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The impact of residual angulation on patient reported functional outcome scores after non-operative treatment for humeral shaft fractures

Edward Shields *, Leigh Sundem, Sean Childs, Michael Maceroli, Catherine Humphrey, John P. Ketz, Gillian Soles, John T. Gorczyca

Department of Orthopaedic Surgery and Rehabilitation, University of Rochester Medical Center, Rochester, NY, USA

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ABSTRACT

Purpose: To determine if residual angular deformity following non-operative treatment of humeral diaphyseal fractures correlates with patient reported outcomes.
Methods: Skeletally mature patients treated by one of three orthopaedic trauma surgeons at a level 1 trauma centre with humeral shaft fractures treated without surgery were retrospectively identified over a 7 year period. After inclusion and exclusion criteria, 42 patients were eligible for the study. Disabilities of the Arm, Shoulder, and Hand (DASH); Simple Shoulder Test (SST); General health questionnaire SF-12 physical component summary (SF-12 PCS) and mental component summary (SF-12 MCS) were obtained from study participants. Healed angular deformity was obtained from patient charts.
Results: Thirty two subjects were successfully recruited (32/42 or 76%). Average age was 45 ± 22 with average study follow up being 47 ± 29 months. Average outcome scores were DASH 12 ± 16, SST 10 ± 2.7, SF-12 PCS 50 ± 7.9, and SF-12 MCS 54 ± 8.8. Healed sagittal plane deformity averaged 8 ± 5.7° [range 0–18], and 15 ± 7.9° [range 2–27] in the coronal plane. There was no correlation between residual sagittal or coronal plane deformity and outcome scores (DASH and SST for both $p > 0.05$). Patients with at least 20° ($n = 7$; 22%) of healed coronal deformity had similar outcomes to those with <20° ([DASH (13.2 ± 18.7 vs 11.7 ± 16.1; $p = 0.83$]; [SST (10.3 ± 2 vs 10.0 ± 2.9; $p = 0.81$]). Higher SF-12 PCS and MCS scores correlated with better DASH and SST scores ($p < 0.05$ for all).
Conclusion: Residual angular deformity ranging from 0 to 18° in the sagittal plane and from 2 to 27° in the coronal plane after non-operative treatment for humeral shaft fractures had no correlation with patient reported DASH scores, SST scores, or patient satisfaction. Instead, overall physical and mental health status as measured by the SF-12 significantly correlated with patient reported outcomes.

Introduction

Diaphyseal fractures of the humerus may constitute up to 5% of all fractures, with the vast majority being amendable to non-operative treatment [1]. Patients typically fall into a bimodal age distribution consisting of mostly young males 21–30 years of age, and older females 60–80 years of age [2]. Published guidelines for non-operative treatment include alignment with less than 20° of angulation in the anterior-posterior plane, less than 30° of varus–valgus angulation, less than 15° of malrotation, and less than 3 cm of shortening [3]. Operative indications include open fractures, vascular injury, articular extension, polytrauma, floating elbow, progressive radial nerve deficits, brachial plexus injury, significant soft tissue injuries prohibiting bracing, pathologic fractures, and failed non-operative management [1].

Complications of non-operative treatment include non-union, malunion, and persistent radial nerve deficits [4–8]. More than 40% of these fractures treated non-operatively may heal in greater than 5° of varus/valgus malalignment, while up to 30% may heal in greater than 5° of anterior or posterior angulation [4], [7]. Residual angulation can result in loss of motion, with up to 40% of patients may losing shoulder motion and 24% of patients having less elbow motion [4]. As a result of lost motion and malunion, up to 35% of patients may experience pain with daily activities [9].

* Corresponding authorat: 601 Elmwood, Box 665, Rochester, NY 14620, USA.
E-mail address: Edward_Shields@URMC.Rochester.Edu (E. Shields).

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Validated patient reported functional outcomes scores have significantly evolved over the past 20 years and are now important measures of patient outcomes in orthopaedic surgery [10],[11]. Although malunion or residual angular deformity and range of motion (ROM) measures continue to play a role in measuring patient outcomes, these objective findings may or may not always correlate with patient reported outcomes. The purpose of this study was to determine if residual angulation in healed humeral diaphyseal fractures treated without surgery would correlate with patient reported functional outcome scores. The study hypothesis was that increasing residual angular deformity of the humeral diaphysis would result in worse extremity specific functional outcomes.

Methods

Patients treated from 2004 to 2011 for humeral shaft fractures were retrospectively identified for three surgeons at a level 1 trauma centre. All skeletally mature patients at least 1 year post-injury at the time of study participation were included in the study. Patients were excluded if they were treated surgically, were deceased, did not have available contact information, diagnosed with dementia, had subsequent but unrelated trauma or surgery to the injured extremity, and non-English speaking. Forty-two patients met criteria and were recruited by telephone to obtain the following outcome scores: Disabilities of the Arm, Shoulder, and Hand (DASH), the Simple Shoulder Test (SST), and general health questionnaire SF-12 physical component summary (SF-12 PCS) and mental component summary (SF-12 MCS). Of the patients meeting criteria for study inclusion, 10 refused or were unable to be reached for participation. A total of 32 patients (76%; 32/42) were successfully recruited.

Patient chart reviews were conducted to obtain basic demographic data. Aetiology of the fracture was determined with chart review and by phone interview. Healed angulation at the fracture site was recorded from the last set of available radiographs from the hospitals Picture Archiving Communication System (PACS). Fractures were classified by the Orthopaedic Trauma Association (OTA) humeral diaphyseal classification system [12].

Non-operative treatment consisted of coapatation splinting for roughly 2 weeks. When the patient no longer had tenderness to pressure at the fracture site, functional bracing was initiated and independent active range of motion exercises was encouraged. As healing progressed, resistive strengthening exercises and passive stretching were started. All patients were cared for by one of three fellowship-trained orthopaedic traumatologists at some point during their care.

Data were analysed using Pearson correlation coefficients and student *T*-tests with IBM SPSS v19 (Armonk, NY), with significance set at $p < 0.05$. All values are average ± standard deviation.

This study was approved by the University Institutional Review Board.

Results

Thirty-two patients were successfully recruited with an average age 45 ± 22 [range 18–84], and average time from injury to study follow up being 47 ± 29 months [range 12–104]. The average outcome scores were DASH 12 ± 16, SST 10 ± 2.7, SF-12 PCS 50 ± 7.9, and SF-12 MCS 54 ± 8.8. Healed angular deformity in the sagittal plane measured on average 8 ± 5.7° [range 0–18], and 15 ±7.9° [range 2–27] in the coronal plane. See Table 1 for patient demographics.

There was no significant correlation between residual sagittal plane angular deformity and outcome scores (DASH score r = -0.14, p = 0.47; SST r = 0.22, p = 0.25; Figs. 1 and 2). There was no significant correlation between residual coronal plane angular deformity and outcome scores (DASH score r = -0.17, p = 0.38; SST r = 0.28, p = 0.14; Figs. 3 and 4).

Table 1
Basic group demographics. Disabilities of the arm, shoulder, and Hand (DASH); Simple Shoulder Test (SST); Body Mass Index (BMI). All values ± standard deviation.

Basic cohort characteristics	(n = 32)
Age (years)	44.6 ± 22
Time from injury to study follow up	46.8 ± 29
Healed angular deformity: saggital plane	8± 5.7°
Healed angular deformity: coronal plane	15 ±7.9°
Average DASH	12 ± 16
Average SST	10 ± 2.7
Average SF-12 Physical Component Summary	50 ± 7.9
Average SF-12 Mental Component Summary	54 ±8.8
BMI	28 ± 5.6
Workers Compensation	6.2% (n = 2)

All patients had less than 20° of residual sagittal plane deformity. Seven patients (22%) had residual coronal plane deformity of at least 20°. These seven patients had similar DASH scores (13.2 ± 18.7 vs 11.7 ± 16.1; p = 0.83), SST scores (10.3 ± 2 vs 10.0 ± 2.9; p = 0.81), and overall satisfaction with their treatment (p = 0.08) and cosmesis (p = 0.44) compared with the rest of the cohort.

Looking at the entire cohort, patients who were pleased with their cosmetic appearance had similar deformity (sagittal plane 7.4 ± 6.7°; coronal plane 15.4 ± 8.5°) compared with those who were not pleased with the appearance of their arm (sagittal plane 8.4 ± 5.4°, p = 0.76; coronal plane 14.8 ± 6.1°, p = 0.83).

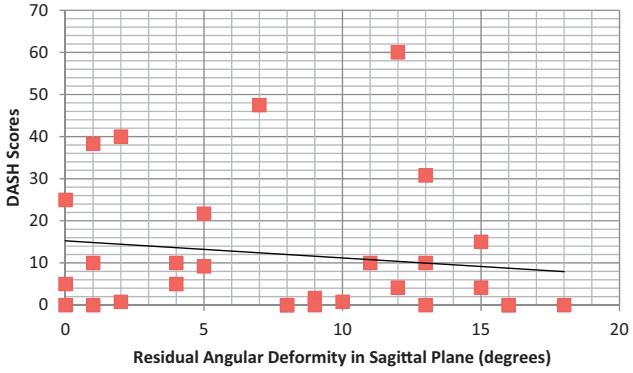

Fig. 1. There was no correlation between healed sagittal plane deformity of the humeral diaphysis and patient reported DASH score (r = -0.14, P = 0.47).

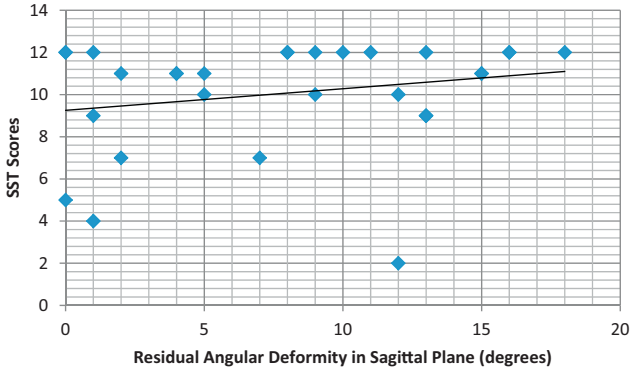

Fig. 2. There was no correlation between healed sagittal plane deformity of the humeral diaphysis and patient reported SST score (r = 0.22, P = 0.25).