Nonoperative Treatment of Closed Extra-Articular Distal Humeral Shaft Fractures in Adults: A Comparison of Functional Bracing and Above-Elbow Casting

Publish date: May 15, 2018
Authors:
H.J. Christiaan Swellengrebel, MS David Saper, MD Paul Yi, MD Alexander A. Weening, MD David Ring, MD Andrew Jawa, MD
Author Affiliation | Disclosures

Authors’ Disclosure Statement: Dr. Ring reports that he is a board or committee member of the American Academy of Orthopaedic Surgeons and the Orthopaedic Trauma Association; is on the editorial or governing board of Clinical Orthopaedics and Related Research and Journal of Orthopaedic Trauma; and receives intellectual property royalties from Skeletal Dynamics and Wright Medical Technology, Inc. The other authors report no actual or potential conflict of interest in relation to this article.

Dr. Swellengrebel is an Attending Surgeon, Haaglanden Medical Centre (HMC), The Hague, The Netherlands. Dr. Saper is an Attending Surgeon, Orthopaedic and Rehabilitation Centers, Chicago, Illinois. Dr. Yi is a Radiology Resident, Johns Hopkins University School of Medicine, Baltimore, Maryland. Dr. Weening is an Attending Surgeon, Onze Lieve Vrouwe Gasthuis, Amsterdam, The Netherlands. Dr. Ring is Associate Dean for Comprehensive Care and Professor of Surgery, Dell Medical School, The University of Texas at Austin, Austin, Texas. Dr. Jawa is an Attending Surgeon, New England Baptist Hospital, Boston, Massachusetts.

Address correspondence to: David Saper, MD, 850 Harrison Ave., Dowling 2 North, Boston MA, 02118 (tel, 617-638-8934; fax, 888-267-7761; email, Dave.saper@gmail.com).

Am J Orthop. 2018;47(5). Copyright Frontline Medical Communications Inc. 2018. All rights reserved.

Take-Home Points

- Closed extra-articular distal diaphyseal humerus fractures heal predictably with both bracing and casting.
- There are no differences in average elbow motion between bracing and casting of these fractures.
- There are no differences in radiographic alignment between bracing and casting of these fractures.
- The distal diaphyseal humerus has a natural anatomic and biologic propensity to heal with closed immobilization.
- Patients preferring nonoperative treatment can choose between a cast or a brace with confidence of the efficacy of either treatment.

Nonoperative treatment of closed fractures of the humeral shaft (AO/OTA [Arbeitsgemeinschaft für
Osteosynthesefragen/Orthopaedic Trauma Association] type 12) with a functional brace or above-elbow cast (AEC) is associated with a high union rate, good motion, and good function. Advocates of casting believe that a brace cannot control fracture alignment as well as a cast that allows for immobilization and molding. Advocates of brace treatment are concerned that immobilization in a cast will cause elbow stiffness.\textsuperscript{1-11}

In our differing institutions, there are advocates of each type of treatment, providing the opportunity for a comparison. This retrospective study compares brace and cast treatment. The working hypothesis was that there is no difference in elbow motion 6 months or more after fracture. We also compared radiographic alignment after union.

**Materials and Methods**

Between 2003 and 2012, consecutive adult patients treated for a nonpathological fracture of the diaphysis of the distal humerus at the orthopedic trauma service of 3 level 1 academic trauma centers were identified from prospectively collected trauma injury databases. Patients with vascular injury, ipsilateral upper extremity fracture, and periprosthetic fractures were excluded. The attending orthopedic surgeon chose the treatment method and evaluated the range of motion (ROM) of the elbow and radiographic union at the final ambulatory visit. We included patients followed to clinical and radiographic union with a minimum of 6 months of follow-up. We also included patients with <6 months’ follow-up who demonstrated union and had elbow ROM within 10° of the uninjured arm.

We identified 105 consecutive adult patients with a closed nonpathological extra-articular distal humeral shaft fracture (fracture of the distal humeral shaft with an AO/OTA type-12.A, 12.B, or 12.C pattern) treated with an AEC or a brace in our databases.\textsuperscript{12} Two patients in the brace group chose surgery to improve alignment within 3 weeks of injury and were excluded from the analysis. Twenty-eight patients had inadequate follow-up.

A total of 75 patients were included in the study. At the first and second institutions, 51 patients were treated with functional bracing with an average follow-up of 7 months. At the third institution, 24 patients were treated with an AEC with an average follow-up of 4 months. Seventeen out of 24 patients in the long arm casting group and 19 out of 51 patients in the bracing group, who were included since they had <6 months of follow-up, demonstrated union and had elbow ROM within 10° of the uninjured arm. Differing methods of closed immobilization were the result of differing treatment algorithms at each institution.

The patients who were treated with a functional brace averaged 34 years of age (range, 18-90 years) and included 27 men and 24 women. The brace was removed at an average of 11.5 weeks (range, 8-18 weeks) after initial injury. Six patients had an injury-associated radial nerve palsy, all of which fully recovered within an average of 4 months (range, 0.5-7 months). Sixteen patients were injured due to a fall from standing height, 2 due to a fall from a greater height than standing, 16 in a motor-vehicle accident, 15 during a sport activity, and 2 were not specifically documented.

Four patients had concomitant injuries: one patient had a mid-shaft humeral fracture on the contralateral arm; a second had an ankle fracture; a third had an ankle fracture, acetabular fracture, a rib fracture, and pneumothorax; and the fourth had 2 rib fractures.

The patients who were treated with an AEC had an average age of 32 years (range, 18-82 years) and included 14 men and 10 women. The cast was removed at an average of 4.2 weeks (range, 3-7 weeks) after the initial injury. Two patients had an injury-associated radial nerve palsy, both of which fully recovered. Five patients were injured due to a fall from standing height, 1 due to a fall from a height greater than standing, 7 during a motor-vehicle
accident, 5 during a sport activity, and 6 were not documented. Two patients sustained concomitant injuries: one patient sustained a tibia-fibula fracture, and another patient sustained facial trauma.

The 2 groups were comparable in age and gender, as well as the injury mechanism (Table).

**Functional Bracing Technique**

Upon presentation after injury, patients were immobilized in a coaptation splint (Figure 1A). Within 10 days, the arm was placed in a pre-manufactured polyethylene functional brace (Corflex) and the arm was supported with a simple sling. Patients were allowed to use the hand for light tasks and move the elbow, but most patients were not capable of active elbow flexion exercises until early healing was established 4 to 6 weeks after injury. Shoulder motion was discouraged until radiographic union. Patients started active, self-assisted elbow and shoulder stretching exercises, and weaned from the brace once radiographic union was confirmed between 6 and 10 weeks after injury (Figures 1B, 1C).

**Above-Elbow Cast**

Patients were also initially immobilized in a coaptation splint upon initial presentation. Within 7 days, an above-elbow fiberglass cast with neutral forearm rotation and 90° of elbow flexion was applied with a supracondylar mold, followed by radiographic imaging (Figure 2A). With the fractured arm dependent, a valgus mold was applied as the material hardened in order to align the fracture site and limit varus angulation.

There were no shoulder ROM restrictions. Casts were removed, skin checked, and replaced every week for 4 to 6 weeks. Casts were removed when callus was noted on radiographs. After cast removal, physician-taught active and active-assisted elbow stretching exercises were given to patients to be performed on a daily basis at home. Patients were followed until clinical and radiographic union and elbow ROM to within 10° of the injured arm (Figures 2B, 2C).

**Statistical Analysis**

Alignment of the humerus (including varus-valgus alignment and apex anterior-posterior alignment) was measured on anteroposterior and lateral radiographs as the angle between lines bisecting the humeral diaphysis proximal and distal to the fracture. The normality of the data was tested using the Kolmogorov-Smirnov test. To statistically compare continuous variables with a normal distribution, t-tests were used; otherwise the Wilcoxon t-test was applied. The Pearson’s Chi-Square test was used to statistically compare dichotomous variables, except when expected cell frequency was <5, in which case the Fisher exact test was used. The level of significance was set at $P < .05$.

**Results**

**Range of Motion and Radiographic Alignment**

The average range of elbow motion was 130° ± 9° after brace treatment and 127° ± 12° after cast treatment ($P = .26$). Four patients (8%) treated with a brace and 3 (12%) treated with a cast lost >20° of elbow motion.

All the fractures healed. The average varus angulation on the anteroposterior radiograph was 17° (range, 2°-26°)
in braced patients and 13 (range, 5°-31°) in casted patients (P = .11). The average posterior angulation on the lateral radiograph was 9° (range, 0°-28°) in braced patients vs 7° (range, 2°-33°) in casted patients (P = .54).

**Complications**

Two weeks after initiating brace treatment, an obese patient suffered a rash with desquamation that necessitated discontinuation of the brace. However, the skin and fracture ultimately healed with a coaptation splint and sling support without additional complications. In the casting cohort, 2 patients returned to the emergency department after AEC placement because of swelling of the hand and pain in the cast. Both casts were removed and reapplied.

**Discussion**

Fractures of the distal third of the humeral diaphysis heal without surgery. Fracture angulation and elbow stiffness are the concerns that lead to variations in nonoperative treatment.\(^1\)\(^-\)\(^3\) Advocates of casting believe they can get better alignment without losing elbow motion, and advocates of bracing feel that the brace is less cumbersome.\(^1\)\(^-\)\(^3\),\(^5\)\(^-\)\(^8\) We compared these treatments retrospectively and found them comparable.

This study should be considered in light of its limitations. Many patients were lost to follow-up in our urban trauma centers. We do not know if these patients did better, worse, or the same as the patients we were able to evaluate, but our opinion is that patients having problems were more likely to return. The evaluation time was relatively short, but motion can only improve in the longer-term. Two patients that were initially braced chose surgery, probably because either they or their surgeon were nervous about the radiographic appearance of the fracture. In our opinion, continued nonoperative treatment of these patients would not affect the findings.

Cast treatment of distal diaphyseal humerus fractures does not cause permanent elbow stiffness. This is confirmed by our results; as casted patients did not lose final ROM compared to the bracing cohort. These injuries are extra-articular and casted patients are transitioned to bracing once humeri have significant union demonstrated by the arm moving as a unit. To our knowledge, there is no other study that has evaluated casting for these fractures, but it may be that evidence of permanent stiffness with nonoperative treatment of distal metaphyseal fractures of the humerus [AO/OTA type 13] is misapplied to distal humeral shaft fractures [AO/OTA type 12].\(^1\)\(^-\)\(^3\),\(^9\)\(^-\)\(^12\) For brace treatment, Sarmiento and colleagues\(^9\) showed no significant elbow stiffness in a consecutive cohort of 69 patients, while Jawa and colleagues\(^5\) showed no increased elbow stiffness compared to plate fixation. Given the accumulated data,\(^3\)\(^-\)\(^6\)\(^,\)\(^8\)\(^,\)\(^13\) advocates of operative treatment for distal third diaphyseal humerus fractures\(^12\) can no longer site elbow stiffness as a disadvantage of nonoperative treatment, whether with cast or brace.

As shown in this study, patients that choose nonoperative treatment can expect their fracture to heal with an average of approximately 15° of varus angulation, as well as 2 others evaluating brace treatment.\(^5\)\(^,\)\(^9\) Some will heal with as much as 30° of varus angulation.\(^5\)\(^,\)\(^9\) The arm may look a little different, particularly in thin patients, but there is no evidence that this angulation affects function. The risks, discomforts, and inconveniences of surgery can be balanced with the ability of surgery to improve alignment and allow elbow motion a few weeks earlier. The aesthetics of the scar after surgery may not be better than the deformity after nonoperative treatment. Patients should be involved in these decisions.

No cost comparison was done between these 2 treatment modalities. However, both casting and bracing offer substantially lower costs compared to surgical treatment with high efficacy and less risk for the patient. In some billing environments, closed treatments of fractures are captured as “surgical interventions” with global periods included in the reimbursement. Both casting and bracing are relatively inexpensive with materials that are readily
accessible in nearly any general or subspecialty orthopedic practice.

There is a passive implication that operative treatment of distal third diaphyseal humerus fractures affords better results and union for patients in the discussed literature. Our results demonstrate that the distal diaphyseal humerus has a natural anatomic and biologic propensity to heal with closed immobilization. Patients should be made aware that while operative treatments exist for this fracture pattern, nonoperative treatment modalities have proven to be efficacious using a variety of immobilization methods. Thus, patients that prefer nonoperative treatment of a distal third diaphyseal humerus fracture can choose between a cast or a brace with confidence of the efficacy of the nonoperative treatment.

**Key Info**

**Figures/Tables**

Figures / Tables:

saper0518_f1.jpg

*Figure 1.* Functional bracing radiographs. (A) Anteroposterior radiograph showing a distal humeral shaft fracture in a coaptation splint, 2 days after initial injury. (B, C) Anteroposterior radiographs showing solid union and good alignment after functional bracing at 1 year.
### Table. Patient Demographics and Outcome Data

<table>
<thead>
<tr>
<th></th>
<th>Functional Bracing (n = 51)</th>
<th>Long Arm Casting (n = 24)</th>
<th>Significance (P &lt; .05)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Male</em></td>
<td>27 (54%)</td>
<td>14 (58%)</td>
<td></td>
</tr>
<tr>
<td><em>Female</em></td>
<td>24 (46%)</td>
<td>10 (42%)</td>
<td></td>
</tr>
<tr>
<td><strong>Average age (y)</strong></td>
<td>34 (range, 18-90)</td>
<td>32 (range, 18-82)</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanism of injury</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Standing height</em></td>
<td>16 (31%)</td>
<td>5 (20%)</td>
<td></td>
</tr>
<tr>
<td><em>Greater height</em></td>
<td>2 (4%)</td>
<td>1 (4%)</td>
<td></td>
</tr>
<tr>
<td><em>Motor vehicle collision</em></td>
<td>16 (31%)</td>
<td>7 (29%)</td>
<td></td>
</tr>
<tr>
<td><em>Sports activity</em></td>
<td>15 (29%)</td>
<td>5 (21%)</td>
<td></td>
</tr>
<tr>
<td><em>Other</em></td>
<td>2 (4%)</td>
<td>6 (25%)</td>
<td></td>
</tr>
<tr>
<td><strong>Follow-up (months)</strong></td>
<td>7 (range, 2-25)</td>
<td>4 (range, 2-15)</td>
<td></td>
</tr>
<tr>
<td><strong>Elbow range of motion (degrees)</strong></td>
<td>130 ± 9.4</td>
<td>127 ± 11.9</td>
<td>P = .26</td>
</tr>
<tr>
<td><strong>Varus/valgus angulation (degrees)</strong></td>
<td>17 ± 7.8 varus</td>
<td>13 ± 8.4 varus</td>
<td>P = .11</td>
</tr>
</tbody>
</table>

*Figure 2. Long arm casting radiographs. (A) Anteroposterior radiograph showing a distal humeral shaft fracture in an above-elbow cast, 7 days after initial injury. (B) Anteroposterior radiograph at 6-month follow-up showing solid union and good alignment, after initial treatment with a long arm cast. (C) Anteroposterior radiograph showing solid union and good alignment at 1-year follow-up, after initial treatment with a long arm cast.*
Anterior/posterior angulation (degrees) | 9 ± 6.2 posterior | 7 ± 7.5 posterior | P = .54

References


**Multimedia**

**Product Guide**

- STRATAFIX™ Symmetric PDS™ Plus Knotless Tissue Control Device
- STRATAFIX™ Spiral Knotless Tissue Control Device
- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop

**Citation**


H.J. Christiaan Swellengrebel, MS