and CT. The GT ratio was obtained for all radiographs and correlated to the GT superior displacement measurement obtained on the CT. The GT ratio was then tested for accuracy of surgical decision guidance using a 5 mm superior displacement as the cutoff on CT. A total of 40 cases of acute isolated GT fractures with radiographs and CT were identified. The GT ratio had a very good correlation with superior GT displacement on CT (Pearson = 0.852, $p < 0.01$). Based on CT, there were 23% (n = 9) GT fractures classified as 'surgical' and 77% (n = 31) were classified as 'non-surgical'. Using a GT ratio cutoff of ≤ 0.00 as non-surgical, ≥ 0.50 as surgical, and 0.00 to 0.50 as warranting further imaging, the sensitivity and specificity for the GT ratio was 89% and 100%, respectively. Additionally, the GT ratio had better inter- and intra-observer reliability than both the AO and Neer classifications.[7] The authors concluded that the GT ratio on plain radiographs correlated very well with CT superior GT fracture displacement. This new measure can accurately classify GT fractures as surgical, non-surgical, or as benefiting from additional imaging, while involving less radiation exposure.

Restoration of hip architecture with bipolar hemiarthroplasty in the elderly: does it affect early functional outcome?

Femoral neck fractures are common injuries sustained by elderly patients and are associated with a high morbidity and mortality. In patients undergoing elective total hip replacement, anatomic reconstruction is correlated with functional outcomes. In theory, the same should apply for bipolar hemiarthroplasty (HA) following a femoral neck fracture. Researchers from **Hamburg (Germany)** aimed to evaluate the short-term clinical and functional outcomes in relation to the degree of anatomic restoration after bipolar HA. This was a retrospective cohort study of patients receiving a bipolar HA following an intracapsular femoral neck fracture between 2010 and 2012. Radiological and functional outcome data were recorded during the acute care phase and during rehabilitation. Post-operative mobilisation data and comorbidities were recorded with outcome data obtained during rehabilitation including Barthel index, Tinetti score, Timed up and go test and Mini-Mental State Exam. Radiological outcomes (determined from the post-operative radiographs) were used to obtain the FO ratio (femoral offset to body weight lever arm ratio), HC-ratio (height of the hip centre to the pelvic height ratio), and the BWLA ratio (body weight lever arm to pelvic height ratio). A total of 193 patients (median age of 84 years, IQR = 78 to 94) of which 72% were female were analysed. A high proportion of these patients had prior comorbidities (96% with at least one), and the in-hospital mortality rate was 5.7%. During geriatric rehabilitation, the Barthel index improved from 40 to 55 ($p < 0.001$). At the time of rehabilitation discharge, the median Tinetti score was 15.5 (IQR = 10 to 19.5). The timed up and go test improved from a median of 22 seconds to 19 seconds. When comparing the FO ratio of the operated *versus* non-operated side a significant difference was found ($p < 0.001$). None of the radiological measures, representing the reconstructed anatomic hip geometry, significantly influenced the clinical and geriatric outcomes. The authors concluded that in this single-centre case series, the anatomic reconstruction of the hip following a femoral neck fracture was not an important factor that influenced short-term geriatric functional outcomes. Other factors like age, number of comorbidities, nutritional status, and cognitive function may be more important.[8] Like many papers that cross our desks here at *360*, this is a single-centre case series in which the authors appear to have 'retro-fitted' a research question into their study design. The question asked is not a particularly useful one without a comparison group. However, this study does nicely underline again for us how many other factors define outcome in hip fracture surgery. The post-operative radiograph is probably very poorly predictive of any outcome measure in these patients.

Short versus long cephalomedullary nails for the treatment of intertrochanteric hip fractures in patients over 65 years

As the population ages, the increasing number of hip fractures and the burden of their care is presenting a difficult financial and healthcare situation. The number of hip fractures, including intertrochanteric, is expected to increase substantially as the geriatric population continues to grow, and there has been a wholesale move towards more expensive cephalomedullary devices, mostly driven by industry without much long-term clinical evidence to support this change. In the face of this increasing healthcare burden, it is important to explore the utility of sliding hip screws and long and short intramedullary devices. Researchers in **Boston (USA)** hypothesised that there would be a difference in the failure rates of long and short cephalomedullary nails used for the treatment of intertrochanteric femoral fractures in patients older than 65 years. They designed a retrospective cohort study (Level IV evidence) of patients aged ≥ 65 years, all of whom underwent open reduction and internal fixation of an intertrochanteric femoral fracture with either a short or long cephalomedullary nail between January 2004 and December 2010. Patients were not randomised and the decision between long and short nails was arbitrary. The primary outcome measure was post-operative treatment failure rates, defined in this case as periprosthetic fracture or reoperation requiring removal or revision of the nail (including arthroplasty). The study population consisted of a healthy 559 patients in whom the incidence of treatment failure (periprosthetic fracture and reoperation requiring nail removal) was 5.4% (n = 30) for the entire cohort, 5.9% (n = 13) after short nail placement and 5% (n = 17) after long nail placement. Failures included 11 patients (2%) who sustained a periprosthetic fracture after nail placement, of which 2.7% (n = 6) were after short nail placement and 1.5% (n = 5) after long nail placement. The 19 remaining failures occurred for various reasons and required nail removal; 3.2% (n = 7) after short nail placement and 3.5% (n = 12) after long nail placement. Failures in this group were due in the most part to screw/helical blade cutout (n = 16), with single cases of progressive arthritis, femoral head avascular necrosis and symptomatic leg length discrepancy all requiring conversion to arthroplasty. Like many similar studies, the longevity of the patients was not great with a median follow-up of 30 months (12 to 85) and an overall 25% one year mortality rate.[9] The authors concluded that based on this study both short and long cephalomedullary nails have similar treatment failure rates and provide predictable outcomes for intertrochanteric femoral fracture fixation in patients aged 65 years and older.

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