

Original Research Article

Results of surgical management of unstable proximal humeral fractures by proximal humeral locking plate

Pankoj Kanti Mondol^{1*}, M. Ziaur Rahman², M. Mehedi Hasan³,
M. Sahidur Rahman Khan³, Sheikh M. Sheikh Sadi³,
Ananta Kumar Bhakta⁴, M. Humayun Kabir³, Sabbir Ahmed³

¹Department of Orthopaedics Oncology and Musculoskeletal Tumor, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh

²Department of Hand & Microsurgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh

³Department of Orthopaedics and Traumatology, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh

⁴Department of Orthopedic Surgery, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh

Received: 14 July 2024

Revised: 08 August 2024

Accepted: 13 August 2024

*Correspondence:

Dr. Pankoj Kanti Mondol,

E-mail: dr.pkmondol@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Unstable fractures of the proximal humerus present a significant surgical challenge despite the variety of treatment options available. One effective surgical method for managing these fractures is the use of a proximal humerus locking plate. This approach provides stability and support to the fracture site, facilitating proper healing and potentially improving patient outcomes. The aim of this study was to evaluate the outcome of treatment of unstable proximal humeral fractures with proximal humeral locking plate.

Methods: This prospective study was conducted in the Department of Orthopedic Surgery, National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from January 2009 to December 2010. A total of 100 patients aged over 18 years were included in the study. Patients with open, pathological and ipsilateral distal fractures in the same limb were excluded from the study.

Results: The mean age of patients with unstable proximal humerus fractures was 41.53 years, ranging from 23 to 78 years. Most patients were male and primarily in business occupations. Fracture types included three-part fractures (53%), four-part fractures (7%), and fracture dislocations (40%). The mean time to plate fixation was 18 days, with a range of 2 to 78 days. High-velocity accidents caused 93% of injuries. Complications included avascular necrosis (7%), screw loosening (7%), and subacromial impingement (13%), with no reoperations needed.

Conclusions: The result of the study demonstrates that the proximal humeral locking plate provides sufficient fracture stabilization in the treatment of unstable proximal humeral fractures.

Keywords: Fracture, Locking plate, Management, Proximal humerus

INTRODUCTION

The incidence of proximal humeral fractures is between 4% to 5% of all fractures.¹⁻³ They occur most commonly in the elderly. In people older than 60 years, the fractures

of the proximal humerus are more frequent than fractures of the hip region.⁴ In the younger patients, high energy trauma is the cause and displacement are often more severe. Some patients have an associated dislocation. Most of these fractures are stable and can be treated

conservatively.⁵ However unstable displaced fractures have high morbidity, especially in older patients.

Operative treatment of proximal humerus fractures remains a significant challenge. Accurate reduction and stable fixation of proximal humeral fractures remain a technically demanding procedure in shoulder surgery. The introduction of new implants has created additional controversy regarding the best possible way for providing stable fixation.⁶

The Neer system is commonly used to classify the proximal humeral fractures. It is based on the presence or absence of displacement or angulation of one or more of the four major segments of the proximal humerus.⁷ Based on the epiphyseal line the four major segments of the proximal humerus are the anatomical head, the greater and lesser tuberosities, and the proximal shaft.⁸ Associated anterior or posterior dislocation of the humeral head can be easily incorporated into this classification system. Over the last decades several techniques have been applied to the treatment of proximal humeral fractures. Widely accepted is the initiation of a conservative treatment regimen for undisplaced fractures; however, the ideal treatment for displaced fractures, especially three- and four-part fractures, is still the center of scientific debate. Many different implants have been tested and investigated, demonstrating lack of concrete results.⁹ The treatment goal is to achieve a painless shoulder with full function. Various methods have been used, including kirschner wire fixation, suture fixation, external fixation, tension band fixation, rush pin fixation, intramedullary nailing, and prosthetic replacement with plating.¹⁰ Recent advances in fracture fixation technology have led to the development of fixed angled locked plates that maintained angular stability under load. Biomechanical data suggest that these implants can resist physiologic loads in osteoporotic bone and may provide an alternative to the hemiarthroplasty.¹¹

The objective of the study was to evaluate the results of the treatment of proximal humeral fractures fixed by proximal humeral locking plate system.

METHODS

This was a prospective study and was conducted in the Department of Orthopedic Surgery National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from January 2009 to December 2010. A total of 100 cases of patients of diagnosed displaced fractures of the proximal humerus of both male and female were included in the study.

Inclusion criteria

Patients with closed displaced three or four-part fractures and fracture dislocations, age above 18 years, the patients who are mentally fit and physically alert (ASA-group 1-3),

and patients without any neurological deficit were included.

Exclusion criteria

Patients with open fracture, pathological fracture, previous shoulder surgery, chronic shoulder pain, and ipsilateral upper limb fractures were excluded.

A standardized semi-structured data collection sheet was used to collect necessary information and face to face interview. Necessary information was collected by reviewing related medical reports. A semi structured questionnaire was developed in English. The questionnaire was developed using the selected variables according to the specific objectives. Also record desired variables from admission record, history sheet and related medical records. Data were checked immediately after completing interview and review of necessary investigation reports. In all cases, a detailed history, clinical examination, and relevant investigations were done. X-rays of the affected shoulder (anteroposterior and lateral views), complete blood count, random blood sugar, and serum creatinine were done routinely. Any associated illnesses such as hypertension, diabetes mellitus, pulmonary problems, and concomitant injuries were treated accordingly. As soon as the patient's general condition got settled the patient underwent operation. In all cases, antibiotics were given intravenously just prior to the operation. Surgery was performed on average within three weeks of injury.

The patients were followed up on an outpatient basis for six months postoperatively at intervals of three weeks. They were requested to attend with check x-rays of the shoulder of the affected side. At each follow-up, patients were evaluated with history, clinical examination, and radiographs.

Postoperative complications, if any were noted and adequately managed. Patients were repeatedly taught about the rehabilitation program and immediate feedback was taken. All relevant data were collected from each respondent by use of an interview schedule, and investigations in a predesigned format. Patients were given full autonomy to participate in the study and informed written consent was obtained.

Statistical analysis

All data were recorded systematically in preformed data collection form and quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Statistical analysis was carried out by using Statistical analysis was done by using SPSS (Statistical Package for Social Science) Version 11.5 for windows. Ethical approval regarding the study was obtained from the institutional ethical review committee.

RESULTS

Table 1 shows that out of 100 patients in 20-29 and 50-59 age groups, each representing 27% of cases. The 30-39 and 40-49 age groups each account for 20% of fractures. Notably, there are no reported cases in the 60-69 age group, while the 70-79 age group comprises 6% of the cases.

Table 1: Age distribution of the respondents.

Age in years	Frequency	Percentage
20-29	27	27
30-39	20	20
40-49	20	20
50-59	27	27
60-69	0	0
70-79	6	6

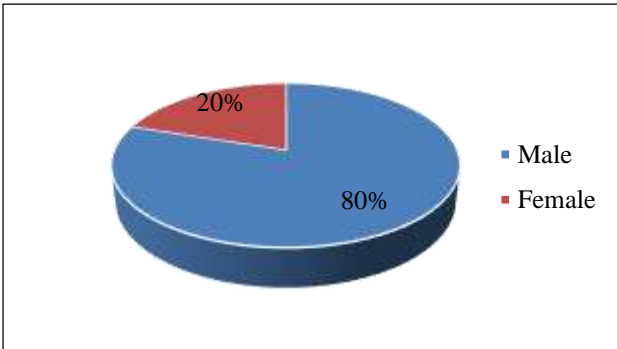


Figure 1: Gender distribution of the respondents.

Figure 1 shows that gender distribution of the respondents. Vast majority (80%) of the patients were male and the rest (20%) female giving a male to female ratio of roughly 4:1.

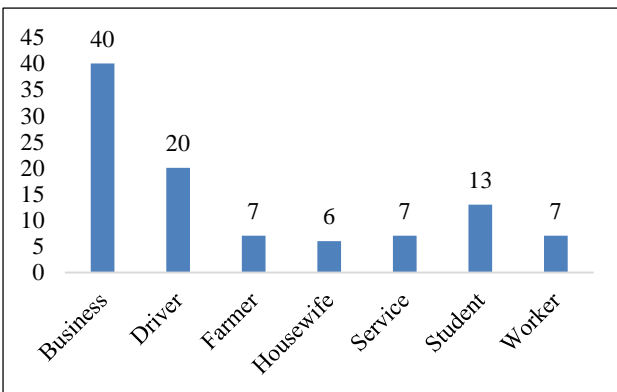


Figure 2: Occupational distribution of the respondents.

Figure 2 shows that occupational distribution of the respondents. Business was the main occupation (40%). However, a significant number of patients were drivers (20%). The rest were students (13%), service holders

(7%), workers (7%) and housewives (6%) and farmers (7%).

Table 2 shows that clinical characteristics of the respondent. Of the 100 patients, 60% presented with left sided proximal humeral fracture and 40% with right side fractures. The most common type of fracture pattern is the 3-part fracture, accounting for 53% of cases, 7% with four-part fractures and 40% with fracture dislocations. In 80 percent cases proximal humeral locking plate was fixed within 3 weeks of occurrence of fracture while in the rest (20%) of cases, fixation was done after 3 weeks of the fracture. The mean interval between injury and nail fixation was 18 days and the minimum and maximum intervals were 2 and 78 days respectively. Vast majority (93%) of injuries were caused by high velocity trauma i.e.; road traffic accident and fall from height and only one (7%) was of low velocity injury i.e.; due to simple fall.

Table 2: Clinical characteristics of the respondent.

Characteristics	Frequency	Percentage	
Affected limb side	Right	40	40
	Left	60	60
Type of fracture pattern	3-part fracture	53	53
	4-part fracture	7	7
	Fracture dislocation	40	40
Time interval (plate fixation)	<3 weeks	80	80
	>3 weeks	20	20
Mechanism of injury	High velocity injury	93	93
	Low velocity injury	7	7

Table 3 shows that distribution of patients according to range of movement. According to the constant scoring criteria the forward flexion of shoulder was 610-900 in (13%) patients, 910-1200 in (33%) patients and 1210-1500 in (53%) patients. According to the constant scoring criteria the abduction of shoulder was 610-900 in (14%) patients, 910-1200 in (73%) patients and 1210-1500 in (13%) patients. According to constant score criteria (66%) patients can externally rotate their shoulder with hand above head and elbow forward, (20%) patients can do it hard behind head and elbow backward, (7%) each can do it either with hand behind head and elbow forward or hand above and elbow backward. According to constant scoring criteria the dorsum of the hand reaches D12 vertebra in (13%) patients, waist in (60%) patients, sacroiliac joint in (7%) patient, buttock in (13%) patients and thigh in (7%) patient.

Table 4 shows that complications of the respondents. During the course of the study (13%) patients developed

superficial infection, (7%) patient developed delayed union, (13%) patients subacromial impingement. Avascular necrosis, loosening of head screw, perforation of the head by screw was seen in (7%) patient each. Radiological evaluation revealed varus malunion in (20%) and subluxation of head in (26%) patients.

Table 3: Distribution of patients according to range of movement.

Range of movement	Frequency	Percentage
Flexion movement (range of motion)		
61°-90°	13	13
91°-120°	33	33
121°-150°	53	53
Abduction movement (range of motion)		
61°-90°	14	14
91°-120°	73	73
121°-150°	13	13
Rotatory movement		
Hand above head and elbow forward	66	66
Hand behind head and elbow forward	7	7
Hand above head and elbow backward	7	6
Hand behind head and elbow backward	20	20
Internal rotatory movement		
D12	13	13
waist	60	60
SI joint	7	7
Buttock	13	13
Thigh	7	7

Table 4: Complications of the respondents.

Complications	Frequency	Percentage
Superficial infection	13	13
Delayed union	7	7
Subacromial impingement	13	13
Avascular necrosis	7	7
Loosening of head screw	7	7
Screw perforation of head	7	7
Varus malunion	20	20
Subluxation of head	26	26

Figure 3 shows that that distribution of patients according to status of fracture union. At final follow up (93%) patients showed union of the fracture and in (7%) patient union was delayed.

Figure 4 shows that outcome of the respondents. To determine the final outcome of the study the good and fair grades according to constant score was treated as satisfactory group and the poor grade was treated as unsatisfactory group. So a total (80%) patients were in the

satisfactory group and only (20%) patients were in unsatisfactory group.

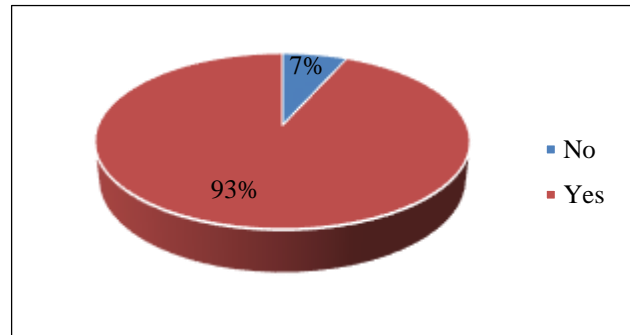


Figure 3: Distribution of patients according to status of fracture union.

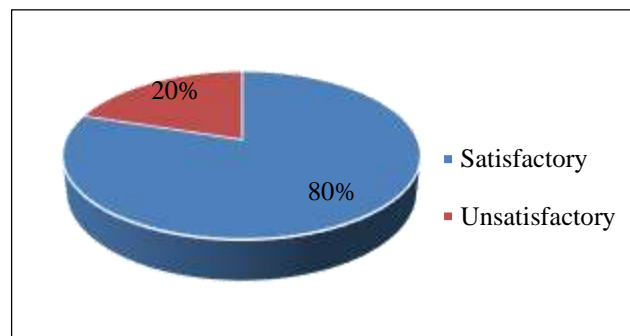


Figure 4: Outcome of the respondents.

DISCUSSION

Proximal humeral fracture is not an uncommon problem encountered in the accident and emergency department of a hospital. However, there is a trend towards treating most of the fractures conservatively hoping that nature would do the best. Displaced proximal humeral fractures always presented a problem in management. According to Neer’s classification displacement is defined as greater than 45 degree of angulation or 1 cm of separation of individual parts.⁷ The results of current study demonstrates that mean age of patients included in the study was 41.53 years and the youngest and the oldest patients were 23 and 78 years old respectively. Majority (80%) of the patients were male and business was the main occupation. Ishaq and his associates reported the average age at which the proximal humeral fractures occurs was 41.21 years and the highest and lowest age in his study were 20 and 58 years respectively. From these two studies it is evident that the proximal humeral fractures in our country seems to occur in early middle aged population. But the studies conducted by Young et al, Hintermann et al showed that relatively older people are affected by the fractures of the proximal humerus.^{12,13} The younger group is characterized as trauma group who sustained the fracture usually due to some high energy mechanism of injury. The older patients often have osteoporotic bone and sustained comminuted fractures even after trivial trauma. High energy trauma following

road traffic accident occurs most commonly in young active people who are usually the earning members of the family. In the present series, in (93%) patients, the fracture was caused by high energy trauma, whereas in only (7%) patient the cause was a fall and she was a 78 years old patient. In a series by Court-Brown et al, 90.5% of the fractures had been caused by a simple fall, 4 percent by road traffic accident, 3.2 percent by fall from height and 1.6 percent by a direct blow. Incidence of proximal humeral fractures by road traffic accident in our country is more due to lack of knowledge about traffic rules, most of the drivers are illiterate, reluctant to abide by the traffic rules.² The mean age being 41.53 years meaning that the younger age group are the major sufferers in this series and coincides with the high energy trauma. There were (80%) males and only (20%) female patients. In another study, the mean age was 66 years (range 40 to 86 years) and 73.6 percent were female and 27.40 percent were male. In this study the fracture occurred at a lower age group than the study done by Young et al. This is probably due to the fact that the average life expectancy in region is much lower than that of western world. In another study by Hintermann et al, the mean age was 72 years, and the female was 78.57 percent and male was 21.43 percent. The age difference is due to the same cause as mentioned before. In this country, the females are still lagging behind engaging themselves in household activities and male, the principle earning member of the member usually are working outside and more prone to road traffic accident. Of the 3 (three) women in this series interestingly two were well educated working women. In the present series, the left side was more affected (60%) than the right (40%). In a series by Hintermann et al, the right side (57%) was more affected than the left side (43%). Whereas, in this series by Young et al, right and left humerus was almost equally affected. The cause of left side involvement is probably due to unpreparedness following high velocity injury in most of the cases.^{12,13} In the present series, the basis of diagnosis was clinical examination and radiological evaluation of the affected part in both anteroposterior and lateral views. All the cases were displaced three or four part fractures and some were also associated with dislocation of the humeral head and all were treated by open reduction and internal fixation with proximal humeral locking plate. After operation long arm back slab was applied and kept for 2 weeks till the stitch removal. Pendular exercise was started as early as 2nd week. Physiotherapy is vital for early recuperation of the patient and is supervised very closely in almost all patients. Only two patients (13%) developed superficial wound infection and were treated by regular local wound dressing with local and systemic antibiotic according to the culture and sensitivity report. Not a single patient developed deep infection in contrast to the series published by Zyto et al, where it was 10 percent.¹⁴ In this series at the time of operation all the fractures were closed, during operation strict asepsis was followed on every step and broad spectrum intravenous antibiotic was given for three days. Initial recovery was uneventful in all the cases except two. In two there was superficial infection and in another there

was persistent subluxation which needed to be corrected under C-arm guidance. Only one patient (7%) did not show complete union even at 6 months. In a series by Neer et al, 18.60 percent patients developed avascular necrosis of the head of the humerus.¹⁵ Another series by Hintermann et al using modified angled plate showed avascular necrosis in 4.76 percent of his patients. In the present series only one (6.7%) patient developed avascular necrosis. It indicates that blood supply of the humeral head had not been critically impaired by open reduction and internal fixation by proximal humeral locking plate.¹³ In a series by Hintermann et al, displaced proximal humeral fractures were treated by modified hip blade plate. After one year follow up their satisfactory result was 65.85 percent and unsatisfactory result was 34.15 percent. Among 42 cases in their series, 2 cases developed avascular necrosis possibly due to the hip blade removing more bone during its insertion into the humeral head.¹³ Neer et al experienced 86% satisfactory results with a suture tension band technique.⁷ Jaberg et al reported 95% fracture union with closed reduction and percutaneous pinning but noted pin tract infection in 7% cases.¹⁶ Kristiansen et al reported only 45% satisfactory results using an AO T plate for 3-part fractures.¹⁷ Early clinical results using locking proximal humeral plate have been promising though not without complications. Friess et al reported a 50% good constant score. There were 3 cases of osteonecrosis, 2 nonunions and 19 fractures (26%) with varus malalignment. In this series there are cases (20%) of varus malalignment. Alignment can be better maintained by augmenting the proximal fixation with sutures placed the rotator cuff and attached through the locking plate.¹⁸ In the present series proximal humeral locking plate showed satisfactory result in 80 percent and unsatisfactory result in 20 percent. Only one (7%) cases showed avascular necrosis. Obviously narrow dissection did not jeopardize the already compromised blood supply

The study has several limitations. There was difficulty in classifying many of the fractures and as only X-rays was used for diagnosis in many cases there were inter observer variation. There was wide range of age and interval of trauma and fracture fixation which may influence the outcome. Wide range of fractures with different type of hard and soft tissue trauma also should be accounted for. The intra operative decision to use supplemental sutures or wire fixation or additional lag screw may influence the subsequent recovery.

CONCLUSION

The management of proximal humeral fractures constitutes a diagnosis as well as therapeutic dilemma. Locking plate fixation appears to be a good option for majority of patients with unstable proximal humeral fractures with good functional outcome. Although there are some limitations of the study still the early are inspiring. Based on the study finding and review of current literature, open reduction and internal fixation of three and four part fractures of the proximal humerus with proximal

humeral locking plate can be strongly recommended in an attempt to achieve a satisfactory and stable reduction. Regardless of whether or not the humeral head is dislocated.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Chadwick R, Kyle RF. 'Fractures and dislocation of the proximal humerus, scapula, sternoclavicular joint, acromioclavicular joint and clavicle'. In: Gustilo RB, Kyle RF, Templeman D, editors. *Fractures and Dislocations. Vol I.* St. Louis: Mosby-Yearbook Inc.; 2009:255-340.
2. Court-Brown CM, Garg A, McQueen MM. The epidemiology of proximal humeral fractures. *Acta Orthopaed Scand.* 2001;72(4):365-71.
3. Kristiansen B, Kofoed H. External fixation of displaced fractures of the proximal humerus. Technique and preliminary results. *J Bone Joint Surg British Volume.* 1987;69(4):643-6.
4. Strohm PC, Köstler W, Südkamp NP. Locking plate fixation of proximal humerus fractures. *Techn Should Elbow Surg.* 2005;6(1):8-13.
5. Duralde XA, Leddy LR. The results of open reduction and internal fixation of displaced proximal humeral fractures using a locking plate. *J Shoul Elbow Surg.* 2009;18:1-9.
6. Ko JY, Yamamoto R. Surgical treatment of complex fracture of the proximal humerus. *Clin Orthopaed Relat Res.* 1996;327:225-37.
7. Charles S NEER II. Displaced proximal humeral fractures: Part I. Classification and evaluation. *JBJS.* 1970;52(6):1077-89.
8. Codman EA. Rupture of the supraspinatus-1834 to 1934. *JBJS.* 1937;19(3):643-52.
9. Korkmaz M, Aksu N, Gogus A, Debre M, Kara A, Isiklar Z. The results of internal fixation of proximal humeral fractures with the PHILOS locking plate. *Acta Orthopaed Traumatol Turci.* 2008;42(2):97-105.
10. Fazal MA, Haddad FS. Philos plate fixation for displaced proximal humeral fractures. *J Orthopaed Surg.* 2009;17(1):15-8.
11. Solberg BD, Moon CN, Franco DP, Paiement GD. Surgical treatment of three and four-part proximal humeral fractures. *JBJS.* 2009;91(7):1689-97.
12. Young TB, Wallace WA. Conservative treatment of fractures and fracture-dislocations of the upper end of the humerus. *J Bone Joint Surg Brit.* 1985;67(3):373-7.
13. Hintermann B, Trouillier HH, Schäfer D. Rigid internal fixation of fractures of the proximal humerus in older patients. *J Bone Joint Surg Brit.* 2000;82(8):1107-12.
14. Zyto K, Ahrengart L, Sperber A, Törnkvist H. Treatment of displaced proximal humeral fractures in elderly patients. *J Bone Joint Surg Brit.* 1997;79(3):412-7.
15. S II NC. Displaced Proximal Humeral Fractures. Part II. Treatment of three-part and four-part displacement. *J Bone Joint Surg.* 1970;52:1090-103.
16. Jaberg H, Warner JJ, Jakob RP. Percutaneous stabilization of unstable fractures of the humerus. *JBJS.* 1992;74(4):508-15.
17. Kristiansen B, Christensen SW. Plate fixation of proximal humeral fractures. *Acta Orthop Scand.* 1986;57(4):320-3.
18. Friess DM, Attia A, Vallier HA. Locking plate fixation for proximal humerus fractures: a comparison with other fixation techniques. *Orthoped.* 2008;31(12):1183.

Cite this article as: Mondol PK, Rahman MZ, Hasan MM, Khan MSR, Sheikh Sadi SM, Bhakta AK, et al. Results of surgical management of unstable proximal humeral fractures by proximal humeral locking plate. *Int J Res Orthop* 2024;10:884-9.