Operative Treatment of Dislocated Midshaft Clavicle Fractures: Plate or Intramedullary Pin Fixation? A Randomized Controlled Trial

Olivier A. van der Meijden, MD[1]; R. Marijn Houwert, MD, PhD[1]; Martijn Hulsmans[1];
***Frans-Jasper G. Wijdicks, PhD**[1]; Marcel G.W. Dijkgraaf, PhD[2];*
Sven A.G. Meylaerts, MD, PhD[3]; Eric R. Hammacher, MD, PhD[4];
Michiel H.J. Verhofstad, MD, PhD[5,6]; Egbert J.M.M. Verleisdonk, MD, PhD[1];
[1]Department of Surgery, Diakonessenhuis, Utrecht, The Netherlands;
[2]Clinical Research Unit, Academic Medical Center, Amsterdam, The Netherlands;
[3]Department of Surgery, Medical Center Haaglanden, The Hague, The Netherlands;
[4]Department of Surgery, St. Antonius Hospital, Nieuwegein, The Netherlands;
[5]Department of Surgery, St. Elisabeth Hospital, Tilburg, The Netherlands;
[6]Department of Surgery, Erasmus Medical Center, Rotterdam, The Netherlands

Purpose: Over the past decades there has been a paradigm shift toward more aggressive treatment of dislocated midshaft clavicle fractures (DMCF). Open reduction and internal plate fixation and intramedullary (IM) nailing are the most commonly used operative techniques. The aim of this study was to compare short and midterm results of plate fixation and IM nailing for DMCF.

Methods: A multicenter randomized controlled trial was performed in four different hospitals. A total of 120 patients, age 18-65 years, were included and treated with either plate fixation (n = 58) or IM nailing (n = 62). Pre- and postoperative shoulder function scores and complications were documented up until 1 year postoperatively. Statistical significance was set at $P < 0.05$.

Results: There were no significant differences noted between the two surgical interventions for both the Disabilities of the Arm, Shoulder and Hand (DASH) and Constant-Murley score at 6 months postoperatively (3.0 and 99.2 for the plate group and 5.6 and 95.5 for the IM group). The area under the curve for the DASH score for the time period between 6 weeks and 6 months did differ significantly in favor of the plate group ($P = 0.02$). There was only one recorded nonunion, which occurred in the plate group, and there were 2 implant failures in the IM group. The cumulative number of complications was high and mainly implant-related. However, 1 year after surgery only 3% of patients in the plate group and 6% in the IM fixation group still experienced implant related irritation.

Conclusion: Patients in the plate group recovered faster than the patients in the IM group, but groups were similar at final follow-up. The rate of major complications was low yet implant-related complications occurred frequently and could often be treated by implant removal.

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Reconstruction Plate Compared with Flexible Intramedullary Nailing for Midshaft Clavicular Fractures: A Prospective, Randomized Clinical Trial

Fernando Brandao, MD*; Kodi E. Kojima, MD; Jorge dos Santos Silva, MD; Rames Mattar Jr, MD;*
Department of Orthopedics and Traumatology, University of Sao Paulo, Sao Paulo, Brazil

Purpose: Previous studies have shown good clinical results in patients with midshaft clavicular fractures treated with reconstruction plate fixation or elastic stable intramedullary nailing (ESIN). The objective of this study was to compare these methods in terms of functional results, radiographic parameters, postoperative pain, satisfaction rates, and complication rates. We hypothesized that there would be no difference between the treatment groups in terms of functional results.

Methods: This is a single-center, prospective, randomized controlled trial, with IRB approval. 59 patients between 16 and 65 years of age with a displaced midshaft clavicular fracture were randomly assigned to receive either reconstruction plate or ESIN fixation. The primary outcome was the Disabilities of the Arm, Shoulder and Hand (DASH) score at 6 months The secondary outcomes were the following: DASH score at 12 months, Constant-Murley scores at 6 and 12 months, radiographic parameters (time to union and residual shortening), visual analog scale (VAS) for pain on the first postoperative day, patient satisfaction rate, and complication rates, divided into minor and major complications.

Results: 29 patients in the plate group and 25 in the ESIN group completed the follow-up. The mean DASH score at 6 months was 9.9 in the plate group and 8.5 in the ESIN group ($P = 0.329$). Similarly, there were no differences in the DASH score at 12 months and the Constant scores at 6 and 12 months. The mean time to union was 16.8 weeks in the plate group and 15.9 weeks in the ESIN group ($P = 0.352$), whereas the residual shortening was significantly greater in the plate group ($P = 0.032$) but was not clinically relevant (0.4 cm). The VAS scores for pain and patient satisfaction rate were similar between the groups. Regarding minor complications, the rate of implant bending was significantly greater in the plate group (11 patients) than in the ESIN group (1 patient) ($P = 0.003$), whereas the rate of hardware-related pain was greater in the ESIN group (10 patients) than in the plate group (4 patients) ($P = 0.035$). There were similar rates of major complications in both groups, with one case of nonunion in the ESIN group, and no cases in the plate group ($P = 0.463$).

Conclusion: Reconstruction plates and ESIN yielded similar functional results, time to union, postoperative pain, and patient satisfaction rates in patients with displaced midshaft clavicular fractures. Reconstruction plates were more susceptible to implant bending, whereas ESIN caused more hardware-related pain. Both methods were safe in terms of major complications.

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Does Insurance Status Affect the Management of Acute Clavicle Fractures?

Ryan Bliss, MD; Arthur M. Mora, MHA; ***Peter C. Krause, MD****;*
Louisiana State University Health Science Center, New Orleans, Louisiana, USA

Purpose: Acute clavicle fractures are a very common orthopaedic problem, representing 2.6% of all fractures. The management has evolved over the past decade with a trend from nonoperative to operative management. However, there is still much debate in the orthopaedic community. The purpose of this study is to evaluate whether insurance is an unrecognized factor that plays a role in a surgeon's decision-making. We hypothesize that orthopaedic surgeons are more likely to operate on clavicle fractures in an insured population, rather than an uninsured or underinsured population.

Methods: A retrospective, cross sectional analysis was performed using the Healthcare Cost and Utilization Project (HCUP) data for Florida in the year 2010. Discharge level data from emergency departments and ambulatory surgery settings were used to identify clavicle fractures by ICD-9 codes 81000, 81002, and 81003. Internal fixation was identified using the CPT code 23515. Clavicle fractures that did not result in a CPT code of 23515 were assumed to have been managed nonoperatively. Multivariate logistic regression, allowing for intragroup correlation among surgeons, was utilized to determine the influence of payer source on treatment modality adjusting for race, age, number of chronic conditions, and gender.

Results: In total there were 9734 clavicle fractures and 1129 instances of internal fixation. Observations were removed from the analysis if there were missing personal demographic data or if the ability to track patients from the emergency department to follow-up care was not possible. Therefore, the final sample consisted of 7633 clavicle fractures of which 976 received internal fixation (12.8%). The odds of a patient with private insurance receiving internal fixation was 3.83 times (95% confidence interval [CI] = 3.02-4.85, $P < 0.001$) greater than a self-pay patient, all else being held constant. Patients defined by "other" sources of coverage that includes Workers Compensation, CHAMPUS (military), CHAMPUSVA (veterans), or other government insurance other than Medicare and Medicaid were 2.85 (95% CI = 1.99-4.09, $P < 0.001$) times more likely to have surgery relative to self-pay patients, all else being held constant. The likelihood of patients with Medicare (95% CI = .54-1.16, $P = 0.23$) or Medicaid (95% CI = .91-1.78, $P = 0.16$) having surgery did not differ significantly from self-pay patients.

Conclusion: Patients with any form of payment versus the self-pay, Medicare, and Medicaid populations have a higher likelihood of operative intervention. As there continues to be debate about management of clavicle fractures, this study suggests that an underlying decision in operative management of acute clavicle fractures may be payer source or the patient's ability to pay. Future areas of inquiry could examine why insurance has this effect and whether insurance status plays a role in surgical decision-making in other orthopaedic injuries and diseases.

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Long-Term Outcome of Isolated Stable Radial Head Fractures

***Andrew D. Duckworth**; Neil R. Wickramasinghe, MBBS; Nicholas D. Clement, MRCS Ed; Charles M. Court-Brown, MD; Margaret M. McQueen, MD;*
Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh, Edinburgh, United Kingdom

Purpose: There is evidence to support the primary nonoperative management of isolated stable fractures of the radial head (Mason type 1 and type 2 fractures). However, the long-term outcome of these fractures remains unclear. The aim of this study was to report the long-term outcome of stable isolated fractures of the radial head following primary nonoperative management.

Methods: We identified from a prospective proximal radial fracture database all patients who sustained a stable isolated Mason type 1 or type 2 fracture of the radial head or neck over an 18-month period. Inclusion criteria included all confirmed isolated stable fractures of the proximal radius that were primarily managed nonoperatively. Demographic data, fracture classification, management, complications, and subsequent surgeries were recorded. The primary long-term outcome measure was the Disabilities of the Arm, Shoulder and Hand (DASH) score.

Results: There were 100 patients in the study cohort with a mean age of 46 years (range, 17-79). A fall from standing height accounted for 69% of all injuries, with one or more comorbidities documented in 35 (35%) patients. There were 57 (57%) patients with a Mason type 1 fracture and 43 (43%) with a Mason type 2. At a mean of 10 years (range, 8.8-10.2) post injury, the mean DASH score was 5.8 (range, 0-67.2) and the mean Oxford Elbow Score was 46 (range, 14-48). Patient satisfaction was 92% with a median satisfaction score of 10 (range, 3-10). 14 (14%) patients reported stiffness and 24 (24%) some degree of pain. Two (2%) patients underwent subsequent surgery for persistent symptoms associated with the original fracture. The median time to return to work was 2 weeks (range, 0-36; n = 73), with a median time to return to sports of 6 weeks (range, 1-24; n = 72). An increased (worse) DASH score was found in older patients ($P = 0.002$), patients with one or more comorbidities ($P = 0.008$), increasing deprivation ($P = 0.026$), increasing fracture displacement ($P = 0.041$), and those patients who pursued compensation in relation to their injury ($P = 0.006$). Further analysis of deprivation adjusting for age, gender, and fracture classification demonstrated that patients in the most deprived quintile had a mean DASH score 13.3 points higher than the least deprived. There was a trend toward a significantly worse DASH for fractures displaced 4 mm or more (5.2 vs. 13.7, $P = 0.07$).

Conclusion: To our knowledge, this is the largest series in the literature documenting the long-term outcome of patients treated with primary nonoperative intervention for an isolated stable fracture of the radial head. Our data would suggest that the conservative management of these injuries is a reliable treatment option, yielding an excellent or good long-term result in the majority of cases. Despite a small number of patients reporting persistent pain and stiffness, patient satisfaction is high, the need for secondary intervention is negligible, and patients routinely return early to work and sports.

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Radial Head Replacement for Complex Unstable Fractures of the Radial Head

***Andrew D. Duckworth**; Neil R. Wickramasinghe, MBBS; Nicholas D. Clement, MRCS Ed; Charles M. Court-Brown, MD; Margaret M. McQueen, MD;*
Edinburgh Orthopaedic Trauma Unit, Royal Infirmary of Edinburgh, Edinburgh, United Kingdom

Purpose: The optimal treatment for unstable radial head fractures needs to balance the risks of radial head excision (eg, instability), the potential complications of open reduction and internal fixation (ORIF) (eg, nonunion), and the possible complications associated with a radial head prosthesis. It is acknowledged that further data are needed to document the longer-term outcome for radial head replacement, in particular the rate and risk factors associated with further surgery for removal and/or revision. The aim of our study was to determine (1) the frequency of revision or removal following radial head replacement (primary outcome) for acute complex unstable radial head fractures, (2) the risk factors for prosthesis revision or removal, and (3) the functional outcome (secondary outcomes) after radial head replacement.

Methods: We identified from our prospective trauma database 119 patients over a 15-year period who were managed acutely for an unstable complex fracture of the radial head with primary radial head replacement. Demographic data, fracture classification, management, complications, subsequent surgerie,s and range of movement at final follow-up were recorded following retrospective clinical record review. The primary outcome measure was failure of the radial head replacement, defined by revision of removal of the prosthesis for any cause.

Results: There were 105 (88%) patients in the study cohort with a mean age of 50 years (range, 16-93) and 54% (n = 57) were female. There were 95 (90%) radial head fractures and 96% were a Mason type 3 or 4 injury. There were 98 associated injuries in 70 patients (67%). All implants were uncemented monopolar prostheses, with 86% metallic and 14% silastic. At a mean of 1.1 years (range, 0.3-5.5 years) after surgery, the mean Broberg and Morrey score was 80 (range, 40-99). The mean elbow flexion arc was 112° (range, 10°-140°; SD, 25°), and the mean forearm rotation arc was 156° (range, 0°-180°; SD, 38°). At a mean of 6.7 years following injury (range, 1.8-17.8) 29 (28%) patients had undergone revision (n = 3) or removal (n = 26) of the prosthesis. Independent risk factors of prosthesis removal or revision were silastic implant type ($P = 0.004$) and younger age ($P = 0.002$).

Conclusions: This is the largest series in the literature documenting the outcome following acute radial head replacement for complex unstable fractures of the radial head. We have demonstrated a high rate of removal or revision following radial head replacement, with lower age and silastic implants independent risk factors. Younger patients should be counseled regarding the increased risk of requiring further surgery following radial head replacement. Future work should focus on the long-term patient-reported outcome following these injuries.

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Early Mobilization Versus Plaster Immobilization of Simple Elbow Dislocations: Results of the FuncSiE Multicenter Randomized Clinical Trial

Gijs I.T. Iordens, MD[1]; Esther M.M. Van Lieshout, PhD[1]; Niels W.L. Schep[2]; Jeroen De Haan[3]; Wim E. Tuinebreijer, MD, PhD, MSc, MA[1]; Ed F. Van Beeck[4]; Peter Patka, MD, Dmed, PhD[5]; Michael H.J. Verhofstad[1]; ***Dennis Den Hartog, PhD[1]****; (on behalf of FuncSiE trial investigators)*
[1]Trauma Research Unit, Department of Surgery, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands;
[2]Trauma Unit, Department of Surgery, Academic Medical Center, Amsterdam, The Netherlands;
[3]Department of Surgery, Westfriesgasthuis, Hoorn, The Netherlands;
[4]Department of Public Health, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands;
[5]Department of Emergency Medicine, Erasmus MC, University Medical Center Rotterdam, Rotterdam, The Netherlands

Purpose: Simple elbow dislocations are traditionally immobilized in plaster following closed reduction. Theoretically, early mobilization may enhance functional outcome, but its relative merit is unknown. The aim of this study was to compare the outcomes of early mobilization and plaster immobilization in patients with a simple elbow dislocation.

Methods: This was a multicenter randomized controlled trial in patients aged 18 years or older with a simple elbow dislocation. Patients were randomized to early mobilization (immediate motion exercises) or 3 weeks plaster immobilization. Patients were followed for 1 year. Outcome measures included the *Quick*DASH, an abbreviated version of the Disabilities of the Arm, Shoulder, and Hand (DASH; primary), Oxford Elbow Score (OES), pain (Visual Analog Scale [VAS]), range of motion (ROM), and activity resumption.

Results: Between August 2009 and September 2012, 48 patients were assigned to early mobilization and 52 to plaster immobilization. At 6-week follow-up, patients in the early mobilization group reported significantly better scores for the *Quick*DASH (mean 12 vs. 19 after plaster immobilization) and the OES function subdomain (86 vs. 73); at that time, they also had a larger arc of ROM of flexion and extension (121 vs. 102). Patients returned to work sooner after early mobilization (10 vs. 18 days). At 1 week, patients in the plaster group reported less pain (mean VAS 2.2 vs. 3.2). Complications occurred in 12 patients; this appeared unrelated to treatment.

Conclusion: Early active mobilization is a safe and effective method of treatment in simple elbow dislocations. It resulted in faster recovery of elbow function and did not lead to recurrent dislocation.

See pages 99 - 147 for financial disclosure information.

Manipulation Under Anesthesia as a Treatment of Posttraumatic Elbow Stiffness

Daniel H. Doty, MD*; Clay A. Spitler, MD; Peter J. Nowotarski, MD; D. Marshall Jemison, MD; University of Tennessee College of Medicine Chattanooga, Chattanooga, Tennessee, USA*

Purpose: Loss of motion is common after traumatic injury to the elbow. There are limited data on the use of forcible passive stretching under anesthesia to improve motion in the posttraumatic elbow. Some authors suggest forcible manipulation may cause a higher rate of complications including ectopic bone formation, ulnar neuritis, and arthrofibrosis. This study is a review of forcible manipulation under anesthesia for patients with posttraumatic elbow stiffness. We hypothesize that manipulation under anesthesia for the treatment of posttraumatic elbow stiffness will significantly increase elbow flexion and extension arc without a high rate of complications.

Methods: A retrospective chart and radiographic review was performed of patients at a single institution who underwent isolated elbow manipulation under anesthesia in treatment of posttraumatic elbow stiffness from 2002 to 2011. The review included an analysis of patient demographics, initial injury data, timing of injury to manipulation, range of motion, previous nonoperative therapy, fracture union at time of manipulation, rate of complications, and additional reoperations. Manipulation was recommended in patients who failed to see adequate improvement in range of motion after elbow trauma. Manipulation involves cautious, but firm, alternating forcible flexion and extension, minimizing the length of the lever arm over which the force is applied.

Results: 46 patients were included in the review, with an average follow-up of 583 days (range, 76-1623). There were 20 open fractures (43.5%), 8 of which required soft-tissue coverage. Average premanipulation flexion arc was 56.6° and improved significantly at final follow-up to an average flexion arc of 83.7° ($P < 0.001$). Five patients developed clinically significant heterotopic ossification, two patients later required cubital tunnel decompression, and 13 patients underwent additional procedures to treat arthrofibrosis. There was no reported loss of fixation. The only acute complication of manipulation was minor tearing of a skin graft in one patient. Post hoc analysis of data identified two distinct subgroups: patients manipulated within 3 months of their final elbow surgery (G_1) and patients manipulated after 3 months of their final elbow surgery (G_2). G_1 had an average improvement in flexion arc of 38.3°; G_2 had an average improvement of 3.1°. This increase in range of motion from pre-manipulation to final follow-up was a significant improvement for G_1 ($P < 0.001$), but not for G_2. The difference in improvement between G_1 and G_2 was statistically significant in favor of the early manipulation group ($P < 0.001$).

Conclusion: Elbow manipulation under anesthesia within 3 months of final elbow surgery is an effective means of improving flexion arc for patients with posttraumatic elbow stiffness. Elbow manipulation after 3 months does not appear to be effective at improving flexion arc.

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Galeazzi Fractures: Are Distal Radioulnar Joint (DRUJ) Injuries Predicted by Current Guidelines?

Paul Tornetta, III, MD; ***Tony Tsismenakis, MD;***
Boston University Medical Center, Boston, Massachusetts, USA

Background/Purpose: DRUJ injuries occur with isolated radial shaft fractures. Several methods have been proposed for their diagnosis on injury films. Based on biomechanical studies, radial shortening at the wrist of >5mm (positive ulnar variance of >5 mm) is predictive of DRUJ instability. Other authors have used fractures within 7.5 cm of the wrist joint as predictive. However, neither of these guidelines has ever been subjected to an evaluation against actual DRUJ injury in a larger data set, nor has the presence of an ulnar styloid fracture been assessed. The purpose of this study is to evaluate the literature-based predictors of DRUJ injury, as well as the presence of ulnar styloid fracture, against the actual operative findings of DRUJ instability.

Methods: All patients with isolated radial shaft fractures with complete radiographs were evaluated over a 10-year period at one Level I trauma center. Demographic, medical records, and radiographic data were tabulated. Radiographs were evaluated for fracture location, radial shortening at the wrist, DRUJ translation, radial angulation, and presence of ulnar styloid fracture. The gold standard of diagnosis of DRUJ instability was any intervention (casting in supination, pinning, direct repair, etc) for DRUJ instability after radial fixation in the operating room or late instability. All patients were specifically evaluated for instability after fixation by the attending orthopaedic surgeon.

Results: 66 patients (51 male, 15 female) with an average age of 34 years (range, 18-90) with 28 right and 38 left radial shaft fractures were included. Mechanism of injury was motor vehicle or fall in 45. By thirds, there were 10 proximal (15%), 27 middle (41%), and 29 distal (44%) fractures. 13 (20%) had an associated ulnar styloid fracture. There were 7 (11%) patients with DRUJ instability after radial fixation. Radial shortening averaged 4.43 ± 5.2 mm (range, –2.6 to 22) and 21 were >5 mm. 26 (39%) of fractures were within 7.5 cm of the wrist joint. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of these findings are in Table 1. Even greater shortening did not predict instability with only 3/7 patients with >10 mm shortening having a true injury. However, 4/7 cases with instability had ulnar styloid fractures ($P = 0.02$). In 7 cases, the final radiology report indicated DRUJ "dislocation" rather than other descriptions such as "injury" or "subluxation." Only 2/7 (29%) were actually unstable.

Table 1. Predictors of Instability

Predictor	Sensitivity	Specificity	PPV	NPV
>5 mm radial shortening	86%	67%	27%	97%
Fracture <7.5 mm from wrist	57%	63%	15%	93%
Ulnar styloid fracture	50%	84%	31%	92%

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Conclusion: We evaluated a large series of isolated radial shaft fractures to determine the relative importance of previously reported guidelines, as well as the presence of an ulnar styloid fracture, for the diagnosis of DRUJ instability. We found that using radial shortening >5 mm or fractures within 7.5 cm of the wrist had 86% and 57% sensitivity, and only 67% and 63% specificity, respectively. Even cases with >10 mm shortening had only a 43% incidence of injury. The presence of an ulnar styloid fracture had specificity, PPV, and NPV similar to or better than previously published guidelines. In conclusion, using a larger data set than has historically been evaluated, we found that previously reported guidelines for DRUJ injury are only moderately accurate and lack specificity, and that the presence of an ulnar styloid fracture can be helpful. Surgeons should be aware of these associations but rely primarily on intraoperative assessment of the DRUJ after radial fixation to determine treatment.

Modern Treatment of 3 and 4-Part Proximal Humerus Fractures: ORIF Demonstrates Better Range of Shoulder Motion Than Reverse Total Shoulder Arthroplasty

Kenneth A. Egol, MD*; Christina Capriccioso, BSE; Thomas Wright, MD;*
Pierre Henri Flurin, MD; Joseph D. Zuckerman, MD;
NYU Hospital for Joint Diseases, New York, New York, USA

Purpose: This study investigates clinical outcomes of patients who sustained 3- or 4-part proximal humerus fractures (PHFs) treated with open reduction and internal fixation (ORIF) or reverse total shoulder arthroplasty (rTSA).

Methods: 102 patients who sustained 103 3- or 4-part PHFs were identified from a prospective database of PHF patients treated with ORIF by one of 3 fellowship-trained fracture surgeons. These patients were compared to 43 patients who underwent rTSA for a 3- or 4-part PHF by a fellowship-trained shoulder surgeon experienced in the technique. Clinical outcomes were assessed via chart review. Functional outcome scores for the ORIF cohort were assessed via the Disabilities of the Arm, Shoulder and Hand (DASH) survey and a generated American Shoulder and Elbow Surgeons (ASES) score. Functional outcomes for the rTSA group were assessed via the Simple Shoulder Test (SST), UCLA Shoulder Rating Scale, Constant Shoulder Score, and ASES Shoulder Survey. All patients had minimum 1-year follow-up.

Results: The ORIF and rTSA study groups were similar except for age and body mass index (BMI). Patients in the rTSA cohort were older and thinner with an average age of 75.7 years and BMI of 26.7 kg/m^2, compared to 62.8 years and average BMI of 29.4 in the ORIF cohort ($P < 0.001$, $P = 0.004$). Shoulder range of motion in patients who were treated with ORIF had an average active forward elevation of 130.8°, compared to 124.6° in the rTSA cohort ($P = 0.273$) and active external rotation of 44.2°, compared with 31.2° in the rTSA cohort ($P = 0.001$). At latest follow-up, no functional difference was seen between groups with patients in the ORIF cohort having a mean ASES score of 73.4 (±23.7) and patients in the rTSA cohort a mean ASES score of 77.6 (±13.7) ($P = 0.774$).

Conclusion: Patients who sustain 3- or 4-part proximal humerus fractures and are treated with reverse total shoulder arthroplasty tend to be older and have a lower BMI than those treated with ORIF. Functionally, patients treated with ORIF had greater final range of motion than those treated with rTSA. However, both strategies resulted in a functional range of shoulder motion. Functional outcome scores between groups were similar and reached population norms at latest follow-up.

See pages 99 - 147 for financial disclosure information.

Operative Versus Nonoperative Management of Humerus Fractures

Reza Firoozabadi, MD, MA[1]*; Edward Westrick, MD*[2]*; Benjamin Hamilton, MS*[3]*;*
Bradford Henley, MD, MBA[1]*;*
[1]*Harborview Medical Center/University of Washington, Seattle, Washington, USA;*
[2]*Allegheny General Hospital, Pittsburgh, Pennsylvania, USA;*
[3]*Case Western Reserve University, Cleveland, Ohio, USA*

Purpose: The ideal treatment of humeral shaft fractures remains controversial. Both operative and nonoperative interventions have limitations, although functional bracing is thought to result in a low rate of complications.

Methods: Patients with humeral shaft fractures (AO 12-A, B, C) from 2000-2011 were identified from our institution's prospective patient data registry. Patient characteristics, treatment type, consolidation period, injury mechanism, nerve palsy, nonunion and other injuries were retrieved from the electronic medical record. Data were analyzed using SPSS version 21.0 for Windows.

Results: A total of 505 patients with acute humeral shaft fractures were identified. 209 patients were excluded for the following reasons: pathologic fracture, age less than 16 years old or failure to follow up to radiographic union; 296 patients met inclusion criteria. A total of 227 fractures were treated operatively, and 69 treated with functional bracing. A high-energy mechanism was identified in 67% of nonoperative and 79% of operative patients. 44% of nonoperative fractures were isolated injuries compared with only 21% treated operatively. The nonunion rate was 9.7% in operative fractures and 23.2% with functional bracing. 12 nonunions resulted after intramedullary nail (54.5%), 9 after plate osteosynthesis (41%), and 1 after external fixation (4.5%). In the nonoperative nonunions, 44% were wedge (12-B2/3), 31% transverse (12-A3), 18.75% oblique (12-A2), and 6.25% comminuted (12-C3). Nerve palsies were identified in 84 operative patients (37%), with 82 palsies diagnosed preoperatively. 14 nonoperatively treated patients sustained nerve palsies (20%). One nonoperative and 10 operative palsies resulted in permanent dysfunction. Seven operatively treated arterial injuries (3%) were identified.

Conclusion: This study of mostly polytraumatized patients demonstrates a higher nerve palsy rate than previously reported for both operative and nonoperative treatment of humeral shaft fractures, likely resulting from high-energy trauma. The incidence of nonunion is higher than previously reported for nonoperative management.

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A Randomized Controlled Trial of Percutaneous Fixation With Kirschner Wires Versus Volar Locking-Plate Fixation in the Treatment of Adult Patients With a Dorsally Displaced Fracture of the Distal Radius

Matthew L. Costa, MD, FRCS; Amar Rangan, MD, FRCS; ***Andrew C. Gray, MD, FRCS****; Warwick Clinical Trials Unit, University of Warwick, Coventry, United Kingdom*

Purpose: This study compared Kirschner wire (K-wire) fixation with locking-plate fixation for patients with dorsally displaced fractures of the distal radius. We hypothesized that locking-plates would provide better improvements in the Patient-Rated Wrist Evaluation (PRWE) in the 12 months after surgery.

Methods: In this multicenter Distal Radius Acute Fracture Fixation Trial (DRAFFT), we randomly assigned 461 adult patients having surgery for an acute, dorsally displaced fracture of the distal radius to either K-wire fixation or locking-plate fixation. The primary outcome measure was the PRWE at 12 months after the fracture. We also collected information on complications, and combined costs and quality-adjusted life years (QALYs) to assess cost-effectiveness.

Results: The baseline characteristics of the two groups were well balanced and over 90% of patients completed follow-up. Both groups of patients recovered wrist function by 12 months. There was no difference in the PRWE score at 3 months, 6 months, or 12 months (difference –1.3; 95% confidence interval [CI] –4.5 to 1.8; $P = 0.398$). There was no difference in the number of complications in each group and negligible differences in QALY gains; K-wire fixation represents a cost-saving intervention, particularly in younger patients.

Conclusion: Contrary to the existing literature, and against the increasing use of plate fixation, this trial shows that there is no difference between K-wires and volar locking-plates for patients with dorsally displaced fractures of the distal radius. K-wire fixation is less expensive and quicker to perform.

See pages 99 - 147 for financial disclosure information.

Clinical Trial in the Treatment of A2-OTA Type Fractures of the Distal Radius by Casting

Amir R. Kachooei, MD*; Ali Moradi, MD; Taghi Peivandi, MD; Mohammad H. Ebrahimzadeh, MD;*
Orthopedic Research Center, Mashhad University of Medical Sciences, Mashhad, Iran

Purpose: This trial was conducted to compare the final results of distal radius A2-OTA type fractures treated with either long or short arm casts.

Methods: This prospective randomized clinical trial was performed on 100 patients with distal radius fractures. Fifty patients were treated in each group either by short or long arm cast. Data were recorded during the 6th and 18th weeks after the reduction and casting.

Results: There were no significant differences between groups regarding age, gender, and the type of fracture. There were significant differences between the two groups regarding the range of elbow flexion and extension and forearm supination and pronation that were decreased with time. There was no significant difference regarding the stability of the distal radioulnar joint. There was no malunion, nonunion, carpal tunnel syndrome, or compartment syndrome in either group.

Conclusion: According to this short-term study, a short arm cast with three-point molding provides adequate therapeutic result in A2-OTA type fracture with low cost and good acceptability.

Table 1.
Preoperative Characteristics of the Fracture in the Long and Short Arm Cast Groups

Fracture Characteristics		Type of Cast		*P* Value
		Long arm cast N (%)	Short arm cast N (%)	
Radial inclination in plain AP view	≤10°	0	0	0.52
	11°-15°	15 (30%)	19 (38%)	
	>15°	35 (70%)	31 (62%)	
Dorsal tilt angulations in lateral view	≤9°	34 (68%)	30 (60%)	0.53
	10°-19°	16 (32%)	20 (40%)	
	≥20°	0	0	
Radial shortening in plain AP view	≤5 mm	38 (76%)	40 (80%)	0.6
	6-9 mm	12 (24%)	10 (20%)	
	≥10 mm	0	0	

Table 2. Evaluation of the Patients at 6- and 18-Week Follow-up*

	Follow-up	LAC	SAC	*P*
Limitation of range of flexion - extension of the elbow	Week 6	26 (52%)	0	<0.05
	Week 18	4 (8%)	0	<0.05
Limitation of range of supination and pronation of the forearm	Week 6	28 (56%)	1 (2%)	<0.05
	Week 18	5 (10%)	0	<0.05
DRUJ Instability	Week 6	1 (2%)	2 (4%)	>0.05
	Week 18	0	0	

*LAC = long arm cast, SAC = short arm cast, DRUJ = distal radioulnar joint.

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Volar Locking Plate Versus External Fixator/Cast Fixation for the Treatment of Distal Radius Fractures: A Randomized, Controlled Prospective Trial

Lidia Koval, MBBS*[1]*; Herwig Drobetz, MD*[2]*;
[1]The Prince Charles Hospital, Brisbane, Queensland, Australia;
[2]Mackay Base Hospital, Mackay, Queensland, Australia

Purpose: Osteosynthesis with a volar locking plate (VLP) is the only treatment option that allows immediate postoperative mobilization of the wrist. However, a VLP is an expensive and technically demanding form of treatment. This study compares the short-term functional outcomes of treatment without postoperative immobilization versus treatment by other modalities.

Methods: Group 1 consisted of distal radius fractures treated with a VLP, with no postoperative immobilization and unrestricted usage of the wrist in activities of daily living (ADL) allowed. Group 2 fractures were treated with either an external fixator ± Kirschner wires (K-wires) or forearm cast ± K-wires, with subsequent immobilization for 6 weeks. Both groups had radiological and clinical controls at 2 weeks, 6 weeks, and 12 weeks. The end points were time to return to work or return to ADLs, range of motion (ROM) of the wrist, and grip strength. Outcomes were evaluate with Disabilities of the Arm, Shoulder and Hand (DASH) and Patient-Rated Wrist Evaluation (PRWE) scores, collected 3 months after the injury.

Results: A total of 60 patients have been recruited, with 28 patients assigned to Group 1 (VLP) and 32 patients to Group 2 (non-VLP). Mean age of group 1 was 52 years, and of group 2 61 years. The predominant fracture type was AO/ASIF type C. All eligible participants completed the required follow-up. Nine patients either failed to attend the OPD, or were discharged early with no follow-up, and 1 patient was found to have bilateral wrist fractures on the follow-up, and was excluded. The average DASH score was the same for both groups (mean = 45). The average PRWE score was 21 for group 1, and 46 for group 2. The mean grip strength for group 1 was 64.33% and for group 2 patients 41.92% of the unaffected arm. Mean flexion was equal for both group; mean extension was for group 1 and for group 2. *Complications:* In group 1, one patient had symptoms of ulnar nerve weakness and one had flexor tendon rupture. One patient had complex regional pain syndrome (CRPS). Two patients requested to have the VLP removed. In group 2, two patients underwent lengthening surgery for malunion with shortening of the radius. Two patients developed symptoms suggestive of CRPS.

Conclusion: It appears that the results of treatment of the distal radius fractures with a volar locking plate followed by immediate postoperative immobilization are not significantly different from the nonoperative treatment of such injuries, as demonstrated by similar mean DASH and flexion in both groups. However, the mean PRWE is lower, and the mean grip strength and extension appear to be higher in the VLP-treated patients.

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Open Reduction and Internal Fixation of the Distal Radius: Catastrophic Thinking Leads to Stiff Fingers

Teun Teunis, MD*; Arjan G. Bot, MD; Emily R. Thornton, BSc; David Ring, MD, PhD; Massachusetts General Hospital - Harvard Medical School, Boston, Massachusetts, USA*

Background/Purpose: There is debate whether patients who have greater pain and disability than expected after musculoskeletal injury have a distinct pathophysiological process (eg, increased sympathetic nerve activity) or ineffective coping strategies such as excessive catastrophic thinking. This study aims to establish predictors of finger stiffness after distal radius fracture surgery. We hypothesize that there are no physical or psychological factors associated with finger stiffness measured by (1) range of motion and (2) distance to palmar crease at 8 weeks after surgical treatment.

Methods: After IRB approval, we prospectively enrolled 116 patients at the time of suture removal after volar plate fixation of a distal radius fracture. At inclusion we recorded patients' demographics, pain intensity, catastrophic thinking (Pain Catastrophizing Scale), symptoms of depression (Patient Health Questionnaire), health anxiety (Whiteley Index), and index through small finger's motion and distance to palmar crease. Motion and distance to palmar crease were evaluated in 96 patients 5 weeks after enrollment (approximately 8 weeks after fracture). 17% (20/116) of the patients did not have a second evaluation: 8 sought follow-up care closer to home and 12 were missed by the research assistant when an appointment was rescheduled.

Results: Age ($r = –0.45$, $P < 0.001$), having another pain condition (pain condition 938° ± 168° versus no pain condition 999° ± 99°, $P = 0.044$), years of education ($r = 0.32$, $P = 0.0017$), catastrophic thinking ($r = –0.42$, $P < 0.001$), health anxiety ($r = –0.22$, $P = 0.033$) and pain score ($r = –0.26$, $P = 0.010$) at enrollment were associated with range of motion 8 weeks after surgery. Age (beta = –3.2, 95% confidence interval [CI] –4.6 to –1.8, $P < 0.001$), years of education (beta = 10, 95% CI 3.1 to 18; $P = 0.006$), and catastrophic thinking (beta = –6.3, 95% CI –9.8 to –2.8, $P = 0.001$) were retained in the final model for range of motion (adjusted R^2 0.35, $P < 0.001$). The same variables were associated with increased distance to palmar crease 8 weeks after surgery: age ($r = –0.28$, $P < 0.0053$), having another pain condition (pain condition 3.9 ± 7.3 cm vs. no pain condition 1.3 ± 3.5 cm, $P = 0.031$), years of education ($r = –0.29$, $P = 0.0042$), catastrophic thinking ($r = 0.59$, $P < 0.001$), health anxiety ($r = 0.38$, $P = <0.001$), and pain score ($r = 0.25$, $P = 0.013$). Years of education (beta = –0.32, 95% CI –0.61 to –0.040; $P = 0.026$), and catastrophic thinking (beta = 0.45, 95% CI 0.32 to 0.58, $P < 0.001$) were retained in the final model for increased distance to palmar crease (adjusted R^2 0.37, $P < 0.001$).

Conclusion: A maladaptive coping response to pain (catastrophic thinking) leads to stiff fingers. Surgeons and therapists should acknowledge the counterintuitive aspects of recovery and help patients change their mindset so that they feel healthy about using their sore arm and doing uncomfortable stretching exercises.

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The Role of Depression in Outcomes of Low-Energy Distal Radius Fractures in Patients Over 55 Years Old

Jane Yeoh, BSc, MD; Jeffrey Pike, MD, MPH, FRCSC; Henry Broekhuyse, MD, FRCSC; Peter O'Brien, MD, FRCSC; ***Kelly A Lefaivre, BScH, MD, MSc, FRCSC****;*
Division of Orthopaedic Trauma, Department of Orthopaedic Surgery,
University of British Columbia, Vancouver, British Columbia, Canada

Purpose: This study aims to determine the effect of depression on functional outcome, complications, and the occurrence of complex regional pain syndrome (CRPS) in patients over 55 years old with isolated distal radius fractures.

Methods: Data were prospectively collected in patients over 55 with acute distal radius fractures in one Level I trauma center. Patient and treatment characteristics collected include age, gender, medical comorbidities, education, smoking, and operative versus nonoperative treatment. General and limb-specific health status was measured at baseline, 3 months, and 1 year using the Short Form-36 (SF-36), and Disabilities of the Arm, Shoulder and Hand (DASH) score. Depression was measured using the Centre of Epidemiologic Studies Depression Scale (CES-D) at the same time intervals. All complications, and specifically symptoms consistent with CRPS were recorded. Univariate analysis was utilized to examine the relationship between depression and complications, and between depression and outcomes. Linear regression models were utilized to assess the effect of depression and other factors on functional outcomes.

Results: 228 patients were enrolled, 204 women and 24 men. The mean age was 67 ± 0.59 years. 120 distal radius fractures were treated nonoperatively and 108 treated operatively. A large portion of patients were depressed at baseline (24.8%), and this rate increased 3 months after injury (32.1%), and returned close to baseline 1 year after injury (26.3%). 32 patients reported some type of complication (14.0%), and 22 of these patients had symptoms consistent with CRPS (10.3%). Univariate analysis showed a significant association between depression at baseline (P = 0.0732) and 3 months (P = 0.0017) and the occurrence of CRPS. This relationship did not exist with complications at baseline, but did at 3 months (P = 0.0211). There was a statistically significant association between baseline depression and worse 1-year SF-36 scores. Patients with baseline depression had worse absolute 1-year DASH scores of 20.14 ± 2.32 compared to 11.60 ± 1.33 in nondepressed patients (P = 0.0031), and worse change in DASH score between baseline and 1 year (P = 0.0229). Using linear regression, baseline depression is the strongest predictor of worse 1-year DASH scores (3.720, P = 0.0078), and more change in DASH score over the first year (2.896, P = 0.0255) controlling for gender, age, treatment, comorbidity, and complications.

Conclusion: A significant portion of patients over 55 with distal radius fracture present with depression, and experience new depression during treatment. In this study, rates of CRPS complicating recovery from distal radius fracture were consistent with previous literature (10.3%). We found an association between CRPS and baseline depression as well as depression at 3 months after injury. There is no

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association between baseline depression and complications overall, yet there is an association between 3-month depression and complications. Baseline depression predicts poorer general functional and limb-specific functional outcome at 1 year. Depression is the most important predictor of DASH at 1 year, and change in DASH over treatment, even after controlling for other important predictors of upper extremity function.

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Efficacy of Postoperative Pain Control After Distal Radius Fracture Fixation: A Prospective Randomized Study

David Galos, MD; David P. Taormina, MS; Alexander Crespo, BS; David Ding, MD; Anthony Sapienza, MD; Sudheer Jain, MD; ***Nirmal C. Tejwani, MD, FRCS;***
NYU Langone Medical Center Hospital for Joint Diseases, New York, New York, USA

Purpose: This study was undertaken to determine the efficacy of brachial plexus blockade as compared to general anesthesia for pain control in patients undergoing operative fixation of distal radius fractures.

Methods: Forty patients with acute distal radius fractures (OTA 23A-C) requiring operative fixation that met inclusion criteria were identified. Patients were assigned to one of two groups, general anesthesia (GA) or brachial plexus blockade (BPB) randomly. Post-anesthesia care unit (PACU) pain medications and data were recorded. Patients were discharged on oxycodone/acetaminophen (Percocet) 5/325 mg for pain control and visual analog scale (VAS) forms were provided. Patients were called at predetermined intervals postoperatively (2, 4, 6, 12, 24, 48, and 72 hours) to gather pain scores, using the VAS, and to document the doses of analgesics consumed. Patients followed up in the operative surgeon's office until union and then continued to be followed until maximal medical improvement. At each follow-up visit, patients were given a short questionnaire regarding satisfaction with pain control. Pain scores were again recorded using VAS at these visits.

Results: All patients, 18 males and 22 females, obtained adequate follow-up. Twenty patients were randomized to the GA group and twenty to the BPB group. Average pain was significantly greater in the GA group at 2 hours postoperatively (6.7 vs.1.4; $P < 0.001$), while average pain was significantly greater for the BPB group at 12 hours (6.6 vs. 3.8; $P < 0.001$) and 24 hours postoperatively (5.6 vs. 3.8; $P < 0.032$). The average amount of PACU Percocet did not differ between the groups ($P = 0.5$). PACU fentanyl and morphine use was significantly higher for GAs than BPBs ($P < 0.003$). Time in PACU was significantly longer for GA than BPB (4:49 vs. 3:20; $P < 0.032$). There was no difference in average total pain medication used at home ($P = 0.777$). The overall satisfaction with pain control was not statistically different between the two group ($P = 0.279$).

Conclusion: Brachial plexus blockade provides superior pain control in the immediate postoperative period while patients who received general anesthesia have significantly lower pain scores at 12 and 24 hours postoperatively. This may be related to rebound pain after the nerve block subsides. Immediate postoperative pain can be controlled in a safe manner in the PACU, but in instances of poorly controlled pain after BPB has worn off, increasing discomfort, anxiety, and fear of unanticipated sequelae may lead to unnecessary emergency room visits and physician phone calls.

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Pain Over Time: GA Versus BPB

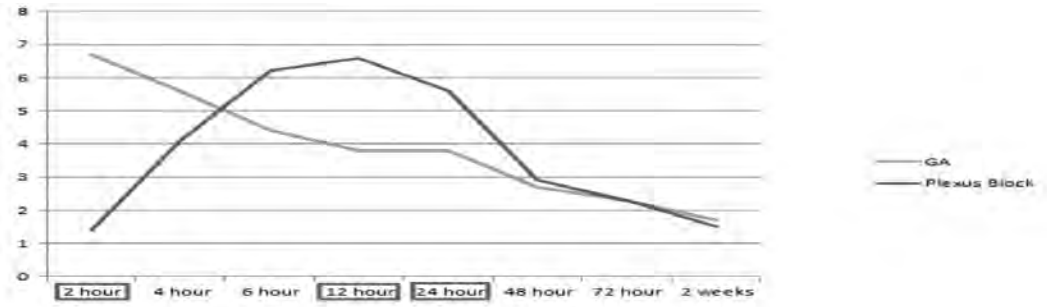

Figure 1. Average VAS scores at each follow-up time point. The GA group had significantly more pain at 2 hours (while in the PACU), while the BPB group had significantly more pain at 12 and 24 hours.

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Radiation Exposure to the Surgeon's Hands:
A Practical Comparison of Large and Mini C-Arm Fluoroscopy

Michael M. Vosbikian, MD[1]*; Charles F. Leinberry, MD*[2]*; Derek Watson, RT*[3]*;*
Asif M. Ilyas, MD[2]*;*
[1]*Thomas Jefferson University Hospital – Department of Orthopaedic Surgery, Philadelphia, Pennsylvania, USA;*
[2]*The Rothman Institute at Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA;*
[3]*Nazareth Hospital – Department of Radiology, Philadelphia, Pennsylvania, USA*

Purpose: Controversy persists as to whether mini C-arm fluoroscopy units are safer than standard units. In particular, radiation exposure to the surgeon's hand, which is often closest to the surgical field, is also not well understood. To determine and compare the radiation exposure to the orthopaedic surgeon's hands with use of a standard and mini C-arm fluoroscopy units in a practical, clinically-based model.

Methods: Two attending hand surgeons monitored the radiation exposure to their hands with a ring dosimeter over a 14-month period using standard and mini C-arm fluoroscopic units. One surgeon performed all cases with a standard C-arm unit in a hospital setting, while the other performed all cases with mini C-arms in surgical centers. For each case, fluoroscopic time, the final dose displayed on the unit, and radiation per unit time were recorded and analyzed.

Results: A total of 160 consecutive cases were reviewed with 71 cases and 89 cases in the standard and mini C-arm limbs of the study, respectively. The median fluoroscopy time per case was 37.7 seconds with the large C-arm and 88 seconds with the mini C-arm. The median dose reported by the large C-arm was 0.68 mGy/case, while the median dose reported by the mini C-arm was 9.97 mGy/case. With dose as a product of time, the median calculated values were 0.02 mGy/second for the large C-arm group and 0.28 mGy/second for the mini C-arm group. The ring exposures showed an exposure of 380 mrem and 1100 mrem for the large and small C-arm groupd, respectively.

Conclusion: The mini C-arm resulted in more than a 10-time increase in radiation exposure dose and more than 3 times greater dosimeter absorption to the surgeon's hand, compared to the standard C-arm. While it has been shown that the mini C-arm produces less scatter of ionizing radiation, in a practical model the mini C-arm may not be a safer alternative to the large C-arm with respect to the surgeon's hands. Although below the maximum recommended radiation dose per year with either model, based on these findings, we would recommend taking precautions toward radiation exposure by utilizing protective equipment and minimizing fluoroscopic time.

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Dorsal Screw Penetration With the Use of Volar Plating of Distal Radius Fractures: How Can You Best Detect?

Brian W. Hill, MD*; Irshad A. Shakir, MD; Lisa K. Cannada, MD;*
Saint Louis University, St. Louis, Missouri, USA

Purpose: The valley between the sigmoid notch and Lister's tubercle make evaluation of screw prominence difficult with conventional fluoroscopic images. Various projections have been described to detect dorsal cortex screw penetration. This cadaveric study is designed to evaluate which described fluoroscopic images are useful to detect dorsal cortex penetration with the use of volar locking plates.

Methods: 21 embalmed forearm cadaveric specimens were used. Volar locking plates (Smith & Nephew, Memphis, TN) were secured in position proximally. Four 2.5-mm locking screws were inserted distally using 18 mm, 20 mm, and 22 mm screws in 7 specimens for each length. The specimen was evaluated to count the number of screws breaching the dorsal cortex. Four fluoroscopic images (lateral, 45° supination, 45° pronation, dorsal tangential view) were taken of each wrist. A group of 63 orthopaedic surgeons with different levels of experience were then asked to evaluate if the screws penetrated the dorsal cortex after viewing each image. The data were analyzed for sensitivity and specificity in the evaluation of dorsal screw penetration and interobserver reliability using the interclass correlation coefficient.

Results: The 21 cadaveric specimens had an average age of 78 years (range, 25-91). Dorsal cortex screw penetration of at least one screw occurred in 14% (1/7) of specimens with 18 mm screw, 57% (4/7) of specimens with 20 mm screw, and 86% (6/7) specimens with 22 mm screws. The sensitivity of the lateral view was 64.1%, 90.3% on the 45° supination view, 63.9% on the 45° pronation view, and 73.2% on the dorsal tangential view. An increase in the number of years of orthopaedic experience demonstrated an inverse relationship with respect to sensitivity/specificity (Table 1).

Conclusion: Dorsal cortex screw penetration can lead to tendon irritation and rupture. This can occur especially with penetration of the third dorsal compartment due to its relationship to Lister's tubercle. This cadaveric study gave us direct visualization of screw penetration to accurately determine which fluoroscopic images detected this breach. The lateral and 45° pronation views detected screw penetration about two-thirds of the time. The sensitivity increased with dorsal tangential views to 73% and the 45° supination view to 90%. Clinicians should consider use of these views to diagnose dorsal screw penetration after volar plating.

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Table 1. Sensitivity and Specificity of the 4 Fluoroscopic Views in Detecting a Screw Penetrating the Dorsal Cortex

Years Experience	Lateral View		45° Supination View		45° Pronation View		Dorsal Tangential View	
	Se.	**Sp.**	**Se.**	**Sp.**	**Se.**	**Sp.**	**Se.**	**Sp.**
>10	58.3%	72.5%	88.6%	79.2%	51.0%	66.3%	62.9%	74.2%
6-10	54.0%	81.8%	86.1%	84.7%	50.0%	70.6%	67.4%	80.6%
1-5	57.6%	80.0%	86.4%	80.0%	54.2%	78.3%	66.7%	86.7%
Resident	64.2%	67.1%	90.4%	70.6%	58.8%	61.2%	70.6%	80.6%
Cumulative	64.1%	82.0%	90.3%	78.1%	63.9%	66.7%	73.2%	78.4%

Values expressed as a percentage. Se = sensitivity, Sp = specificity.

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