The Bone & Joint Journal

Journal Club: 28 January 2014
Chairman: Mr H Sandhu
Convener: Mr AJ Stevenson
Royal United Hospital Bath

Presented Papers

Haug LC, Glodny B, Deml C, Lutz M, Attal R. A new radiological method to detect dorsally penetrating screws when using volar locking plates in distal radial fractures. *Bone Joint J* 2013;95-B:1101-5.

Kukkonen J, Juoukainen A, Lehtinen J, Matitila KT, Tuominen EKJ, Kauko T, Aarimaa V. Treatment of non-traumatic rotator cuff tears: a randomised controlled trial with one-year clinical results. *Bone Joint J* 2014;96-B:75-81.

Parker l, Garlick N, McCarthy I, Grechenig S, Grechenig W, Smitham P. Screw Fixation of medial malleolar fractures: a cadaveric biomechanical study challenging the current AO philosophy. *Bone Joint J* 2013;95-B:1662-6.

Hamilton TW, Hutchings L, Alsousou J, et al. The treatment of stable paediatric forearm fractures using a cast that may be removed at home. Comparison with traditional management in a randomised control trial. *Bone Joint J* 2013;95-B:1714–20.

Reviews

Haug LC, Glodny B, Deml C, Lutz M, Attal R. A new radiological method to detect dorsally penetrating screws when using volar locking plates in distal radial fractures. *Bone Joint J* 2013;95-B:1101-5.

Reviewers: Andrew Stevenson, Govind Chauhan, Tim Pearkes

Introduction
Volar locking plates are commonly used to treat fractures of the distal radius. Assessing the true depth of penetration of screws placed through these plates can be difficult due to the bony contours of the dorsal distal radius. This paper examines a fluoroscopic imaging technique used to assess screw penetration of the dorsal cortex, which can result in damage to the extensor

tendons. This study used cadaveric specimens implanted with volar locking plates and measured screw penetration using direct measurement with digital calipers, fluoroscopy and CT.

Methods

Volar locking plates were inserted in six uninjured cadaveric distal radii using a standard volar approach under fluoroscopic guidance. The plates were secured using a cortical screw in the gliding hole and locking screws through distal holes. All screws were matched to the thickness of each radius using direct vision.

The forearms were then positioned vertically, fully supinated and with the wrist fully flexed for imaging. Fluoroscopic images were then taken at 0 degrees angulation (parallel and in line with the radius). The forearm was then extended with imaging at 5 degree intervals up to 45 degrees angulation (measured using a digital goniometer).

All screws were then replaced with screws 2mm longer, and the above process repeated.

The dorsal penetration of the screws was measured using digital callipers, with negative values used for screws still shy of the cortical surface.

All radii were also imaged using CT for both screw lengths and assessed for cortical penetration by both a hand surgeon and a radiologist.

Statistics

Two factors were assessed here:

The apparent length of screw protrusion assessed using the ‘dorsal horizon’ technique of fluoroscopic imaging was compared to the real protrusion lengths measured under direct vision. The correlation was investigated using Spearman's rank correlation coefficient.

The correlation of the angle of inclination of the radii and the real dorsal screw protrusion was analysed using infraclass correlation coefficients (ICC).

Results

The authors found that using this technique, for the +2mm screws, the most accurate positioning for measurement was at 15 degrees. For these, 24 of the 25 screws were detected as being too long, with a mean difference between actual and radiological over-penetration being 0.3mm They also noted that at angles of 20 degrees and greater, the accuracy deteriorated significantly due to the overlapping projection of the carpal bones.

Fluoroscopy was found to be more accurate than CT as CT was unable to accurately measure screw lengths due to a 'blooming effect' causing over-estimation of screw length.

Discussion

Plating of fractures of the distal radius has become a common trauma procedure.

This paper is important due to the frequency of 2% to 6% of irritation or rupture of extensor tendons by penetrating screws.

The method of this cadaveric study is able to clearly demonstrate the extent of screw penetration and relate this to clinical measurement of this using fluoroscopy or CT.

Although this is a cadaveric study with small numbers the conduct of study design is plausible and reproducible.

This paper introduces a technique of imaging the distal radius to assess for protruding screws. The 15 degree axial fluoroscopic view is demonstrated to be an effective way to assess the over penetration of screws used with volar locking plates.

Strengths

1. A standardised reproducible and realistic technique was used for fitting the plates to the radii.

2. An accurate diagrammatic representation of the positioning of the forearm was included in the paper

3. This is a cadaveric study rather than a saw-bone study allowing assessment of the penetration of the screws against the correct density of bone and its subsequent imaging using fluoroscopy and CT is a realistic reproduction of *in vivo* circumstance. Direct visualisation following dissection is also gold standard for assessment of screw penetration, which is not achievable *in vivo*.

4. Appropriate statistical analysis was used.

Weaknesses

1. The study uses cadaveric, uninjured specimens. In clinical, fractured radii the interpretation of screw penetration and its clinical impact may be significantly different, and thus requires further evaluation (acknowledged by the authors).

2. Whilst a 15 degree angulation was accurate to within a mean 0.3 mm at detecting the over penetrating screws, for the screws positioned at 0 mm, the accuracy had a mean of 0.7 mm. This suggests that screws, which are satisfactorily positioned, may actually be measured as protruding beyond the cortex. This is not covered in the paper, and a form of Figure 3b for the 0 mm screws would be especially informative.

3. Only 6 cadaveric forearms were used. To improve the data, a higher number of forearms would be beneficial.

4. Whilst the authors have suggested ways of improving the accuracy of positioning the forearm at 15 degrees, the practicalities of implementing these in theatre (e.g. costs, varying BMI of patients complicating positioning, alignment in fractured radii, etc) have been potentially overlooked.

5. Only the Synthes VA-LCP Two-Column Distal Radius Plate was assessed, and the application to different implants may vary.

6. The authors have not stated how many surgeons took part in the study and therefore we are unable to comment on inter-observer reliability.

Summary
In summary, this was a well-designed study that assesses a technique that will help in the reduction of complications related to this common trauma procedure. The 'dorsal horizon view' is simple to adopt and both raises the awareness of this potential complication, and also provides a method of assessment of dorsal screw over-penetration in the used of volar plating of the distal radius.

Kukkonen J, Juoukainen A, Lehtinen J, Matitila KT, Tuominen EKJ, Kauko T, Aarimaa V.
Treatment of non-traumatic rotator cuff tears: a randomised controlled trial with one-year clinical results. *Bone Joint J* 2014;96-B:75-81.

Reviewers: N Sullivan, OLI Davies

Introduction
Painful rotator cuff tears of non-traumatic aetiology that cause dysfunction are common in 60-80 year olds. Kukkonen et al. aimed to determine the most effective treatment option by comparing outcomes of physiotherapy (group 1) versus acromioplasty and physiotherapy (group 2) versus rotator cuff repair, acromioplasty and physiotherapy (group 3) up to one year post-treatment.

Methods
This was an open, three centre, randomised controlled trial in Finland between October 2007 and December 2012. 271 shoulders met clinical inclusion criteria, however only 180 shoulders (of 173 patients) met the criteria of age > 55; MRI measurement of atraumatic, symptomatic supraspinatus tendon tear as < 75% of tendon insertion; full range of motion at the shoulder and consenting for randomisation to the study group. Of the 99 exclusions: 8 patients were unable to undergo MRI, 28 had tears > 75% of tendon insertion, 47 had no tear, 2 had spontaneous resolution of symptoms and 14 declined to be included in the study. Patients were allowed to have cuff repair if their allocated treatment failed to relieve symptoms by 6 months.

The 180 shoulders were randomised by sealed envelope to one of the three groups –60 shoulders to each. The Constant score for shoulder pain and function recorded by an independent, unblinded nurse was the primary outcome measure. Scores were recorded for

each shoulder at one month prior to intervention, at three months, six months and one-year post intervention. At one year 167 shoulders remained for assessment (93%).

Statistics
ANOVA was used to compare the 3 groups by intention to treat. The study was powered to produce statistical significance if each group contained at least 51 patients; allowing a dropout rate of 23.75% per group. P <0.05 were considered statistically significant.

Results
Mean pre-treatment Constant scores were 57.1 (group 1), 59.6 (group 2) and 58.1 (group 3). At one year the mean Constant scores were reported as 74.1, 77.2 and 77.9, respectively, with no significant difference (p = 0.34). Subset analysis of the Constant score did reveal a statistically significant (but not clinically significant) difference in reported pain and activities of daily living between the groups. There was no significant difference between strength or range of movement at 1 year. Patient satisfaction was 87%, 96% and 95%, respectively – this was not statistically significant. Mean cost of treatment in group one (physio alone) was €4765 compared to €5461 in group 3

Discussion
Strengths:

- Multi-centre trial
- Randomised, prospective trial
- Statistical analysis powered for determining significant difference between treatment groups
- Shoulders between groups well matched (size of tear, age, gender, pre-intervention Constant score)
- Low drop-out rate (7.2% overall)
- Recording of Constant score carried out by single, independent observer thus minimising inter-observer error

Weaknesses:

- No true control – all groups had an intervention and there is no good evidence for physiotherapy making significant difference to rotator cuff tears
- Trial not blinded – potential for placebo effect of surgery for patients in group 2 and 3
- Nurse assessor not blinded
- Large spread in ages within group
- Constant score only has one section on pain
- Short follow-up period of only one year
- Data for analgesia usage between different groups not recorded – could this influence difference in pain between groups

Conclusions
This randomised controlled (but open) trial provides strong evidence for managing patients with non-traumatic rotator cuff tears conservatively in the first instance as surgical repair of these tears provides no additional benefit to shoulder pain/function when measured with the Constant shoulder score. This study also highlights the cost-effectiveness of non-operative management. It would be of interest to evaluate how these patients symptoms evolve over a

longer follow-up period – compared to at 6 months patients in group 1 and 2's constant score had relatively plateaued however group 3 shoulders (surgically repaired) was still demonstrating improvement in their constant score. The authors suggest this may be due to the initial period of post-operative immobilisation however only a longer follow-up period will be an able to definitively verify this.

Parker l, Garlick N, McCarthy I, Grechenig S, Grechenig W, Smitham P. Screw Fixation of medial malleolar fractures: a cadaveric biomechanical study challenging the current AO philosophy. *Bone Joint J* 2013;95-B:1662-6.

Reviewers: Sabina Barbur, Richard Barksfield

Introduction

- Traditional fixation of the medial malleous recommended by the AO council involves using two 4.0 mm parallel partially threaded cancellous screws, augmented by a washer in osteoporotic bone
- Tightening of a screw is limited by a maximum torque - Tightening beyond 89% results in micro-fracturing of the bone trabeculae and significantly reduces the axial compression at the fracture site
- Experience indicates that over-tightening of partially threaded screws are more prone to loss of purchase

Aim

- To establish whether superior grip may be achieved within the physeal scar of the distal tibia where bone is more dense
- To establish which screw types would be best to achieve maximum compression

Methods

- Original study as no previous studies examining specific forces over fracture sites nor utilising physeal dense bone (recognised by the authors). There is a previous study investigating screw pull out forces based upon screw length and design published in 2012, which is obviously a surrogate measure of the ability to compress.

Ethics

- No mention of ethics – not required for cadaveric bone

Study Type / Level of Evidence

- Not stated in text. We consider this to be a prospective in vitro study: Level IIIc.

Study Design

The study was conducted at a single centre in Austria

Experimental subgroups were created to test 4 types of screw application

- A: 4.0 x 45 x 15mm partially threaded cancellous screw
- B: 4.0 x 45mm fully threaded cancellous screw

- C: 4.0 x 45mm fully threaded cancellous screw with a 4.0 mm glide hole
- D: 4.0 x 30 x 15mm partially threaded cancellous screw

- 21 randomised unpaired lower limb adult cadavers selected (no history of injury or disease pre death)
- Limbs preserved in Thiel (to prevent stiffness of ligaments and joint)
- Mean age: 71 years, M: F 1:1
- The deltoid ligament was detached from all medial malleoli
- Each ankle was marked with a typical fracture line at the level of the distal tibial plafond and a 2.5 mm hole was predrilled with an AO drill bit perpendicular to the plane of the fracture to optimise compression
- The fracture was created using a 25 mm wide oscillating saw blade
- A Tekscan pressure transducer (kg/cm2) was inserted into the fracture site
- To maximise the surface area available for pressure readings one screw was used at a time to close fracture site
- Fractures were held with reduction clamps and the transducer was turned on post screw insertion to minimise pressure exerted by investigator
- Mean pressure over 20 seconds was recorded

Compression was tested using two paired experimental groups

Groups A & B (n = 13)

- Ankle 1: 2 separate readings from two separate screws with washers - 1x 45mm partially threaded screw, 1x 45 mm fully threaded screw
- Repeated 13 times

Groups C (n = 8)
- Examined effect of over drilling the near fragment
- 45 mm fully threaded screw
- Repeated 8 times

Group D (n = 8)
- 30 mm partially threaded screw with washer

- In order to correlate trajectory and positioning during experimentation a mini c-arm was used.
- Image intensifier confirmed that all partially threaded 45mm screws passed the physeal scar line and threads of the fully threaded or short partially threaded screw fell within the scar line

Statistical Analysis
- Shapiro-Wilko test for normality confirmed results were not normally distributed
- The non-parametric Wilcoxon's signed rank test was used to compare the paired measurements

- A Mann-Whitney U test compared the unpaired measurements

Results

- Median compression over 20 seconds was significantly greater (p=0.001) in fractures treated with fully threaded 45mm screws. Group A: 0.6kg/cm2, Group B: 1.0kg/cm2

- Utilising the over drilling lag effect significantly reduced (p=0.002) the overall compression using a 45mm fully threaded screw. Group C: 0.25kg/cm2, Group B: 1.0kg/cm2

- Short 30mm partially threaded screws with a washer had a significantly greater compression to long partially threaded screws. Group D: 0.95kg/cm2, Group A: 0. 6kg/cm2

- There was no significant difference (p=0.56) between Group B and D

Discussion

- AO foundation advises fixation with two partially threaded screws and use of a washer is recommended in osteoporotic bone
- Physeal scar line offers best purchase
- Study illustrates a statistically greater compression utilising long fully threaded screws allowing threads to take purchase in the physeal scar line
- No advantage to place screw past physeal line

Strengths

- This is a biomechanical simulation of medial malleolar fixation using different fixation methods.
- The study is immediately applicable to the practice of orthopaedic surgeons involved in managing general trauma and evaluates currently employed fixation methods.
- The authors have made efforts to control for potential differences in bone density by performing two fixation methods on each ankle and comparing pressure measurements directly
- The use of cadaveric samples has significant benefits over the use of sawbones in terms of interpreting results due to the geographical trabecular arrangement of the ankle, which is not replicated in sawbone models
- The statistical methods used are well recognized and properly applied to the data assessed.
- The paper gives a clear message, suggesting that fully threaded cancellous screws be used in place of long partially threaded cancellous screws

Weaknesses

- No power calculation performed prior to study to assess how many test ankles would be required, though the study was clearly adequately powered to demonstrate the differences outline above.
- Only ankles 1-5 had a DEXA scan performed on them to examine their relative bone densities and to ensure a degree of uniformity. Where a paired evaluation is

undertaken, e.g. Group A *versus* Group B, this is not such a problem as a discernable difference is adjusted for in the experimental model. When comparing unpaired groups that used different ankles, e.g. Group B and Group D, this is more of an issue as the relative similarity in compressive pressures between groups may well be influenced by differences in the mean group bone density and not the type of fixation method employed. If all ankles had undergone DEXA scanning and the bone densities of all groups shown to be the same then it would be safer to accept the results presented.

- Previous studies have used maximum torque measurements to failure of different screw types in medial malleolar fixation. It is not inconceivable that unless the tightening of screws is standardised then we are only measuring the "clinician's faith" in the screw fixation rather than the true compressive ability of the construct.
- Screw positioning – not clear the exact location and trajectory of the screws drilled, but perhaps the screw position in the sagittal plane will effect the achievable compressive forces.

Summary
This cadaveric biomechanical study has demonstrated that fully threaded cancellous screws should be considered in the management of medial malleolar fractures and has challenged current AO management principles on this issue.

Hamilton TW, Hutchings L, Alsousou J, et al. The treatment of stable paediatric forearm fractures using a cast that may be removed at home. Comparison with traditional management in a randomised control trial. *Bone Joint J* 2013;95-B:1714–20.

Reviewers: L Beddard, S Bennet, V Sharma

Introduction
The majority of stable paediatric forearm fractures are managed with a cast requiring removal in hospital. This method is used for these injuries in our unit. A Cochrane review in 2008 investigated the use of home-removable splintage and found evidence to support their use. This included 827 children in ten randomised or quasi randomised trials. However they suggested further trials should be carried out to assess the best type of support.
The purpose of this study is to show that treatment in a removable cast is equal to traditional treatment. The hypothesis is that this method of treatment will have no worse functional outcome a week after removal of the cast.

Methods
Although the study is not entirely original work, it adds to the small amount of data that is available.
This was a randomised controlled trial featuring 317 children at the randomisation stage. Data was collected over a 34-month period.
Participants were recruited from trauma clinic at a UK regional trauma centre. They were included if they were between the ages of two and 16 years, presented within 72 hours of injury and were accompanied by a responsible adult. Stable fractures of the distal radius and ulna, with minimal angulation, including those involving the growth plate were included.

There were numerous clear exclusion criteria. A large number of children were not included due to administrative reasons, such as no researcher available (n = 175) or no information sheet (n = 122). In total 398 children were excluded, which is a significant proportion of the patients that were assessed for eligibility (926). There was shown to be no significant difference between the demographics of children who were included and those who were not.
The randomisation procedure is clear, with the use of sequentially numbered envelopes containing a computer-generated random allocation sequence. There does not appear to be any selection bias or performance bias.
The primary outcome measure was the change in childhood health assessment questionnaire (CHAQ) from the week prior to injury and the week after cast removal. Other outcomes were the change in each domain of the CHAQ score, the change in EuroQol 5-Dimensions (EQ-5D) score one week after cast removal, the absolute CHAQ domain scores and EQ-5D scores six months after injury, user satisfaction and cost-effectiveness. The CHAQ score has been validated in the assessment of juvenile idiopathic arthritis and dermatomyositis.
Assessment could not be blinded, although an independent reviewer, who was blinded, carried out the statistics.
Follow-up was by postal questionnaires, and also telephone.

Results
The results have shown no significant difference in any of the outcome measures. There was no significant difference in satisfaction between the two groups. Economically the removable casts were superior to traditional casting, overall saving over £100 per child, even when the increased cost of the cast itself were considered.

Discussion
Strengths:

- The sample size of 317 is reasonably large, and greater than the calculated recruitment target of 300, once a power of 80% and p-value of 0.05 were set, and allowing for a 20% loss to follow up
- 317 is a large addition to the current knowledge, which is based on 827 patients
- Methodology is clear, with a good randomisation procedure and no bias
- Patients were followed up to six months
- This has confirmed that there may be a new method of treating these fractures, which is safe and approved by parents

Limitations:
The authors recognise the limitations to the study:

- High rate of loss to follow up
- Sample size determined by CHAQ score one week after cast removal
- CHAQ scores can vary with age

Other limitations

- A high number of children were excluded prior to randomisation, therefore extrapolation of the data to involve these groups may not be possible
- The methods of follow-up (questionnaire or telephone) may contribute to poor numbers involved in follow-up

Conclusion
The conclusions drawn from this research are that there is no disadvantage from treating these

fractures in a flexible removable cast that can be removed at home.
We conclude that this is a well designed RCT, which has added to the already available body of knowledge. It has both good internal and external validity.