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Research Paper

Comparison of complications, reoperations, and outcomes between tension band wiring and plate fixation in olecranon fractures

MICHAEL DEL CORE, JUNHO AHN, STEPHEN GATES, CHAN-HEE JO, MEDARDO MAROTO, DREW SANDERS

University of Texas Southwestern Department of Orthopaedic Surgery, Dallas, Texas, United States of America

Address for correspondence:
Michael Del Core, University of Texas Southwestern Department of Orthopaedic Surgery, Dallas, Texas, United States of America
madelcore@gmail.com

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Abstract

Introduction: Olecranon fractures are relatively common upper extremity fractures often treated with tension band wiring and plate fixation. The purpose of this review is to compare the complications, reoperation rates, and clinical and radiographic outcomes of tension band wiring and plate fixation in patients treated surgically for olecranon fractures at our institution.

Methods: Retrospective review identified 59 patients (27 men and 32 women) treated operatively for olecranon fractures between 2006 and 2016 at our level 1 trauma center. The average age was 47 years (range: 17 to 81 years). Medical records were reviewed for complications, reoperation rates, and other perioperative variables. The average follows up time was 12 months. All patients were assessed clinically and radiographically at their latest follow up.

Results: Of the 59 patients with an olecranon fracture, 23 underwent treatment with tension band wiring and 36 underwent plate fixation. The overall complication rate was 55.9%. The most common overall complication was symptomatic implants seen in 44.1% of patients. Complications were greater in the tension band group (65.2%) compared to the plate fixation group (50%). The overall rate of implant removal for both fixation groups was 39.0%, performed at an average time of 11.6 months. This was seen in 43.5% of the tension band group and 36.1% in the plate fixation group. Implant removal was most commonly performed for symptomatic hardware. The mean elbow extension deficit was 7 degrees for both groups. Plate fixation required significantly longer operating times (110 verse 81 minutes). Radiographic arthrosis was seen in nine patients (15.3%) and heterotrophic ossification was seen in seven (11.9%).

Conclusion: Though both tension band wiring and plate fixation are reliable fixation methods that provide a consistent union of olecranon fractures, our series demonstrates high rates of complications and reoperations for both methods.

Keywords: Olecranon fractures, tension band, plate fixation, outcomes, complications

INTRODUCTION

Simple olecranon fractures are a common injury representing 10% of all upper extremity lesions [1]. Most olecranon fractures occur through either direct trauma onto the posterior aspect of the elbow or an indirect tension injury from the triceps, leading to an avulsion injury. These fractures present along with a spectrum from simple transverse patterns to complex comminuted injuries. Due to the intra-articular nature of the fracture and the importance of the olecranon in maintaining the extensor mechanism, an attempt at operative anatomic reduction should be undertaken. The goals of operative intervention include restoring joint congruency and providing rigid fixation in efforts to preserve range of motion and prevent post-traumatic arthritis. A variety of fixation methods have been employed to treat these fractures including tension bands, plates, partially threaded screws, and intramedullary nails. Tension banding techniques are effective for simple transverse fractures with no comminution, while comminuted and oblique fractures are generally treated with plating. Both fixation methods are associated with well-known complications including symptomatic implants, wound problems, and stiffness. Complications such as these frequently necessitate unplanned reoperations, exposing patients to further morbidity. Each fixation method carries its advantages and disadvantages and there remains debate regarding the optimal fixation construct.

The primary purpose of this study was to investigate, in a retrospective manner, the clinical and radiographic outcomes of olecranon fractures treated with either tension band wiring or plate fixation. Our primary endpoints for review were surgical complications, reoperations, the arc of motion, and progression to union or nonunion.

MATERIALS AND METHODS

The electronic medical records of a level 1 trauma registry were retrospectively reviewed for all patients treated with an operative fixation for olecranon fracture between July 2006 and February 2016. Inclusion criteria were: (1) olecranon fractures; (2) treatment with plate or tension band technique; and (3) skeletal maturity. Exclusion criteria were: (1) associated concomitant lesions of the elbow; and (2) less than six months of clinical and radiographic follow up.

After charts were reviewed, 59 patients met inclusions criteria. There were 27 men and 32 women with an average age of 47 years (range: 17 to 81 years). Twenty-six patients (44.1%) injured their dominant arm. Of the 59 patients, 36 were injured in a fall, 17 in a motor vehicle accident, and six from blunt trauma to their elbow. There were 44 (74.6%) closed and 15 (25.4%) open fractures. All fracture patterns were classified according to the Mayo Classification [2]. Of the 59 fractures, there were 2 type IA (3.4%), 2 type IB (3.4%), 20 type IIA (33.9%), 32 type IIB (54.2%), 0 type IIIA (0%), and 3 type IIIB (5.1%). The demographic characteristics can be seen in Table 1.

Patients were treated operatively at an average of 4.8 days (range 0 to 21 days) from injury. Surgical technique and method of fixation were chosen by the primary surgeon. The fixation consisted of tension band wiring in 23 cases (39.0%) and plate fixation in 36 (61.0%) cases. Bone graft was used in 4 patients; all of whom were treated with plate fixation. Post-operative antibiotics were administered for 24 hours. Patients were either briefly immobilized in a plaster splint, or given immediate free range of motion. This was determined by the attending surgeon, and based on the severity of comminution, the fixation used, and the extent of soft tissue injury.

Patients were evaluated clinically and radiographically for a minimum of six months. The follow-up period ranged from 6 to 27 months with an average of 12.2 months. Electronic medical records were reviewed to collect complications, reoperations, and outcomes. Radiographs were reviewed pre and post-operatively for evidence of union, arthrosis, and heterotrophic ossification. The Broberg and Morrey system was used to rate arthrosis [3].

Statistical analysis was conducted to assess for significant differences between the two groups in regards to complications, reoperations, the range of motion, operative time, and radiographic outcomes. A p-value of <0.05 indicated statistical significance.

RESULTS

Complications were seen in 33/59 (55.9%) patients. The most common complications were symptomatic implants in 26/59 (44.1%), infection in 6/59(10.2%), wound complications in 4/59 (6.8%), ulnar neuritis in 2/59 (3.4%), and implant failure in 2/59 (3.4%) patients. For the six patients that developed wound infection, five were operatively treated with irrigation and debridement, and one was successfully treated with a course of oral antibiotics. There was no difference (p=0.251) in complication rates between the tension band (65.2%) and the plate fixation groups (50.0%). The overall implant removal rate was 39.0% (23 of 59 patients) at an average time of 11.6 months (range: 3 to 23 months). Implant removal was needed in 43.5% of tension band patients and 36.1% of plating patients (p=0.571). The average time to implant removal was 9.4 months among those treated with tension band fixation, and 13.3 months in those with plate fixation (p=0.081). Of the

Table 1. Demographic characteristics of the two groups

	Age, mean (SD)	Sex, N (%)	Dominant arm, N (%)	MOI, N (%)	Open injuries,N (%)	Mayo Classification, N (%)	Time till OR, mean (days)	Follow up time, mean (months)
TBW (N=23)	47 (15)	10 (43) M 13 (57) F	10 (43)	12 (52) Fall 8 (35) MVA 3 (13) Blunt	5 (22)	1 (4) 1B 13 (57) 2A 9 (39) 2B	2.2	12.0
PF (N=36)	47 (17)	17 (47) M 19 (53) F	16 (44)	24 (67) Fall 9 (25) MVA 3 (8) Blunt	10 (28)	2 (6) 1A 1 (3) 1B 7 (19) 2A 23 (64) 2B 3 (8) 3B	6.5	12.4
Overall (N=59)	47 (17)	27 (46) M 32 (54) F	26 (44)	36 (61) Fall 17 (29) MVA 6 (10) Blunt	15 (25)	2 (3) 1A 2 (3) 1B 20 (34) 2A 32 (54) 2B 3 (5) 3B	4.8	12.2

TBW: Tension band wiring
PF: Plate fixation
MOI: Mechanism of injury
MVA: Motor vehicle accident

10 tension band patients undergoing implant removal, 9 were for symptomatic implants and the remaining one for infection with wound dehiscence. In the plate fixation group of 13 patients undergoing implant removal, 11 reoperations were for symptomatic implants and the remaining 2 for infection and wound dehiscence. The overall reoperation rate, including but not limited to implant removal, was 44.1%. There was no difference (p=0.642) in reoperation rates between tension band (47.8%) and plate fixation (41.7%). Data regarding complications and implant removal rates between the two groups can be seen in Table 2.

The postoperative range of motion at the latest clinical follow up was reviewed for all patients. The average ulnohumeral arc of motion was 133 degrees. The mean flexion was 139 degrees (range: 90 to 150 degrees) and the mean elbow extension deficit was 6.6 degrees (range: 0 to 50 degrees). The mean arc of forearm rotation was 155 degrees (range: 80 to 160) with mean supination of 77 (range 0 to 80) and mean pronation of 78 degrees (range 20 to 80 degrees). For those not already at the full range of motion, the average arc of elbow motion improvement after implant removal was 35 degrees. There was no significant difference in the range of motion between the two groups. A range of motion data between the two groups can be seen in Table 3.

Operative time averaged 81 minutes (range: 48-131 minutes) for the tension band group and 110 minutes (range: 60-231 minutes) for the plating group with the exclusion of poly-trauma cases.

Radiographs at the latest clinical visit showed union and articular congruity in all patients regardless of the procedure. Ulnohumeral arthrosis was radiographically seen at final review in nine patients according to the Broberg and Morrey classification. Seven patients had grade 1 (slight joint space narrowing with minimal osteophytes), two patients had grade 2 (moderate joint space narrowing with moderate osteophytes, and zero patients had grade 3 (severe joint space narrowing and joint destruction). Seven patients were found to have evidence of heterotrophic ossification at the latest radiographs. There were no differences in the rate of arthrosis or heterotrophic ossification between the two fixation techniques. Data can be seen in Table 3.

DISCUSSION

Olecranon fractures are a relatively common upper extremity injury in adults with displaced fractures requiring operative management. The goals of surgical treatment are to provide adequate fixation and to restore articular congruity in efforts to preserve stability, strength and a pain-free arc of elbow motion. Operative fixation, regardless of procedure, has good long-term results. A study by Karlsson et al., reports on one of the longest follow-up periods of operatively treated olecranon fractures. In their review of 73 cases, they showed that 96% of individuals with olecranon fractures treated by open reduction internal fixation had good to excellent outcomes with 15-25 year follow up [4]. Despite the good to excellent results, the perioperative period is not without issues.

There are well-known complications following operative fixation of olecranon fractures, most notably symptomatic implants, wound problems, ulnar neuritis, and stiffness. The proximity of the implants to the skin makes symptomatic implants a common occurrence regardless of fixation technique. Macko et. al, in a series of 20 patients treated with TBW, reported a 75% rate of painful implants [5]. Hume et al., evaluated 41 patients treated with either TBW or PF and found that symptomatic hardware occurred in 42% of the TBW group compared to 5% in the plating group [6]. De Giacomo reported a much higher rate (31%) of symptomatic hardware after plate fixation [7]. In a series of 23 patients, Snoddy et al found hardware prominence in 39% of patients treated with ORIF and 65% of their TB cohort [8]. Our rate of symptomatic implants in TBW (52.2%) and PF (38.9%) falls within these published ranges.

Given the lack of soft tissue coverage over the olecranon, infections

Table 2. Analysis of complications and implant removal rates

	Tension band, N (%)	Plate fixation, N (%)	P-value
Complications			
*Overall	15 (65.2)	18 (50.0)	0.251
Symptomatic implants	12 (52.2)	14 (38.9)	0.316
Infection	3 (13.0)	3 (8.3)	0.669
Wound dehiscence	2 (8.7)	2 (5.6)	0.639
Ulnar neuritis	2 (8.7)	0 (0.0)	0.148
Implant failure	0 (0.0)	2 (5.6)	0.516
Implant removal			
Overall	10 (43.5)	13 (36.1)	0.571
Symptomatic implants	9 (39.1)	11 (30.6)	0.497
Infection/Wound dehiscence	1 (4.3)	2 (5.6)	0.999

TBW: Tension band wiring
PF: Plate fixation
P- value<0.05 indicates statistical significance
*The overall rate is not the sum of its subparts as some patients presented with multiple complications

Table 3. Range of motion, surgical time, and radiographic data

	ROM						Mean surgical time, minutes (SD)	Arthrosis, N (%)	HO, N (%)
	Flexion, mean (SD)	Extension, mean (SD)	Pronation, mean (SD)	Supination, mean (SD)	Final flexion arc, mean (SD)	Final rotation arc, mean (SD)			
Overall	139.2 (17)	6.6 (10)	78.3 (9)	76.5 (15)	132.7 (24)	154.8 (18)	97.4 (34.8)	9 (15)	7 (12)
TBW	138 (16)	7.8 (11)	79.8 (1)	79.8 (1)	130.2 (26)	159.6 (2)	80.8 (20)	2 (8.7)	3 (13)
PF	140 (18)	5.8 (8)	77.4 (11)	74.4 (18)	134.2 (23)	151.8 (23)	109.9 (38)	7 (19)	4 (11)
P -value	0.361	0.448	0.533	0.224	0.507	0.219	0.0018	0.263	0.999

TBW: Tension band wiring
PF: Plate fixation
ROM: Range of motion
HO: Heterotrophic ossification
P- value<0.05 indicates statistical significance

are a serious complication that frequently requires reoperation. Chalidis reported a 6.5% wound infection rate in patients treated with tension band wiring [9]. Our overall infection rate was slightly higher at 10.2%. A relatively rare complication is ulnar neuritis, with Villanueva et al. reporting rates of 2.7% after TB fixation [10]. This is comparable to the 3.4% of ulnar neuritis presented in this series

Many of these complications require a second operation and numerous studies cite the relatively high rate of reoperations for implants removal following operative treatment of olecranon fractures. Looking at plate fixation, Anderson et al. found a 9.3% rate of symptomatic hardware requiring removal [11]. In a retrospective review of 25 patients over 5 years, Bailey et al. found a 20% plate removal rate [12]. Buijze et al. reported a much higher rate (56%) of plate removal in their cohort of patients [13]. Literature reviewing reoperations after TBW frequently reports even higher rates of hardware removal. In one of the largest retrospective reviews, Chalidis et al. identified 62 patients treated with TBW with an overall 82.3% implant removal rate [9]. Helm et al., reported a rate of 82% removal following TBW and Macko et al reported a 65% TBW implant removal rate in 20 patients [5,14]. Comparing the implant removal rates between the two groups, Edwards et al. found a 63% TBW removal rate compared with 62.5% with the PF group [15]. Snoddy et al. found a statistically significant difference in implant removal rates (p=0.0006) between TBW (46.51%) and PF (18.66%) [8]. There was no significant difference (p=0.571) noted in implant removal rate amongst our cohorts with 43.5% of tension band and 36.1% of plate fixation patients requiring removal. Patients must be counseled appropriately regarding this matter to manage expectations.

Loss of motion after olecranon fractures is a common occurrence, however, these deficits rarely exceed the functional limits of elbow range of motion. Postoperative ranges of motion estimates have varied widely in the published literature. Regarding plate fixation, Anderson and Buijze both reported a 13° extension deficit [11,13]. De Giacomo found an average ROM from 11-133° [7]. Schliemann reported 6.5° extension deficit and Tarallo reported a 7.8° deficit [16,17]. Our plate fixation cohort had an average extension deficit of 5.8°. In regards to the range of motion after tension band fixation, Schliemann reported an arc of 5-141° and Villanueva from 14-141° [10,16]. Tarallo reported an extension deficit of 9.7° [17]. Hume, in a comparison between the two, did not find any statistically significant difference in regards to the range of motion [6]. Ren, in a systematic review and meta-analysis, found no difference between the two in regards to ROM as well [18]. There were no statistically significant differences in any range of motion noted in a comparison of our tension band to plate fixation groups.

Our study found a statistically significant difference in regards to operating time between the tension band and plate fixation when excluding poly-trauma cases (80.8 vs. 109.9 minutes, P=0.0018). Amini et al., found a similar difference with an average operative time of 55.3 for tension band verse 85.4 minutes for plate fixation [19]. Hume et al found that PF took on average 25 minutes longer to perform than TBW [6]. Schliemann found a statistically significant difference in average operating times with PF taking 121 verse 88 minutes for the TB group (p=0.001) [16].

In a long term follow up study, Karlsson et al found a 50% rate of degenerative changes following olecranon fractures compared to their ipsilateral extremity [20]. Chalidis in a similar study found a 48.8% rate [9]. Our overall rate of arthrosis was 15%, however, since arthrosis develops over many years, no conclusions can be drawn from our results.

Limitations of our study include its retrospective design, our relatively short clinical follow up (average of 12 months), and our lack of validated functional outcomes scores. Additionally, multiple surgeons at our institution performed the operations each with their own operative techniques. Nevertheless, our study has several strengths to address. First, the detailed medical record review provides valuable insight into the clinical variables surrounding olecranon fractures. Second, our population size is relatively large compared to other similar studies. Lastly, we report time to implant removal in efforts to provide surgeons with the necessary postoperative details for counseling patients on outcomes after olecranon fractures. Larger randomized controlled trials with long follow up and functional scoring are needed to further clarify these strengths and outcomes of tension band wiring and plate fixation after olecranon fractures [21-28].

CONCLUSION

Olecranon fractures are a common fracture of the upper extremity with a variety of treatment options and generally acceptable results. The different operative techniques each have known complications of symptomatic implants, frequent reoperations, and decreased the postoperative range of motion. Despite no statistically significant difference noted between the cohorts, our study confirms the high rate of complications and reoperations between the two most popular treatment techniques. This review attempts to add insight into the outcomes of operatively treated olecranon fractures in efforts to assist surgeons in guiding their patient's expectations.

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