

**Original Article**

Evaluation of Results of Open Reduction and Internal Fixation of Intraarticular Fracture of Distal Humerus AO type 13-C1 by 90-90 Plate Through Triceps Sparing Approach

Mohammad Reza Hossain Khan,¹ Md. Shameem,² Asma Sharmin,³ Jesmin Jahan,⁴
Syed Mohammad Shakhawat Hossain,⁵ Muhammad Eusuf Harun⁶

Abstract

Background & objective: The complex anatomy of the distal end of the humerus with its unique orientation of articular surfaces supported by cancellous bone makes its fracture a constant challenge to orthopaedic surgeons. Internal fixation techniques seek to stabilize these fractures by using a plate on both columns. Without this dual plate arrangement, stability of fixation can be inadequate.

Materials & Methods: This observational, descriptive, longitudinal, prospective study was carried out in the outpatient and inpatient at Department of National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka over a period of two years, between July 2014 to June 2016. Participants were 18 in number and aged between 18 to 50 years. Fractures are classified according to AO classification system and only closed intra-articular fractures of distal humerus AO type 13-C1 was included in this study. Patients with open fractures, fracture more than 2 weeks old and fractures in children were excluded from this study. Majority of cases 11(61.11%) were operated within 1 week of injury. Open reduction internal fixation by pre-contoured 90-90 locking plate was performed in all cases through triceps sparing approach. The plaster cast was removed 2 weeks after operation and rehabilitation was encouraged during this period and afterwards. Patients were advised to come for follow up after discharge in different scheduled date till the fracture union was achieved. The final outcome of the patient was graded according to Mayo Elbow Performance Index (MEPI). Chi-square test was used for testing statistical significance. Statistical significance was set at $p < 0.05$.

Results: Most of the injury was caused by motor vehicle accident 9(50.00%) and rest of the injury caused by fall 5(27.77%). Final outcome by MEPI showed that 15(83.33%) were excellent, 2(11.11%) were good, 1(05.56%) was fair, there was no poor result. Complications were seen during the follow up period that included wound scar, delayed union which was treated conservatively and union occurred at 18th week.

Conclusion: Open reduction and internal fixation of closed intra-articular fractures of distal humerus AO type 13-C1 by 90-90 plate in sagittal plane on medial column and in coronal plane on lateral column through triceps sparing approach is an effective procedure to provide sufficient stability for the postoperative rehabilitation with an excellent union rate and a very good clinical outcome.

Key words: distal humerus fracture, AO type 13-C1, 90-90 plate, triceps sparing approach.

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¹ Junior Consultant (Orthopaedic Surgery), National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka.

² Assistant Professor (Neonatology), Department of Pediatrics, Rajshahi Medical College, Rajshahi.

³ Medical Officer (Obstetrics and Gynaecology), Department of Obstetrics and Gynaecology, Kurmitola General Hospital, Dhaka Cantonment, Dhaka.

⁴ Junior Consultant (Obstetrics and Gynaecology), Upazila Health Complex, Tongibari, Munshiganj.

⁵ Junior Consultant (Orthopaedic Surgery), National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka.

⁶ Junior Consultant (Orthopaedic Surgery), National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka.

Introduction

Distal humeral fractures in adults are complex and technically demanding injuries to manage. Operative intervention is indicated in most cases and is often complicated by difficult exposure.¹ Several classification systems for intra-articular both column fracture of distal humerus have been proposed.

According to AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification, when there is complete articular fracture of distal humerus, it is labeled as 13-C and when both articular and metaphyseal fractures are simple in this 13-C fracture, then again this distal humerus fracture is leveled as 13-C1.

Fractures of the distal humerus account for 0.5% to 7% of all fractures and 30% of elbow fractures. These fractures are difficult to manage because of anatomic complexity and articular and metaphyseal comminution. Distal humerus fractures occur most commonly in a bimodal distribution: - in younger people in second decade as the result of high-energy trauma and in elderly woman as the result of relatively low-energy injury (i.e. - fall) due to osteoporosis. The basic treatment principle for distal humerus fractures is similar to that for other intra-articular fractures: - anatomical reduction and rigid fixation of the fracture to allow early mobilization of joint.²

Fracture of the adult distal humerus is challenging to treat and carry a relatively high complication rate. The elbow is an unforgiving joint and successful treatment requires rigid internal fixation to allow early mobilization.³ Non-surgical management of displaced complete intra-articular fractures can be unsuccessful for several reasons. Closed reduction with immobilization is difficult to achieve and maintain and can lead to joint incongruity. Additionally prolonged immobilization of the adult elbow leads to stiffness.^{2,3} Open reduction and internal fixation (ORIF) remains the standard treatment of intra-articular distal humeral fracture in the physiologically active patient.⁴

The distal humeral shaft is triangular-shaped in cross section with its apex directed anteriorly. As

the shaft approaches the distal humerus it bifurcates into two divergent cortical columns and termed as the medial and lateral columns. Standard surgical techniques are used for fixation of both column using a combination of pre-contoured 90-90 plate, reconstruction plates, locking compression plates and screws and k-wires. In rare situation, total elbow arthroplasty (TEA) may be considered. However, in the management of intra-articular distal humeral fractures in adult controversy still exists regarding the surgical approaches, types of olecranon osteotomy, method of stabilization of osteotomy, type of fracture stabilization, use of orthogonal (90-90 plate) or parallel plate fixation, need for transposition of ulnar nerve, place for primary TEA and type of rehabilitation schedule after surgical treatment of the fracture.⁵

The 90-90 plate has several unique characteristics suitable for fixing the complex anatomy of the distal humerus. The pre-contoured 90-90 plate are placed in sagittal plane on medial column and in coronal plane on lateral column of distal humerus after anatomical reduction of both humeral condyles and both columns. Rigid fixation is done by cancellous and cortical screws. Before that incision is made over posterior aspect of distal arm both lateral and medial intermuscular septae is released, ulnar nerve is safe-guarded, triceps is elevated which visualizes the fracture site.⁶

In spite of different approaches to exposure of the fracture site, different methods of fixation of fracture, distal humerus fracture especially intra-articular fracture leads to elbow stiffness hampering daily activities of life. Triceps sparing approach provides limited exposure but it is better than triceps splitting approach because triceps sparing approach does not cross the neurological interface. It can protect the extensor mechanism maximally and permit early functional exercises after surgery that increases the chances of regaining strength of elbow extensor earlier.

This type of study was done in abroad but no study was done previously in our country. The primary aim of this study was to investigate to determine the functional outcome of ORIF of intra-articular

fracture of distal humerus AO type 13-C1 by 90-90 plate (in lateral column and medial column) through triceps sparing approach and subsequently evaluate the motion arc of the elbow by MEPS (Mayo elbow performance scoring), status of the union of the fracture, the complications of the treatment.

Materials and Methods

This observational, descriptive, longitudinal, prospective study was carried out in the outpatient and inpatient at Department of National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka over a period of two years, between July 2014 to June 2016. A total 18 patients (13 males and 5 females) aged between 18-50 years irrespective of sex were selected by purposive sampling in this study. Fractures are classified according to AO classification system and only patients suffering from recent T-Y condylar fracture (closed intra-articular fracture) of distal humerus AO type 13-C1 were included in this study. Patients with open fractures, fracture more than 2 weeks old and fractures in children were excluded from this study. Patients were discharged from the hospital between 3rd - 7th postoperative days (POD). Long arm back slab was applied for 2 weeks. Patients were advised to come for follow up after discharge in different scheduled date to see the possible outcome. First follow-up was scheduled on 14th

POD or thereafter. Second follow-up was scheduled at 2 weeks interval. Next follow-up was scheduled at 4 weeks interval till the fracture union was achieved. Patients were also advised to attend the Out Patient Department or contact personally if in case of any problems. Pendulum shoulder exercise and elbow (active and active-assisted) exercise advised as pain permits after removal of long arm back slab at 14th POD. Use of elbow bag was advised and the patient was allowed to move the elbow and wrist joints intermittently. Patients were also advised to continue physiotherapy to increase muscle strength and range of motion of elbow and wrist joints. Light work was allowed after clinical and radiological evidence of fracture union. Strenuous work was allowed when there was radiological evidence of consolidation and the patient felt no pain. The final outcome of the patient was graded according to Mayo Elbow Performance Score. Four criteria such as pain, motion, stability, performance at work were used in this scoring system. Functional outcomes were graded as excellent, good, fair and poor if score were 90-100, 75-89, 60-74 and <60. Chi-square test was used for testing statistical significance. Statistical significance was set at $p < 0.05$. The protocol of the study was approved by the ethical review committee of NITOR.

Results

This study was intended to evaluate the outcome of the treatment in 18 patients aged between 18 to 50 years. 13 were male and 5 were female. Fracture was left sided in 13 patients and right sided in rest of the patients.

Figure-1 bar diagram shows 9(50.00%) of the injuries were caused by motor vehicle accident (MVA) 5(27.77%) due to fall during walking and the rest 4(22.22%) of the injuries were caused by fall from height.

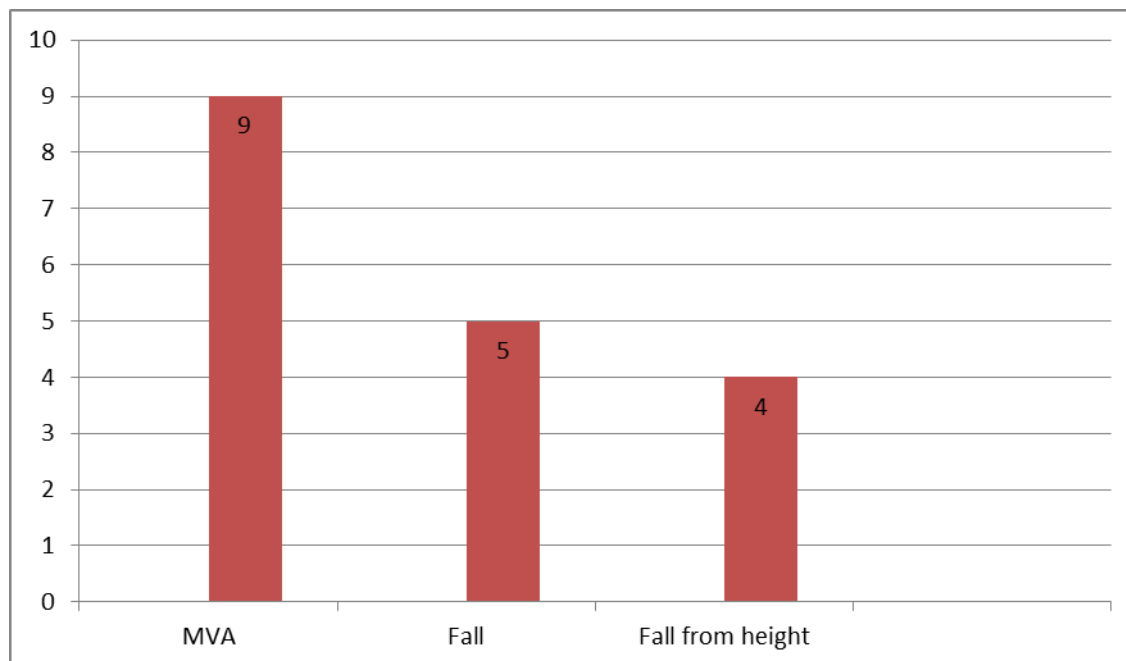
Figure 1: Distribution of the patients by mechanism of injury (n=18)

Table I shows distribution of the patients (n=18) by type of complication during the course of the study. 1(5.55%) patient had delayed union (united at 18th week), 1(5.55%) patient had wound scar and 16 (89.0%) of the patients had no complication. The difference was statistically ($p < 0.05$) significant.

Table I: Patients with different type of complications (n=18)

Complication	No. of patient	Percentage (%)	p value
Wound scar	1	5.55	
Delayed union	1	5.55	$< 0.05^s$
No complication	16	89.0	

s= significant, p value reached from chi square test

Table-II showing distribution of the patient by pain symptoms (n=18) while doing normal activities during the course of study. 3(16.67%) had mild pain and the rest 15(83.33%) patients had no pain. The difference was statistically ($p < 0.05$) significant.

Table II: Distribution of the patient by pain symptoms during normal activities (n=18)

Type of pain	Frequency	Percentage (%)	p value
No pain	15	83.33	
Mild pain	03	16.67	$< 0.05^s$
Total	18	100	

s= significant, p value reached from chi square test

Table III: shows range of movement of elbow according to Mayo Elbow Performance Scoring criteria. The arc of motion of elbow was $>100^\circ$ in 16(88.89%) patients, arc was in between 50° to 100° in 2(11.11%) patients and motion arc was $< 50^\circ$ in none of the patient.

Table III: Distribution of the patient according to the motion arc of elbow (n=18):

Motion arc	Frequency	Percentage (%)	p value
$>100^\circ$	16	88.89	
50 to 100°	02	11.11	
$< 50^\circ$	00	00	$<0.05^s$
Total	18	100	

s= significant, p value reached from chi square test

Table- IV shows the time of radiological union during the course of the study. Union occurred at 6-12 weeks in 17 (94.44%) patients and delayed union (united at 13-18 weeks) occurred in 01(05.56%) patient.

Table IV: The time of radiological union (n-18)

Time in weeks	No. of patients	Percentage	p value
6-12	17	94.44	
13-18	01	05.56	$<0.05^s$
Total	18	100	

s= significant, p value reached from chi square test

Table-V shows the performance level in daily life activities, such as ability to comb hair by the affected hand on the final follow up. 16(88.89%) patients had no difficulty to comb hair and the rest 2(11.11%) had difficulty to comb hair.

Table V: Distribution of the patient according to ability to comb hair by the affected hand (n=18)

Comb hair	Frequency	Percentage (%)	p value
Can do	16	88.89	
Cannot do	02	11.11	$<0.05^s$
Total	18	100	

s= significant, p value reached from chi square test

Table VI shows another performance level of daily life activities, such as self-ability of taking meal by the affected hand on the final follow up. 16(88.89%) of the patients had no limitation of taking meal himself or herself and rest 02(11.11%) of the patients could not take meal himself or herself.

Table VI: Distribution of the patients according to performance of taking meal (n=18)

Self-feeding	Frequency	Percentage (%)	p value
Can do	16	88.89	
Cannot do	02	11.11	<0.05 ^s
Total	18	100	

s= significant, p value reached from chi square test

Table VII showing performance levels of daily life activities, such as ability to maintain personal hygiene on the final follow-up. 17(94.44%) of the patients can maintain personal hygiene by himself or herself and 01(05.56%) patient cannot.

Table VII: Distribution of patients according to ability to maintain personal hygiene

Personal hygiene	Frequency	Percentage (%)	p value
Able to maintain	17	94.44	
Not able to maintain	01	5.56	<0.05 ^s
Total	18	100	

s= significant, p value reached from chi square test

Table-VIII showing distribution of the patients according to performance on wear Shirt/Blouse (n=18) on the final follow up. 17(94.44%) of the patients had no limitation of wearing shirt /blouse and only 01 (05.56%) patient had limitation in doing so.

Table VIII: Performance levels of daily life activities, such as ability to wear shirt/blouse

Wearing of shirt or blouse	Frequency	Percentage (%)	P value
Can do	17	94.44	
Cannot do	01	05.56	<0.05 ^s
Total	18	100	

s= significant, p value reached from chi square test

Table -IX shows performance levels in daily life activities, such as ability to wear lungi/saari on the final follow up. 17(94.44%) of the patients can wear lungi/sharee and only 01(05.56%) patient unable to do this.

Table-IX: Distribution of patients according to performance on ability to wear lungi/saari (n=18)

Wearing lungi/saari	Frequency	Percentage (%)	P value
Can do	17	94.44	
Cannot do	01	05.56	<0.05 ^s
Total	18	100	

s= significant, p value reached from chi square test

Table X showing the final outcome of the patients which was graded according to Mayo Elbow Performance Score. Score was excellent in 15(83.33%) patients, good in 02(11.11%) patient and fair in 01(05.56%) patient.

Table X: Distribution of the patients according to the Mayo Elbow Performance Scores (n=18)

Grading	Frequency	Percentage	P value
Excellent (>90)	15	83.33	
Good (75 to 89)	02	11.11	
Fair (60 to 74)	01	05.56	<0.05 ^s
Total	18	100	

s= significant, p value reached from chi square test

Discussion

Intra-articular fractures of the distal humerus in adults are difficult to treat because of anatomic complexity, articular and metaphyseal comminution. There are very few series in the literature with a large number of cases due to the small incidence of these fractures.⁷ This may explain the reason of small number of patients enrolled in this study to some extent.

While there have been numerous studies regarding the management of this uncommon fractures, the over-all number of reported cases has been small, the fracture has been classified by varying criteria and the results have been judged by a wide range of methods of functional evaluation. However, a comparable analysis of postoperative results among these studies is difficult because of the great variation in the ratings used.⁸ In this study

patients were assessed according to Mayo Elbow Performance score to evaluate the overall functional result which was important for the specific functional index used in clinical practice that represent all functions of the elbow joint as accurately as possible.

There are several classifications of these fractures. But in this study AO classification was followed. The aim of the treatment of intra-articular fracture of distal humerus in our study was to achieve a painless elbow which would be fully mobile and stable. This required anatomical reconstruction of the articular surface, restoration of the overall geometry of the distal humerus and stable fixation of the fracture fragments to allow early and full rehabilitation. Although these goals are now widely accepted by the orthopedic community, these may be technically difficult to achieve,

especially in the presence of substantial osteoporosis or comminution.⁹

In our study, we found AO type 13-C1 was a rare fracture of distal humerus and most of the fractures were comminuted. We also found 90-90 pre-contoured locking plate was costly (20,000 to 25,000Taka) in our perspective and only few patients can hardly afford it. During our study, we found that Triceps -sparing approach was not practiced by most of orthopaedic-surgeon in our hospital. So, with these limitations, we could enroll only 18 patients in 2 years of study time. In a prospective study done by V Gupta which includes 26 adult patients of intercondylar fracture of distal humerus, found motor vehicle accident was the commonest mode of injury 18(70%) and the next common mode was fall during walking 8(30%).⁷ These findings were consistent with our study. In this study, all fractures were closed and during operation strict asepsis was maintained in every step of operation and a broad-spectrum intravenous antibiotic was given for three days. Initial recovery was uneventful in all except in two cases which constitute 11% superficial infection resulting in wound scar 05.55% and delayed union 05.55%. Aslam in his study among 26 patients also found the rate of superficial infection was 10%. So, superficial infection rate was almost same in those two studies.¹⁰

In a study done by V Gupta et al on intercondylar fracture of distal humerus among 26 patients found, pain and stiffness in 3(11.5%), implant loosening in 3(11.5%), nerve injury in 2(7.5%) were the common complications of their study. These 26 patients were treated with open reduction and internal fixation by either dual reconstruction plate or one third tubular plate or small dynamic compression plate by transolecranon approach.⁷ These were different from our study and these changes could be due to difference in approach, difference in internal fixation procedure.

Regarding the functional arc of motion of elbow, it was observed in this current study, 16(88.89%) patients had motion arc more than 100°(100-120degree) and 2(11.11%) patients had 50° to 100°. Aslam N found 13 (50%) of 26 cases

having range of movement between 100° to 120 depending on fracture age, age of the patients, type of fracture.¹⁰ Our study showed better performance in terms of functional arc of motion of elbow. In the current study, patients were assessed by using the joint specific Mayo Elbow Performance Index (MEPI) which measures motion, pain, stability and function. In this study 15(83.33%) were excellent, 02 (11.11%) were good, 01 (05.56%) were fair result. Gupta V et al on the basis of Jupiter, et al system reported 20(77%) of 26 cases had excellent to good result and 06(23%) had fair to poor result.⁷ Due to different assessment tool, true comparison could not be made.

Conclusion:

Open reduction and internal fixation of closed intra-articular fractures of distal humerus AO type 13-C1 by 90-90 plate in sagittal plane on medial column and in coronal plane on lateral column through triceps sparing approach is an effective procedure to provide sufficient rotational and translational stability for the post-operative rehabilitation, postoperative early mobilization of elbow joint which avoids stiffness of joint, good range of motion, an excellent union rate of fracture site and a very good clinical outcome.

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All correspondence to:

Mohammad Reza Hossain Khan

Junior Consultant (Orthopaedic Surgery)

National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka.

E-mail: dr.rejahkhan@gmail.com