RESEARCH ARTICLE

Humeral Shaft Fractures: Surgical versus Nonsurgical Management in Workers' Compensation

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Abstract

Background: The optimal surgical indications for humeral shaft fractures in the working population remain uncertain. This study investigates the impact of surgical fixation on return to duty, union, and complications in workers' compensation patients with humeral shaft fractures.

Methods: All workers' compensation patients with humeral shaft fractures managed at a single institution between 2007 and 2017 were identified. Manual chart and radiographic review was performed to identify etiology of injury, type of work, time until return to duty, length of physical therapy, complications, and time to fracture union.

Results: There were 39 humeral shaft fractures in workers' compensation patients managed at our institution (25 surgical; 64.1%). There was no difference in the return to light (106.1 versus 60.4 days; *P=0.20*) or full (140.1 vs. 139.9 days; *P=0.99*) duty for surgical versus nonsurgical treatment, respectively. There was no difference in the length of physical therapy (132.6 versus 106.3 days; *P=0.15*) or time to maximum medical improvement (174.3 vs. 198.8 days; *P=0.25*) for surgical versus nonsurgical treatment, respectively. Three patients returned to the operating room in the surgical group. Nonunion was observed in two surgical cases (8.0%) and one case (7.1%) of nonsurgical management.

Conclusion: This study did not identify an advantage for faster return to work after surgical management of humeral shaft fractures in workers' compensation patients. Though one of the perceived advantages of surgical fixation is a quicker return to physical activity, there may be other variables in this patient population that influence the timing of return to work.

Level of evidence: III

Keywords: Humeral shaft fracture, Return to work, Union, Upper extremity trauma, Workers' compensation

Introduction

Humeral shaft fractures account for 1-3% of all fractures (1). The incidence peaks in the working population (14.5/100,000 person years) as well as in the elderly (60/100,000) (1–3). For the working class, these injuries result in occupational disability. There is a need to better understand these injuries in the workers' compensation population and factors that positively influence functional recovery and return to work.

Nonsurgical management of humeral shaft fractures was popularized by Sarmiento who reported excellent union rate of 97% in a cohort of 922 patients (4). However, more recent studies have been unable to replicate these outcomes and found proximal and

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transverse fracture patterns have nonunion rates of 20-50% (5-9). In an effort to improve functional outcomes and avoid nonunions, surgical management through plate osteosynthesis or intramedullary nailing has become increasingly more prevalent in the past two decades (10, 11).

Surgical management permits early mobilization, which may lead to decreased pain and earlier functional recovery. Nonsurgical management may be associated with more pain and longer immobilization, which may delay functional recovery and return to work. However, there is limited evidence comparing surgical to nonsurgical management (6, 12-16). Moreover, there is little evidence to support the theory that surgical management facilitates quicker recovery and return to work. Van Middendorp et al prospectively evaluated outcomes of 47 patients with midshaft humerus fractures managed by surgical or nonsurgical treatment and reported significantly greater shoulder abduction strength, elbow flexion strength, functional hand positioning and return to recreational activities at 6 weeks in the surgical group; however, there was no difference at 12 weeks and 1 year. There was also no difference in return to work between the groups (15). Denard et al found a significantly higher occurrence of nonunion and malunion in patients treated conservatively, but no difference in time to union, final range of motion or return to work (6). No study reporting on return to work has evaluated insurance type or workers' compensation status.

There is a large body of literature that reports workers' compensation patients have longer return to work and worse outcomes after upper extremity injuries and surgery compared with non-workers' compensation patients (17-24). Therefore, there is great societal importance to evaluate modifiable factors that improve outcomes and return patients to work sooner. The purpose of this study was to evaluate workers' compensation patients after surgical or nonsurgical treatment of humeral shaft fractures to identify factors that influence the time for return to work and fracture union. We hypothesized that workers' compensation patients with humeral shaft fractures managed with surgical intervention would have earlier return to work compared to conservative treatment.

Materials and Methods

Patient Selection

Following approval from the institutional review board, an institutional database was utilized to identify all patients aged eighteen years or older with humeral shaft fractures managed from January 2007 to October 2017. We identified all patients' receiving workers' compensation for humeral shaft fracture. Patients younger than eighteen years of age, not receiving workers' compensation, periprosthetic and pathologic fractures were excluded.

Management of Humeral Shaft Fracture

The decision to treat surgically versus nonsurgical was determined by the treating surgeon's training, experience, and judgment. The treating orthopaedic surgeons were all fellow-ship trained, in a variety of fields (sports, trauma, shoulder and elbow, hand, and oncology). The nonsurgical group were initially treated in a coaptation splint until swelling subsided, then transitioned to a fracture brace. The duration of fracture brace wear was not standardized and was maintained until the treating surgeon noted the fracture had adequately healed on radiographic and clinical evaluation.

Surgical management consisted of open reduction internal fixation by plate osteosynthesis or antegrade humeral nailing based on treating surgeon preference and fracture characteristics. Physical therapy start time and duration was determined on a case by case basis by the treating surgeon based upon fracture healing, patient tolerance, and surgeon preference.

Data Collection

Manual chart review was performed to identify demographics, operative versus nonoperative treatment, etiology of injury, type of work, time from injury to return to light and full duty, time to maximal medical improvement, length of physical therapy, and complications. Operative reports were reviewed for surgical cases to identify mode of fixation (plate osteosynthesis or antegrade intramedullary nailing). Etiology of injury was classified as low-energy fall from standing height or higher-energy trauma (motor vehicle accident, fall from height). Other fracture characteristics including—open versus closed, neurovascular involvement, as well as fracture location and pattern—were also collected. Type of work was classified as a physically demanding occupation or a non-physical demanding occupation based on senior author consensus (JA, SN).

At our institution, a specific workers' compensation document must be completed for each visit on any workers' compensation case, and the surgeon is required to detail the work status, work/activity restrictions, and treatment plan including physical/occupational therapy. Work status options were classified as: patient is totally disabled from employment activities (temporary or permanent), modified duty, full duty, if the patient has reached maximal medical improvement (MMI), and the date of anticipated MMI. Work restrictions were none, sedentary or restricted with extremity weight limits. Patients were followed until they reached MMI. The average follow-up for the entire cohort was 9.6 months (range: 2.5 to 124.5 months). The surgical cohort average follow-up was 12.0 months (range: 2.5 to 124.5 months) and nonsurgical cohort average follow-up was 5.3 months (range: 2.8 to 8.9 months). Two patients in the surgical group were followed for 3 and 8 months but were never determined to reach MMI and did not follow up thereafter. Several attempts to contact via phone calls and messages were made without response.

Anteroposterior (AP) and lateral injury radiographs were reviewed to determine fracture location (proximal third, midshaft, distal third) and to classified based on the AO/OTA fracture classification. Postoperative AP and lateral radiographs of the humerus were reviewed to evaluate fracture healing.

Fracture Healing and Nonunion Definition

Fracture healing was defined by the treating surgeon as no tenderness to palpation at the fracture site with bridging callus on orthogonal radiographs of the humerus. Nonunion was defined as tenderness to palpation at the fracture site, continued motion at the fracture site, and lack of bridging callus on the radiographs beyond three months after initiation of treatment.

Outcomes

The primary outcome of this study was time to return to light duty and full duty. Secondary outcomes included time to reach MMI, length of physical therapy, time to union, and complications including neurovascular injury, delayed union, return to operating room.

Data Analysis

Descriptive statistics were calculated and reported for all outcome variables of the surgical and nonsurgical treatment groups. To compare outcome variables between the treatment groups, a Student's t-test was used for continuous variables and a Fisher's exact test was used for categorical variables. To confirm data normality of continuous variables, skewness and kurtosis were determined for each variable tested. All patients identified in this cohort were included in this analysis.

Results

In total, there were 39 humeral shaft fractures in workers' compensation patients managed at our institution. Twenty-five (64%) patients underwent operative management of which 20 (80%) were treated with open reduction and internal fixation with plate osteosynthesis and 5 (20%) underwent antegrade intramedullary humeral nailing. There were no significant differences in demographics, work-type, or mechanism of injury between the groups [Table 1]. In addition, no difference in the profile of fracture location or classification was noted between the two groups [Table 2].

There was not a statistically significant difference in the return to light (3.5 versus 2.0 months; *P=0.20*) or full (4.6 vs.4.6 months; *P=0.99*) duty for surgical versus nonsurgical treatment, respectively [Table 3]. Two patients (8.7%) in the surgical group and two patients (14.3%) in the nonsurgical group never returned to full duty. There was not a statistically significant difference in the length of physical therapy (4.4 versus 3.5 months; *P=0.15*) or time to maximum medical improvement (5.7 vs. 6.5 months; *P=0.25*) for surgical versus nonsurgical treatment, respectively.

There was one preoperative and one iatrogenic postoperative radial nerve palsy in the surgical group. Three patients returned to the operating room in the surgical group (a deep infected nonunion of a plate that resolved with irrigation and debridement, symptomatic proximal interlocking screw backing out of a humeral nail requiring revision nailing, and subacromial impingement and rotator cuff tear from humeral nailing). Nonunion was observed in two surgical cases (8.0%), of which one was an infected nonunion, and one case (7.1%) of nonsurgical management. The infected nonunion, as stated above, returned to the operating room for irrigation and debridement, a course of intravenous antibiotics, and went on to union and returned to full duty at 6 months. The remaining two nonunions were offered surgical intervention, but never followed up, and we were unable to be reached by phone. Overall complication

Table 1. Demographics, mechanism of injury and occupation of cohorts reported as mean and standard deviation

	All cases (n=39)	Treatment Groups		
		Nonsurgical (n=14)	Surgical (n=25)	*P-value*
Male (No.)	16 (41.0%)	7 (50%)	9 (36%)	0.50
Age (years)	52.8 ± 15.7	51.3 ± 19.2	53.6 ± 13.8	0.67
BMI	33.9 ± 8.2	33.4 ± 7.9	34.2 ± 8.6	0.80
Mechanism of Injury				
High-energy injury	5 (12.8%)	2 (14.3%)	3 (12.0%)	1.0
Low-energy fall	34 (87.2%)	12 (85.7%)	22 (88.0%)	
Occupation				
Physically demanding	13 (33.3%)	5 (35.7%)	8 (32.0%)	
Non-physical demanding	23 (59.0%)	8 (57.1%)	15 (60.0%)	1.0
Not documented	3 (4.4%)	1 (7.1%)	2 (8.0%)	

BMI=body mass index

Table 2. Fracture location and AO/OTA classification by cohort

	Nonsurgical (n=14)	Surgical (n=25)	*P-value*
AO/OTA Classification (No.)			
Proximal third	4	7	1.00
Midshaft	9	12	0.50
Distal third	1	6	0.39
AO/OTA Classification (No.)			
12-A All	8	12	0.74
A1	2	5	
A2	0	3	
A3	6	4	
12-B All	2	6	0.69
B1	2	4	
B2	0	2	
B3	0	0	
12-C All	4	7	1.00
C1	0	4	
C2	0	2	
C3	4	1	

rate of surgical intervention was 16% (4/25) compared to no complications observed in the nonsurgical group (*P= 0.28*) [Table 4].

Discussion

In theory, the workers' compensation population may benefit from timely surgical intervention of humeral shaft fractures in order to allow for a quicker return to full duty. The purpose of this study was to compare time until return to work in workers' compensation patients treated operatively and nonoperatively for humeral shaft fractures. We reported no difference in return to light or full duty between surgical and nonsurgical management of humeral shaft fractures in an all workers' compensation cohorts. Furthermore, our study did not identify any difference in length of physical therapy or time to MMI between cohorts.

Van Middendorp et al, compared outcomes of operative (retrograde unreamed humeral nail) and nonoperative treatment of midshaft humeral fractures in 47 patients (14/47, 30.0% nonoperative, vs 33/47, 70.2% operative) and found when they excluded ten retired patients, there was no difference in duration of occupational disablement or return to work at 6 weeks, 12 weeks and 1 year (15). They found 79% returned to work without restrictions after 12 months. In our study of all workers' compensation patients, we found 89% of patients return to full duty around four months after injury regardless of selected treatment. Unfortunately, the existing literature regarding return to work in the privately insured population is sparse. Koch et al, in their analysis of humeral shaft fractures treated with a functional brace, found that the average return to work was just under three months (25). Van Middendorp et al did observe that operative patients had an early benefit of shoulder abduction and elbow flexion strength, functional hand positioning, and return to recreational activities at 6 weeks, however, this difference was not sustained at 12 weeks or one year. We did not evaluate these parameters or early pain scores in our population. Denard et al, reported outcomes on 213 patients with humeral shaft fractures managed nonoperatively (63/213, 30.0% functional brace) or operatively (150/213, 70.4% compression plating) and found of those patients employed at the time of injury (179/213, 84.0%), there was no difference between treatment modality and the return to working status (32/39, 82.1% nonoperative, vs 116/140, 82.9% operative) (6). Neither of the studies reported on insurance status of patients or differences regarding return to light or full duty.

Shields et al used a national workers' compensation database to evaluate outcomes of clavicle fractures

Table 3. Return to work, length of physical therapy and time to maximum medical improvement between cohorts reported as mean and standard deviation

	Overall (n=39)	Nonsurgical (n=14)	Surgical (n=25)	*P-value*
Return to work				
Light duty (months)	2.9 ± 3.2	2.0 ± 1.2	3.5 ± 3.9	0.20
Full duty (months)	4.6 ± 1.8	4.6 ± 1.8	4.6 ± 1.9	0.99
Never returned to full duty / permanent disability (No. patients)	4 (4/37, 10.8%)*	2 (2/14, 14.3%)	2 (2/23, 8.7%)*	0.61
Length of PT (months)	4.0 ± 1.7	3.5 ± 1.1	4.4 ± 1.9	0.15
Time to MMI (months)	6.0 ± 1.8	6.5 ± 2.2	5.7 ± 1.6	0.25

MMI=maximal medical improvement; PT=physical therapy;
*Two surgical patients were lost to final follow-up.

Table 4. Complications and nonunion between surgical and nonsurgical cohorts

	Overall (n=39)	Nonsurgical (n=14)	Surgical (n=25)	*P-value*
Complication	4	0 (0%)	4 (16%)	
Deep infection	1	0	1	
Hardware failure	1	0	1	0.28
Hardware impingement	1	0	1	
Radial nerve palsy, iatrogenic	1	0	1	
Nonunion	3	1 (7%)	2 (8%)	1.00

treated surgically versus nonoperatively (26). Similar to our results, they found no difference in time from injury to return to work based upon treatment type. They found surgery was almost three times more expensive than non-operative treatment and litigation was a predictor of longer return to work and costlier overall care.

The complication rate in the surgical group was 16% compared to no complications in the nonsurgical group. The complications experienced in our surgical cohort may have been affected by treatment selection to either antegrade humeral nail or plate osteosynthesis. Of patients that underwent antegrade humeral nailing, two patients required return to the operating room (one for persistent shoulder pain found to have a rotator cuff tear at nail insertion site and one for proximal nail migration with the proximal interlock backed out who underwent revision nailing). In the plate osteosynthesis group one patient required return to operating room for irrigation and debridement of deep infection and one patient had a postoperative radial nerve palsy. There is controversy regarding the best surgical fixation method in the treatment of humeral shaft fractures. Reported advantages of humeral nailing include shorter operative time, decreased blood loss and length of stay, at the expense of higher rates of impaired postoperative shoulder function compared to plating (27, 28). Studies have reported plating is associated with higher rates of postoperative radial nerve palsy and infection compared to nailing, although a meta-analysis showed no difference (27-30). Systematic reviews and meta-analysis of randomized controlled trails comparing plating to nailing have not been able to show a difference in time to union or rates of delayed union or nonunion and cite problems of poor randomization protocols, possible attrition and reporting bias of the primary studies (31, 32).

The findings of this study must be viewed in the light of its limitations. This was a retrospective review with all the limitations inherent of that study design. The cohort included patients of several surgeons with no standardized management protocol. The low number of included cases may have resulted in lack of power to detect true differences in return to work; however, the differences between groups were so small that, even if they were statistically significant, the differences were unlikely to be clinically significant. Unavailable in this review was data pertaining to cost and ongoing litigation. Furthermore, this retrospective study did not provide an opportunity to compare pain experience, functional scores, and range of motion in the acute post-injury period.

This study did not identify an advantage for faster return to work after surgical management of humeral shaft fractures in workers' compensation patients. Though one of the perceived advantages of surgical fixation is a quicker return to work, there may be other variables in this patient population that influence the results. Further work is required to identify the most appropriate treatment of humeral shaft fractures in this unique patient population.

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