Original Article

Evaluation of Outcomes of Open Reduction and Internal Fixation Surgery in Patients with Type C Distal Humeral Fractures

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Abstract

Background: In this study, functional state of patients with Type C distal humerus fractures undergone surgical plating was evaluated 6 and 12 months after the surgery in order to record postsurgical factors such as pain level and job/performance satisfaction. **Materials and Methods:** In this cross-sectional study, 46 patients with humerus fractures were recruited and their ability to do daily tasks, presence of degenerative changes, stability of elbow joint, and range of motion was evaluated. For assessment of response to surgery, Mayo score was used. **Results:** Among 46 patients, 45 (97.8%) of them had joint stability. Evaluation of postsurgical complications showed that six subjects (13%) had no complications, but superficial infection was observed in 12 (26.1%) subjects. Neuromuscular disorders in ulnar nerve were present in 11 subjects (23.9%), recurrent articular bursitis of elbow joint in 6 subjects (13%), stiffness of elbow joint in 29 subjects (63%), nonunion of fracture in 3 subjects (6.5%), and myositis ossification in 4 (8.7%) subjects. Furthermore, 18 (39.1%) patients presented with more than one (2–4) complications. **Conclusion:** Open reduction and internal fixation surgery with dual plating is the method of choice for treatment of Type C distal humeral fractures. Evaluation of long-term outcomes of this surgery could be done via several different questionnaires as many studies suggest. This study demonstrated that the outcomes of this surgery in Isfahan, Iran, have been noticeably inferior compared to results of the studies in other parts of the world.

Keywords: *Distal humeral fracture, Mayo elbow performance index, outcomes, visual analog scale*

Introduction

Treatment of fractures in distal part of humerus bone is a hard and rather complicated process. This fracture is categorized into three different types, the first of which, called Type A fracture is an extra-articular fracture; Type B is a partial articular fracture, whereas Type C has a more complicated pattern and is the hardest to treat due to involvement of both condyle and articular surface.[1,2]

Treatment of Type C fractures of humerus is quite challenging due to anatomical complexities of this area and considering the presence of brachial neuronal network and triple chords in hand (ulnar, radial, and medial) and the fact that all these other structure are also affected in the fracture.[3]

In the past, these fractures lead to several complications and treatments at hand could seldom retrieve normal functions of the organ. Nevertheless, with development of open surgery procedures, these treatments have improved drastically. At present, the technique of choice for many surgeons is orthogonal dual plate fixation. This procedure could improve biomechanical stability of involved location following joint immobilization after the surgery and lead to recovery of the organ.[4,5]

Even though several studies have been carried out on the outcomes of open surgery and internal fixation, drawing an inclusive conclusion based on the results of these studies is hard due to a wide variation of fractures and surgical techniques. In addition, the majority of these studies have used subjective methods to evaluate surgical outcomes.[6,7]

Similar studies on this subject have never been done in Iran and on the Iranian population. The goal of the current study is to evaluate the results of open surgery and internal fixation in patients with Type C fractures of humerus bone. There are two types of tools generally used in orthopedics evaluations: patient rated and physician rated. In the current study, Mayo scaling

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and visual analog scale (VAS) were used to assess patients' functional state.[8,9]

Materials and Methods

The present study is a cross-sectional study on 46 patients' undergone open surgery and internal fixation following Type C fractures of the humerus. Inclusion criteria for patient recruitment were having undergone surgery between July 2013 and July 2014 with at least 6 months interval between the operation and beginning of the study. Subjects also had to be between ages of 20 and 70 years old to be recruited for the study. Patients with chronic diseases such as rheumatoid arthritis, diabetes mellitus, chronic kidney disease, chronic heart failure, and osteoporosis were excluded from the study. Moreover, subjects on long-term corticosteroid based treatments or on any other medications that may change bone density (thyroid hormones, methotrexate, heparin, anticonvulsants, alendronate, calcitonin, raloxifene, and Vitamin D) were excluded from the study. Patients who refused to refer for physical examination and follow-ups were also excluded.

Study design

Subjects that filled the inclusion criteria were selected and reached by phone. Patients with a desire to enter the study were recruited after full explanation of the study process and having signed a written consent. A complete patient history and physical examination was done to rule out systemic diseases treatment with certain medications. Physical examination assessed patients' functional criteria such as joint stability and range of elbow motion (extension-flexion, and range of motion [ROM]). Radiographs were also examined to determine degenerative changes. Demographic data were extracted from hospital documents.

The level of pain was evaluated using VAS[10] based on sex and age. VAS is an assessment tool for evaluation of factors that cannot be directly measured. In this scale, a line is shown to the patients with one end indicating "no pain" and the other end representing "the worst imaginable pain." The patient is asked to indicate their level of pain on this scale. The scale is a 10 cm line and the result is shown from 1 to 10.

Assessment of patients' function was done using Mayo elbow performance index (MEPI). MEPI is one of the most widely used physical-based elbow joint rating systems. This criteria is a four-part system including pain (145 scores), ulnohumeral motion (20 scores), joint stability (10 scores), and the ability to perform five functional tasks (125 scores). In this scale, pain is indicated by no pain (45 scores), mild pain without movement limitations or regular use of analgesics (30 scores), moderate pain with movement limitations and regular use of analgesics (15 scores), and severe pain despite regular use of analgesics and movement limitations (0 scores). Joint stability is scaled as stable, mildly unstable, and unstable. Functional state is evaluated based on patient's ability to do daily tasks. The total score varies from 5 to 100 in which the higher the score, the better the function.

Postsurgical complications were indicated and recorded including superficial infection neuromuscular disorder in ulnar nerve, recurrent articular bursitis of elbow joint, stiffness of elbow joint, nonunion of fracture, and myositis ossification.

Statistical analysis

All recorded data were analyzed qualitatively using SPSS 20 (SPSS, Inc., Chicago IL). In addition, all variables such as VAS and MEPI and results from physical examination including ROM and joint stability and radiographic findings such as degenerative changes were analyzed based on age and sex using analysis of variance (ANOVA) test.

Results

In the present study, 46 patients with Type C distal humeral fractures participated that had undergone open surgery using a dual plating system with locking plates. The subjects had an average age of 46.2 ± 17.6 years. Moreover, the ratio of male to female subjects was 33–13 with average age of female subjects being 49.7 ± 15.2 and for males being 44.8 ± 17.8 years old. The average age of male to female subjects had no significant difference.

Pain severity average baseline based on VAS was 3.30 ± 1.86. ROM was over 100° in 15 subjects, 50–100° in 20 subjects, and under 50° in 11 subjects. Considering usual daily activities, 4 patients had complete recovery whereas 15 patients showed relative recovery and 27 patients had obvious decline in daily activities.

Radiographic findings showed lack of any degenerative changes in 21 patients while 17 patients demonstrated with mild osteoarthritis and 8 patients had medium osteoarthritis. Physical examinations determined that all but one subject had appropriate joint stability.

Results from ANOVA analysis of these variables-based age and gender are shown in Table 1. According to these results, pain was more severe in patients over 50 years compared to younger subjects, but no significant difference was found between male and female group. Age and gender had no significant effect on ROM and joint stability. Degenerative changes were significantly more prevalent among subjects over 50 years of age, but gender had no significant effect on this factor.

Evaluation of postsurgical complications showed that the most prevalent complication after this surgery was stiffness of elbow joint was evident in 29 patients. Other complications including superficial infection (12 patients), neuromuscular disorder in ulnar nerve (11 patients), and nonunion of fracture (3 patients) were less

Table 1: Distribution of severity of pain, range of motion of joint and ability to perform daily tasks according to age and gender

Variables	All patients, count (%)	Age			Gender		
		Younger than 50, count (%)	50 or older, count (%)	*P*	Male, count (%)	Female, count (%)	*P*
Pain severity average	3.39±1.86	2.82±1.42	4.28±2.14	0.008	3.06±1.56	4.23±2.31	0.53
ROM							
>100	15 (32.6)	12 (42.9)	3 (16.7)	0.08	13 (39.4)	2 (15.4)	0.31
50-100	20 (43.5)	12 (42.9)	8 (44.4)		13 (39.4)	7 (53.8)	
<50	11 (23.9)	4 (14.3)	7 (38.9)		7 (21.2)	4 (30.8)	
Ability to perform daily tasks							
As before	4 (8.7)	3 (10.7)	1 (5.6)	0.11	3 (9.1)	1 (7.7)	0.05
Relatively as before	15 (32.6)	12 (42.9)	3 (16.7)		14 (42.4)	1 (7.7)	
Reduced	27 (58.7)	13 (46.9)	14 (77.8)		16 (48.5)	11 (84.6)	
Degenerative changes							
Without change	21 (45.7)	21 (46.4)	0 (0)	0.001	16 (48.5)	5 (38.5)	0.061
Mild osteoarthritis	17 (37)	7 (25)	10 (55.6)		14 (42.4)	3 (23.1)	
Medium osteoarthritis	8 (17.4)	0 (0)	8 (44.4)		3 (9.1)	5 (38.5)	
Severe osteoarthritis	0 (0)	0 (0)	0 (0)		0 (0)	0 (0)	
Joint stability							
Stable	45 (97.8)	27 (96.4)	18 (100)	0.99	32 (97)	13 (100)	0.99
Unstable	1 (2.2)	1 (3.6)	0 (0)		1 (3)	0 (0)	

ROM: Range of motion

common [Figure 1]. In addition, 6 patients showed no postsurgical complications and 18 patients had more than one complication (2–4 patients).

The average Mayo score from the questionnaire was 61.63 ± 14.18. A total of 3 subjects' scores excellent in the Mayo scale with 4 subjects scoring well, 2 subjects scoring satisfactory (fair), and 35 subjects scoring weak (poor) [Figure 2]. Table 2 shows details of obtained results from Mayo questionnaire. In Table 2, Mayo score is shown based on age and sex. As it is evident from this table, the average Mayo score was higher in subjects below 50 years of age. On the other hand, this score was significantly higher in male subjects compared to females.

Discussion

The goal of this study was to determine the outcomes of open reduction and internal fixation (ORIF) surgery with dual plate in patients with Type C distal humeral fractures. Mayo questionnaire and VAS were utilized to assess patients' functional state and severity of pain.

The results showed that the average MEPI score was 61.63 ± 14.18 in this study. While only 9 subjects had excellent and good results, over 80% (37 subjects) had showed poor results. These findings are against findings from other studies, i.e. in most of the previous studies, over 50% of subjects demonstrated with good and excellent results.

In a study by Pajarinen and Björkenheim,[11] undertaken in 2002 on patients with Type C distal humeral fractures, evaluated retrospectively over 4 years, the outcomes of surgery were measured using different tools such as disabilities of the arm, shoulder, and hand (DASH), patients-rated ulnar nerve evaluation, American shoulder and elbow surgeons elbow form, and short form-36. In this study, patients' satisfaction level was 93%. In another study by Puchwein *et al*.,[12] in 2011, 22 patients who had undergone surgery for Type C fractures of humerus between 1999 and 2008 were evaluated retrospectively. In this study, JUPITER, CASSEBAUME, and Quick DASH tools were utilized to evaluate surgery outcomes. According to CASSEBAUME and JUPITER scales, 86.4% and 81.8% of patients reported excellent results, respectively.

Distal humeral fractures are quite varied and many factors play a key role in their postsurgical prognoses such as patients' age, bone quality and bone density of patients, nicotine use, and comorbidities such as diabetes mellitus and finally quality of the operation and used material. Drawing a conclusion from the results and generalization from studies is hence quite difficult.[13] As for the tools used for evaluating the outcome of the surgery and patient's functional state, there are two types of tools generally used in orthopedics: patient rated and physician rated. These tools are quite diverse and the results from one tool could not be directly and quantitatively compare with results from another tool. According to this, in a study by Schmidt-Horlohé *et al*.,[14] 51 patients with Type C fractures of humerus were evaluated in 2010 using MEPI tool (the same tool applied in the present study). Over 95.5% of patients reported excellent and good results which is entirely different from our results.

Another finding from this study was pain severity average baseline drawn from results of VAS. This average was 3.39 ± 1.86 from 10. This scale has rarely been used in

Table 2: Distribution of frequency of patients' status improvement according to age and gender

	All patients, count (%)	Age			Gender		
		Younger than 50, count (%)	50 or older, count (%)	*P*	Male, count (%)	Female, count (%)	*P*
Average	61.3±14.18	66.61±11.87	53.89±14.3	0.002	64.85±12.78	53.46±14.77	0.013
Mayo score							
Excellent	3 (6.5)	3 (10.7)	0 (0)	0.29	3 (9.1)	0 (0)	0.6
Good	6 (13)	5 (17.9)	1 (5.6)		5 (15.2)	1 (7.7)	
Fair	2 (4.3)	1 (3.6)	1 (5.6)		2 (6.1)	0 (0)	
Poor	35 (76.1)	19 (67.9)	16 (88.9)		23 (69.7)	12 (92.3)	
Pain intensity							
Painless	8 (17.4)	7 (25)	1 (6.5)	0.058	6 (18.2)	2 (15.4)	0.082
Mild	28 (60.9)	18 (64.3)	10 (55.6)		22 (66.7)	6 (46.2)	
Moderate	9 (196)	3 (10.7)	6 (33.3)		5 (15.2)	4 (30.8)	
Severe	1 (2.2)	0 (0)	1 (5.6)		0 (0)	1 (7.7)	
Joint ROM							
>100°	18 (39.1)	15 (53.6)	3 (16.7)	0.019	16 (48.5)	2 (15.4)	0.061
50-100°	18 (39.1)	10 (35.7)	8 (44.4)		12 (36.4)	6 (46.2)	
<50°	10 (21.7)	3 (10.7)	7 (38.9)		5 (15.2)	5 (38.5)	
Joint stability							
Stable	44 (95.7)	28 (100)	16 (88.9)	0.15	31 (93.9)	13 (100)	0.51
Unstable	2 (4.3)	0 (0)	2 (11.1)		2 (6.1)	0 (0)	
Function							
Can comb hair	3 (6.5)	0 (0)	3 (16.7)	0.004	1 (3)	2 (15.4)	0.32
Can eat	11 (23.9)	5 (17.9)	6 (33.3)		7 (21.1)	4 (30.8)	
Can perform hygienic tasks	12 (26.1)	5 (17.9)	7 (38.9)		8 (24.2)	4 (30.8)	
Can do shirt	11 (23.9)	11 (39.3)	0 (0)		10 (30.3)	1 (7.7)	
Can do shoes	3 (6.5)	2 (7.1)	1 (5.6)		2 (6.1)	1 (7.7)	
All	5 (10.9)	5 (14.3)	1 (5.6)		5 (15.2)	1 (7.7)	

ROM: Range of motion

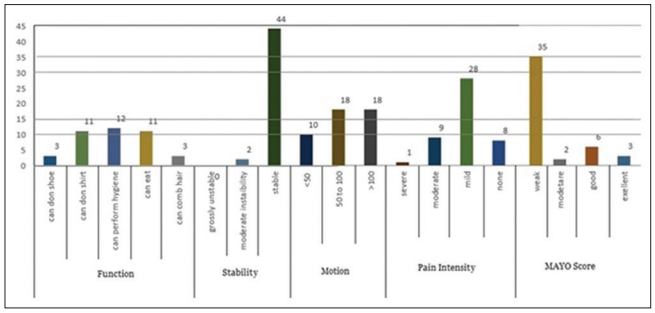

Figure 1: Frequency of surgery complications in studied patients

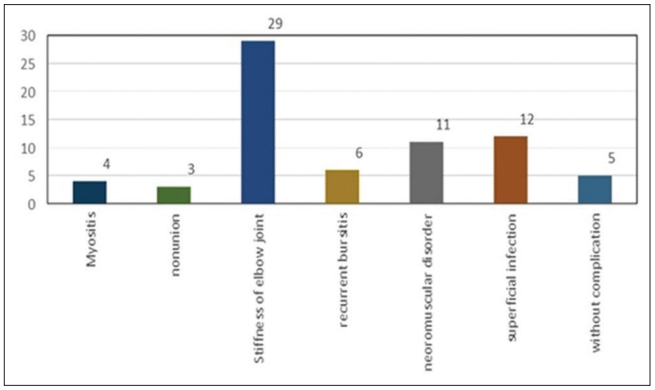

Figure 2: Frequency of Mayo score in studied patients

other studies due to the fact that most other tools include pain assessment scores within themselves and there is no further need to apply this scale.

Our findings showed that ROM of elbow joint was smaller than 50° in 11 patients, whereas in most studies this number is within a more acceptable range. For instance, in a study by Reising *et al*.,[15] in 2009, evaluation of 40 patients with Type C fractures of humerus showed that the average ROM was 100° with the majority of patients showing better results than the present study.

Postsurgical complications were observed in 40 out of 46 patients in this study. The most common complication being stiffness of elbow joint was observed in 29 subjects. Studies showed that a factor contribution to reduction of this complication is early mobilization of joint after surgery.[16] The next prevalent complication was found to be superficial infection as observed in 12 patients. Ulnar nerve neuropathy, recurrent articular bursitis of elbow joint, nonunion, and myositis ossification were other complications seen in our subjects. This is while in similar studies, the number of postsurgical complications and their frequencies are considerably lower. In a study by Krishnamurthy,[13] of 20 patients, three presented with

superficial infection, two with ulnar neuropathy, and one with nonunion. Several factors such as nicotine use, high blood glucose, and HbA1c levels may play roles on postsurgical infections. Moreover, in case of nonunion of fracture, a follow-up surgery and bone grafting is needed.[17]

The average age of patients in this study was 46.1 ± 17.6 years old which was the same as other studies. The ratio of male to female subjects was 33 to 13 while in most other studies females are the majority of subjects. In the current study, the results from MEPI and pain severity and degenerative changes are better in patients less than 40 years compared to older subjects. This is in agreement with previous studies. Parajinen *et al*. reported that the outcomes of surgery are better in patients who are less than 40 years compared to older patients. Furthermore, the average MEPI score was higher in male subjects compared to females which could be attributed to higher prevalence of bone disorders such as osteoporosis in females.

A limitation of the current study was its being retrospective and also its short 1-year study interval. Nevertheless, sample size was rather large compared to previous studies. Another upside of this study was determining the effect of age and gender on other variables. This study is one of the very few studies on this subject carried out in Iran. As it was previously said, several factors contribute to postsurgical outcomes in these studies and similar studies need to be undertaken in a prospective fashion, with larger sample sizes and in different areas and different populations for the results to be conclusive.

Conclusion

ORIF surgery with dual plating is the method of choice for treatment of Type C distal humeral fractures. Evaluation of long-term outcomes of this surgery could be done via several different questionnaires as many studies suggest. This study demonstrated that the outcomes of this surgery in Isfahan, Iran, have been noticeably inferior compared to results of the studies in other parts of the world.

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Conflict of interest

The authors have no conflicts of interest.

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