candidates for surgery, which is the standard treatment for nonunion, complicating the picture somewhat. In those patients unsuitable for, or wishing to avoid surgery, a variety of techniques have been employed, with mixed success, including extracorporeal shock wave therapy, pulsed electromagnetic wave therapy, and low-intensity pulsed ultrasound (LIPUS) stimulation. These have been postulated as a means of enhancing enchondral ossification at the fracture site and there are studies concerning use in small and long bones. The argument is that these interventions will promote union without the need for surgery; however, they can be inconvenient and costly. This group from **Baltimore, Maryland (USA)** has performed a systematic review and meta-analysis to study the use and efficacy of low intensity pulsed ultrasound stimulation.[8] Five studies were included and, in total, these reported just 166 cases, with an average patient age of 31 years and fracture age of 20 months. Across these studies, a mean healing rate of 78.6% was seen and an average time to union of 4.2 months was reported; however, an exclusion included cases of avascular necrosis. As the authors note, there are a lack of prospective studies in this area and so the evidence base remains relatively weak, especially as the evidence here was mostly level III, with only a single level II paper reported in the literature. Nonetheless, there are few options other than surgery for this group of patients, so, in specific circumstances where funding permits and patients can bear the long lag time, LIPUS may be worth trying. Without doubt, however, better-designed and better-conducted studies are required here to make anything but the weakest of recommendations.

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Shoulder & Elbow

X-ref *For other Roundups in this issue that cross-reference with Shoulder & Elbow see: Research Roundups 5 & 7.*

Scapular fractures: is surgery beneficial in the mid to long-term? X-ref

The scapular fracture has been gaining more interest of late, with recent symposia at the Orthopaedic Trauma Association (OTA) and a broadening interest in the orthopaedic shoulder and trauma communities. We were delighted, here at *360*, to see a relatively large series examining the long-term benefits or otherwise of intervening in the scapula fracture. In this retrospective study from **St. Paul, Minnesota (USA)**, 66 (67%) of 98 eligible patients with an acute operatively managed intra- (n=29) or extra-articular (n=37) scapular fracture were followed up for a mean of seven years (4.7 to 10.3) post-surgery.[1] The operative indications are well documented in the paper, are based on the existing literature, and are consistent with previous studies from this group. The authors report in their series a 100% union rate, no infections, and Disabilities of the Arm, Hand and Shoulder (DASH) scores approaching normative values for the population studied, which steadily improve over time. An excellent range of motion and strength was achieved compared with the patient's contralateral arm, but with a reduced range of external rotation. The secondary surgery rate in the extra-articular group was 26% (n=8); this was for elective metalwork removal (n=5) or manipulation under anaesthesia (MUA) for stiffness (n=3). In comparison, the secondary procedure rate in the intra-articular group was 31% (n=9) and was for elective metalwork removal (n=3), MUA for stiffness (n=4), or shoulder arthroplasty (n=2). The authors concluded that operatively managed intra- and extra-articular scapular fractures report excellent functional outcomes at between five and ten years after open reduction and internal fixation (ORIF), but no difference was identified between those groups. As the authors acknowledge in their paper, there are limitations to this very large series of patients. First, the retrospective nature leads to problems with loss to follow-up and a heterogeneous group of patients included in the report. There is no nonoperative control group within in the study, and as such there is no evidence presented here to suggest that surgery provides a superior outcome for these injuries in the longer term. Finally, but importantly, only six patients in this series sustained low-energy trauma, which is not consistent with the current data, which would suggest an increasing incidence of low-energy scapular fractures in women, where nonoperative treatment is possibly more appropriate.

Proximal humerus fractures: still no evidence surgery provides benefit X-ref

The role of surgery for fractures of proximal humerus continues to be debated, and a recent large study documented an almost three-fold increase in the use of primary reverse shoulder arthroplasty for fractures of the proximal humerus. Given the recent results of the Proximal Fracture of the Humerus Evaluation by Randomization (PROFHER) study, which demonstrated no benefit of open reduction and internal fixation (ORIF) over nonoperative management in certain patients, some have suggested that reverse shoulder arthroplasty should be the next comparator to nonoperative treatment for these complex fractures. However, to date we are aware of no study that has definitively proven the superiority of surgery, with a recent study we discussed here at *360* demonstrating no difference in any patient-reported outcome or range of movement between nonoperative management and reverse shoulder arthroplasty. In this new large systematic review with meta-analysis from **Utrecht (The Netherlands)**, the authors attempt to establish what the evidence is from the literature to support or otherwise operative management of proximal

humerus fractures.[2] The authors report a comprehensive systematic review and meta-analysis incorporating the results from 22 studies (seven randomized controlled trials, 15 observational studies) that reported the clinical outcomes of 1743 patients (910 surgery, 833 nonoperative). The epidemiology of the patients included was consistent with the current literature and follow-up ranged between 12 and 86 months. No difference was found in the primary outcome score (Constant–Murley) at a minimum of one year following treatment in favour of any of the tested interventions. Major re-interventions were more common in the operative group (relative risk 2.72), but with a lower risk of nonunion in this group (relative risk 0.45), these two risks to a certain extent balance each other out. Subgroup analysis for Neer three- or four-part fractures found no differences in functional outcomes reported between the higher and lower grade fractures. The authors therefore conclude that, from what is thought to be the largest meta-analysis to date, they would currently recommend nonoperative treatment "for the average elderly patient (aged >65 years) with a displaced proximal humeral fracture". As with previous literature in this area, nonoperative management is yet to be bettered. It is clear, however, that there is a role for surgery (including reverse shoulder arthroplasty) for these potentially complex injuries, but advancements in fracture classification and our ability to predict outcomes still need to be made before we can advance the literature in this area.

Frozen shoulder: is capsular release better than hydrodilatation?

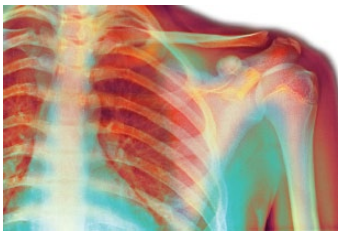
■ In this trial from **Exeter (UK)**, the authors randomized 50 patients with idiopathic frozen shoulder of at least three months duration (as defined by the Codman criteria), which was refractory to physiotherapy and deemed to require surgery.[3] Patients were randomized on a 1:1 basis to receive either arthroscopic capsular release or hydrodilatation. The primary outcome measure was the Oxford Shoulder Score at six months post-intervention. No power analysis is reported in the paper, and, as such, this can really only be seen as a pilot study. The groups were reasonably well matched at baseline, apart from the arthroscopic capsular release, having a higher proportion of women (85% *vs* 57%; p=0.18) and a much higher baseline EuroQol-5D (EQ-5D) visual analogue scale (VAS) (79.1 *vs* 61.2; p=0.007). Of the 50 patients reported to be enrolled, only 39 (78%) were analyzed at the primary outcome point. Without a reported power analysis, it is impossible to assess the effect of this loss to follow-up rate. There were 20 patients analyzed in the hydrodilatation group (procedure not performed in four and lost to follow-up in one) and 19 in the arthroscopic capsular release (procedure not performed in five and lost to follow-up in one). Furthermore, four patients crossed over from hydrodilatation to capsular release before six months, with one patient in the capsular release group crossing over to hydrodilatation. The authors reported significant improvements from baseline in the Oxford Shoulder Score for both groups, with 75% of the improvement occurring within six weeks. The Oxford Shoulder Score was significantly higher in the capsular release group (43.8 *vs* 38.5), with similar findings when employing a per-protocol analysis. No complications were noted in either group. Despite the obvious limitations associated with this study (small sample size, lack of power analysis, high crossover rates, loss to follow-up), it is the first randomized controlled trial to compare these two treatment modalities and suggests that an improvement following these interventions should really be seen within six weeks of the intervention in most patients. Clearly, larger studies in this area are needed; however, there is enough data presented here to power a larger, more definitive trial.

Another trial suggesting no evidence for prophylactic doxycycline in shoulder surgery

■ It is a well-established cause for indolent infection throughout shoulder surgery, but what is the answer to *Propionibacterium acnes*? Here at *360*, we recently discussed a single-centre prospective randomized controlled trial from the Rothman Institute that included 74 patients undergoing shoulder arthroscopy, which were randomized to either oral doxycycline or standard care. Whilst acknowledging this study was underpowered, the authors did not recommend routine administration of a one-week preoperative prophylactic course of doxycycline to patients undergoing shoulder arthroscopy. In this trial from **Chicago, Illinois (USA)**, the authors report their own randomized trial of fewer (n=56) patients with primary osteoarthritis, rotator cuff arthropathy, or post-traumatic arthritis for which an anatomic or reverse total shoulder arthroplasty was being undertaken.[4] Patients were randomized on a 1:1 basis to either standard perioperative cefazolin or a combination of doxycycline and cefazolin with the intention that the latter would provide better cover for *P. acnes*. The primary outcome measure was a positive tissue culture from superficial and deep samples obtained during surgery. Initial power analysis showed that 56 patients were needed to determine what the authors define as a clinically significant 50% decrease in positive culture rate (at 80% power). The groups were well matched at baseline and the authors found no difference (37% *vs* 38%) in the rate of at least one positive tissue culture between groups. No adverse events related to the doxycycline were reported. However, the authors did establish that one or more positive cultures was significantly more common in younger patients (65 years of age *vs* 69 years), male patients (76% *vs* 49%), and patients with a lower Charlson Comorbidity Index. The authors acknowledge that their study could in fact be underpowered, but in this otherwise well-performed trial, the authors conclude that they found no benefit of preoperative doxycycline in reducing positive culture rates in patients undergoing shoulder arthroplasty. Although larger studies would clearly be beneficial, one does wonder whether larger studies in high-risk patients could lead to a different result. Furthermore, as the authors of this study have pointed out, doxycycline is bacteriostatic and not bactericidal and thus may have minimal effect, as it works by preventing replication of bacteria rather than killing bacteria. This raises the question as to whether doxycycline is the right antibiotic to be investigating as a potential prophylactic agent for these cases.

Botulinum toxin injection for tennis elbow: is it a reasonable option?

■ It is increasingly well established that corticosteroid injections are not likely to be objectively beneficial in the management of lateral epicondylitis of the elbow, otherwise known as 'tennis elbow', with some literature suggesting that injections are associated with an increased rate of conversion to surgery. Platelet-rich plasma (PRP) has also been advocated, although surgeon opinion remains very much divided on the benefits. However, is there a potential role for Botox? In this phase-3 double-blind placebo-controlled trial from **Bordeaux (France)**, the authors set out to establish if Botox does have a role to play in the management of tennis elbow.[5] They designed and completed a small randomized controlled trial including 60 patients with refractory tennis elbow of at least six months duration, randomly allocated to Botox treatment or placebo. Patients were



randomized on a 1:1 basis to either a 40 IU injection of botulinum toxin A or placebo (saline solution) into the extensor carpi radialis brevis (ECRB) muscle using electromyographic (EMG) stimulation. Patients were assessed at 30 and 90 days, and the primary outcome measure was the percentage of patients whose initial pain level was reduced by > 50% at three months. Initial power analysis determined that 56 patients were needed to detect a clinically significant 50% decrease in pain levels in 50% of patients receiving Botox and < 30% in the placebo group (80% power). The groups were reasonably well matched at baseline. Of the 60 patients enrolled, 57 (95%) were analyzed at the primary outcome point. The authors reported that 15 (51.7%) in the Botox group had a > 50% reduction in initial pain intensity at three months, compared with seven (25%) of the patients in the placebo group ($p = 0.005$). No difference in grip strength was found between the groups, but pain intensity was significantly lower in the Botox group 90 ($p = 0.032$). No adverse effects were found at three months in the Botox group, with 17.2% of patients having clinically detectable temporary paresis of middle finger with no associated functional impairment. The authors conclude that for patients with refractory chronic lateral epicondylar tendinopathy, Botulinum toxin A is an effective treatment. Despite limitations associated with lack of patient-reported outcome measures, short-term outcome only, and the small numbers included, this trial does add to some existing evidence supporting the use of Botox in refractory cases of tennis elbow. Further work in this area is needed.

Long head of biceps tendinopathy: how useful are MRI and arthroscopy to detect pathology?

The long head of biceps is frequently implicated as a pain generator in the shoulder and its management is a longstanding matter for debate in the shoulder community. The mainstay of management when therapy and injections fail is of the tendon itself, where either tenodesis or tenotomy can be performed. Tenodesis is often performed in younger patients, mainly to avoid the resulting cosmetic deformity and discomfort that can result from tenotomy: that of the 'Popeye' sign. A variety of techniques can be employed and the tenodesis can be performed proximally in the bicipital groove or more distally, open, or even arthroscopic. In order to avoid continuing pain, the diseased section of the tendon should be excised and, when deciding on the anatomical level of tenodesis, the available information includes MRI scans and a visual inspection at the time of arthroscopy. It is not uncommon for biceps pathology to be associated with a superior labrum anterior and posterior (SLAP) tear. But are these tests adequately sensitive? This group from **Columbia, Missouri (USA)** have performed an interesting study in order to investigate.[6] A total of 16 patients undergoing a subpectoral biceps tenodesis on the basis of a positive clinical examination and at least three months of symptoms were recruited; a combination of investigations, including postoperative histopathology, are reported here. All patients underwent preoperative MRI and had a close visual assessment of the tendon, both arthroscopically and on open approach. The excised tendon was histologically examined. For descriptive purposes, the tendon was divided into three zones, with the first zone consisting of the intra-articular first 3.5 cm, zone two being the 3 cm in the groove, and zone three being distal to this. MRIs were assessed by a blinded radiologist using a 1.5T shoulder coil. Histopathological examination was performed both for the tendon and its adjacent tenosynovium, and utilized immunohistochemistry techniques as well as microscopic structural staining. The MRIs showed no significant difference in appearance between zones one and three, whereas the histopathological tendinopathy findings and cellular inflammatory markers showed significantly more pathological changes in zone one. The MRI investigations also did not correlate with intraoperative findings, which included non-specific degenerative SLAP tears or mild/moderate biceps tenosynovitis in all cases. Overall, despite significant histopathological findings that were more severe in the proximal and mid-tendon, neither MRI nor intraoperative visualization found significant structural abnormalities within the tendon. In the clinic, we should be aware of the potential false negative findings of MRI with respect to the long head of biceps, and perhaps we should not be falsely reassured by a relatively benign-appearing arthroscopic inspection.

Superior capsular reconstruction: a novel technique to measure the subacromial space

The management of active patients with massive irreparable rotator cuff tears and no glenohumeral joint arthritis is a matter of great debate in the shoulder community, and one to which the surgical and clinical challenge is only matched by the lack of proven techniques. Options include: partial cuff repair, which is somewhat unsatisfactory, with poor long-term outcomes; reverse shoulder arthroplasty, which is hazardous in high-demand patients; tendon transfer procedures; and interposition techniques, including subacromial balloon spacers and superior capsule reconstructions (SCR). The latter are aimed at correcting the proximal migration and restoring the joint fulcrum but are technically very demanding. Furthermore, dependent on the technique and material used, recurrence of superior migration may occur, exposing the patient to the risks of complications of surgery with little long-term benefit. This paper from **Franklin, Wisconsin (USA)** reports their experiences of a clinically and radiologically successful SCR technique at a minimum of one-year follow-up.[7] This cohort series reports 86 patients with an average age of 59 years who underwent SCR for massive irreparable rotator cuff tears. The tears were assessed as irreparable intraoperatively, which is an important point to note, as the definition of this condition is often not clear, and will vary from centre to centre. Acellular dermal allograft was used to effect the capsular reconstruction, which avoids the morbidity of fascia lata autograft harvest. The overall results were good, with significant improvement in visual analogue scale (VAS) and American Shoulder and Elbow Surgeons (ASES) scores at one year. Strength and range of motion also significantly improved, with 90% of patients reporting their satisfaction with the outcome. The subacromial space was also maintained, indicating integrity of the reconstruction. Indeed, the authors describe a new method to assess this humeral position, as the measurement of acromio-humeral height is extremely sensitive to patient positioning and hence has a high risk of inaccuracies. They define the 'superior capsular distance' in their paper as the arc length between the superior glenoid and the medial aspect of the greater tuberosity of the humerus on an anteroposterior radiograph. This is more cumbersome than the simple acromio-humeral height measurement, and it will be interesting to see if its use gains traction in the literature. Regardless, both radiographic measurements demonstrated restoration and maintenance of the subacromial space. This paper shows SCR to be an effective option in experienced hands for this cohort of

patients at short-term follow-up, and is a technique that we suspect will be used with increasing frequency.

Grit-blasting alone a poor choice for short stem proximal humerus implants

Short-stem shoulder replacements are growing in popularity due to the preservation of humeral bone stock, especially in younger patients. As a relatively recent design development, the longer-term follow-up studies are not yet available. Following cohorts of patients is useful to spot problems that either have not or may not appear on joint registry data. This paper from **Heidelberg (Germany)** and **Lyon (France)** reports the mid-term results of a series of 67 shoulders, all performed with a short-stem uncemented total shoulder prosthesis for primary osteoarthritis.[8] A previous paper studying the same cohort at a mean of 2.6 years postoperatively had identified potential problems with adaptive changes seen in the proximal humerus surrounding the stem, such as cortical thinning and osteopenia in the medial calcar segment in over 50% of patients. The clinical results were, however, good at this stage. This new report updates the series of patients, who are now at a mean of 5.6 years follow-up. As before, the clinical results remain good, and certainly comparable to long-stem designs. However, the radiological results are much more worrying, and show 40% of patients developing substantial bone loss in the proximal humerus at between four and seven years of follow-up. The changes therefore remain essentially static from the 2.6 year follow-up with no evidence of frank loosening. Patients with a higher filling ratio of the stem in the metaphyseal had a significantly higher rate of adaptive changes. It is important to note that this first generation of stem was a grit-blasted prosthesis and later designs are utilizing a porous coating. The authors therefore suggest that improved coating of the stem, and the implantation of a stem that does not achieve cortical contact and fills the canal less, should decrease the stress shielding and permit improved radiological outcomes. Medium-term clinical outcomes are satisfactory and longer-term follow-up will reveal if these radiological changes are benign or not. For the time being, the take-home message perhaps should be to treat grit-blasted short stems with caution, as there is clearly a risk here of high rates of secondary failure.

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Spine

Adult spinal deformity surgery: how bad is reoperation?

For most patients, having surgery to relieve the symptoms of adult spinal deformity (ASD) is enough of an undertaking. The impact of adult spinal deformity in terms of quality of life leaves some patients in a poorer position than many patients with chronic medical illness. Furthermore, corrective surgery carries with it a risk of complications reported in the literature at between 20% and 71%. For some unfortunate patients, things can get even more difficult if they are one of the 15% to 20% who need a second operation. The need for reoperation can be due to a complication, or might be from a new problem that rapidly follows the first – either way, it's probably bad news. But how bad is not entirely clear. A group from **Barcelona (Spain)** looked at the impact of second procedures from ASD on the healthcare quality of life (HQoL), and specifically the impact of unplanned reoperation within the first year of adult patients being treated for adult spinal deformity.[1] This study reports a retrospective analysis of 280 patients, most of whom had been diagnosed with idiopathic scoliosis who underwent corrective surgery in one of six European centres in four countries. The authors included any patient aged 18 years or more who underwent ASD corrective surgery with a preoperative Cobb angle $>20°$, thoracic kyphosis $>60°$, or sagittal vertical axis >5 cm with a two-year minimum follow-up. There were 280 patients who met the necessary criteria, with idiopathic scoliosis being the most common diagnosis. Of the initial cohort, 43 patients underwent 46 revision procedures (18%), most commonly due to implant-related complications; 43.5% of these were within the first month and 67% within the first three months following the primary procedure. Patients were more likely to undergo revision surgery if they were older, had a higher American Society of Anesthesiologists (ASA) grade, showed a greater sagittal deformity, or had a worse starting HQoL. At one year, the Oswestry Disability Index (ODI) and the Scoliosis Research Society outcome score (SRS22) were significantly better in the group who did not require revision surgery; however, the overall improvement in HQoL was no different between the two groups at two years. Importantly, the SRS22, ODI, and 36-Item Short-Form Health Survey (SF-36) outcomes improved by the minimal clinically important difference (MCID) only in the non-revision surgery group. In addition, the mental health component of the outcome scores was significantly adversely affected by revision surgery and took longer to recover to preoperative norms. So, are these findings unsurprising? Perhaps. The improvement in HQoL