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### Clinical study of internal fixation of closed complex fractures of proximal humerus with single tine T plate

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#### Abstract

**Background:** The management of complex proximal humerus fractures (Neer's type III, IV and fracture dislocation) is complicated. There are various treatment modalities available for proximal humerus fractures. We have designed and indigenously manufactured new plate called "SINGLE TINE PROXIMAL HUMERAL T-PLATE (3.5 mm)" for fractures of proximal humerus. The aim of this study was to examine the clinical outcome of complex proximal humeral fractures treated surgically with single tine T-plate.

**Materials and Methods:** This is retrospective observational study included 25 patients who underwent open reduction and internal fixation with single tine T plate for proximal humerus fractures in between 2010 and 2013. All patients were evaluated using point system of Neer's shoulder evaluation system.

**Results:** Mean age of the patient 47.12 years (range 22-60 years). All the fractures united with a mean duration of 14 weeks (range 10 weeks to 18 weeks). As per Neer's score we achieved excellent or satisfactory results in 21 out of 25 i.e. 84%. The mean Neer's score was 85.2 (range 64-94). We had unsatisfactory to poor result in 4 out of 25 cases (16%). (Table 1) Complications were seen in 3 cases (12%). One case of superficial wound infection and two cases of screw loosening.

**Conclusion:** Single tine T-plate is a good alternative implant for treating complex fracture and fracture dislocation of proximal humerus. It is cost effective, and easy to use. The single tine T-plate offers good support against varus mal-reduction. Primary bone grafting is a powerful tool in managing complex fractures/ fracture-dislocation of proximal humerus.

**Keywords:** Shoulder, humeral fractures, proximal, humerus head, dislocation fracture

#### 1. Introduction

Proximal humeral fractures are the common fractures and represent about 4–5% of all fractures [1, 2, 3]. Although they may occur in any age group, an increased frequency occurs in older middle-aged and elderly individuals because of the age-related increase in osteoporosis [4, 5]. Majority of proximal humeral fractures can be treated conservatively [6, 7]. But malunion is inevitable in conservative management [8, 9]. In operative management, there are various types of fixation—transosseous suture fixation, percutaneous pinning, intramedullary nailing, or plate fixation [8, 9]. They are used depends on the patient's age, activity level, and bone quality; the fracture type [8].

Plate-and-screw constructs provide stable fixation for proximal humerus fractures [8]. Plates have undergone a series of modifications. Initial, T-Buttress Plates relied on proximal screws. Loss of reduction resulted when shoulder was mobilized because of TOGGLE between the screws & plate and screw pull out in osteoporotic bones and comminuted fractures of proximal humerus [10]. Sehr & Szabo [11] bent the Semi-tubular Plate to form a blade plate. Later Hintermann [12] designed a Cannulated Blade Plate. Currently locking plates are used widely.

We have designed and indigenously manufactured new plate called "SINGLE TINE PROXIMAL HUMERAL T-PLATE (3.5 mm)" for fractures of proximal humerus to prevent the problems like loosening of plate, varus collapse.

The aim of this study was to examine the clinical outcome of complex proximal humeral fractures treated surgically with single tine T-plate.

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**2. Materials and methods**

This is retrospective observational study included 25 patients (male 14 and female 11) who underwent open reduction and internal fixation with single tine T plate for proximal humerus fractures in between 2010 and 2013.

Inclusion criteria included

1. Radiologically diagnosed cases with type III and type IV of the Neer classification [13]
2. Closed fractures

Exclusion criteria included

1. Neer's type 1 and 2 fractures
2. Compound fractures with any type.
3. Skeletally immature patients

**2.1 Operative method**

Preoperative true AP, lateral X-rays along with 3d CT scan were done. Fracture patterns were classified according to the Neer classification [13].

Surgery was performed in supine position using the deltopectoral approach.

Preliminary reduction of the fracture fragments is done under image guidance. In varus collapse of the head of humerus, a thick k-wire/ Steinmann pin is passed through the fracture into the medial aspect just below the inferior aspect of the humeral head and is used as a joystick to lift the humeral head and to correct the varus. Preliminary stabilization achieved using multiple 2 mm k-wires passed through the greater tuberosity quite proximally and across the lateral aspect of proximal humerus into the head so as to not to interfere with jig placement. Sometimes inter-fragmentary screws will be used to hold the fragments as well as to further ease the process of plate fixation. (Fig. 1)



**Fig 1:** inter-fragmentary screws were used to hold fragments well.

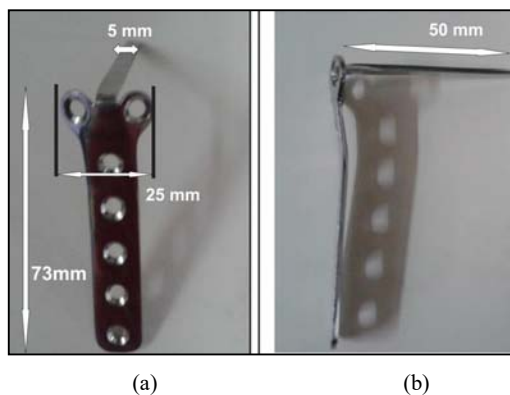
In case of fracture dislocations , (A) If the lesser tuberosity is not fractured then two stay sutures are placed 2 cm proximal to the insertion of the subscapularis tendon. With limb in external rotation the subscapularis is then incised 1cm proximal its insertion. Then the subscapularis tendon is retracted medially with Kocher's retractor and the dislocated head is delivered out and reduced into the glenoid cavity. K-wires are placed across the greater tuberosity and the proximal humerus to stabilize the humeral head. (B) If the lesser tuberosity is fractured then the tuberosity along with the tendon are both retracted medially to deliver the humeral head. The rest of the procedure is same as above. Jig is placed over the lateral aspect of the humeral head taking care not to place is very high and its position is confirmed

under image intensifier and 3.2 mm drill bit used to drill across the jig hole into the head up to the subchondral bone. Jig is removed and depth is measured by depth gauge and required length the tine is cut using a cutter. Tine is introduced into the hole created through the jig, gently hammering it until the vertical part is snug with the lateral cortex of the humerus. (Fig. 2) This plate is now secured with the bone using 3.5 mm cortical screws.

**Single Tine T plate:** Single tine T-plate (Fig. 3) is a modification of the T-butress plate. It is a 3.5 mm plate with a single tine that protrudes from its proximal end. We used either 2X5 holed or 2X6 holed plate.



**Fig 2:** After using jig to make the entry point of tine, the tine of the t-plate is placed into the humeral head



**Fig 3:** Single tine T-plate (5 holed) a) front view b) side view

**2.2: The post operative rehabilitation:** The post operative immobilization was done by chest arm strapping for 2 weeks. The post operative rehabilitation protocol included gentle pendulum exercise after 2 weeks and active shoulder mobilization with full range of motion after 4-6 weeks. Patients were followed up on OPD basis at 2, 4, 6,8,12, 24 weeks, 6th month, 12th month and at yearly interval. All patients were evaluated using point system of Neer 's shoulder evaluation system which is graded as Excellent, (above 90 units); satisfactory (80-89 units); unsatisfactory (70-79 units); failure (below 70 units). Analysis of the data done and the results will be expressed in terms of numbers and percentages.

**3. Results**

Mean age of the patient 47.12 years (range 22-60 years). All the fractures united with a mean duration of 14 weeks (range

10 weeks to 18 weeks). As per Neer’s score we achieved excellent or satisfactory results in 21 out of 25 i.e. 84%. The mean Neer ‘s score was 85.2 (range 64-94). We had unsatisfactory to poor result in 4 out of 25 cases (16%). (Table 1) Complications were seen in 3 cases (12%). One case of superficial wound infection and two cases of screw loosening.

**Table 1:** Grading of results by Neer’s shoulder score

Result	Units	No. of Cases	Percentage
Excellent	more than 90 units	9	36%
Satisfactory	80-89 units	12	48%
Unsatisfactory	70-79 units	2	8%
Failure	less than 70 units	2	8%

**4. Discussion**

Indications for operative treatment include displaced two-part surgical neck fractures, displaced (>5 mm) greater tuberosity fractures, displaced three-part fractures, and displaced four-part fractures in young patients [8]. Plate-and-screw constructs provide the more stable fixation than transosseous suture fixation and percutaneous pinning [8]. Over the years, plates have undergone a series of modifications [11, 12, 14]. Locking plate gives good functional outcome especially in elderly and osteoporotic bone [3, 8, 15].

Various studies of proximal humerus fracture osteosynthesis have reported various functional outcomes. Paavolainen P *et al* [16] in 1983 reported excellent or satisfactory results in 23 out of 31 patients (74%). In another study by Wijgman *et al* [17] *et al*, they reported good to excellent results in 87% of their patients with three or four part proximal humeral fractures operated with a T-butress plate and cerclage wires. Hintermann B *et al* [18] used Blade plate in 38 patients with proximal humerus fractures, and reported good to excellent results in 30 patients (78.94%), fair in 7 patients (18.43%) and poor in 1 patient (2.63%). Koukakis A *et al* [19] studied 20 patients with proximal humeral fracture treated with Philos plate and the mean Constant score of this study was 76.1%. Aggrawal S *et al* [3] reported excellent to good satisfactory results in 55.5% cases of displaced proximal humerus

fractures and poor outcome in 10.5% of the cases.

We have designed a special plate called fixed angle single tine proximal humeral plate. The fixed angled tine added for stability of proximal fracture fragment. T-plating and specific insertion of screws into the head (4 screws and tine in the head) gives us a good purchase of the proximal fragments i.e. head humerus. As per Neer’s score, we achieved excellent or satisfactory results in 21 out of 25 i.e. 84%. The mean Neer’s score was 85.2 (range 64-94). (Fig. 4)

We used bone grafting in 10 cases. 3 cases (12%) 3 part fracture and 3 cases (12%) 4 part fracture and 4 cases (16%) fracture dislocation. No bone grafting was done in 15 cases (60%) of cases. We used autogenous bone graft from iliac crest or the proximal tibia in patients with poor bone quality, to fill up the fracture gaps between head, greater/lesser tuberosities, and shaft so as to give fracture stability.

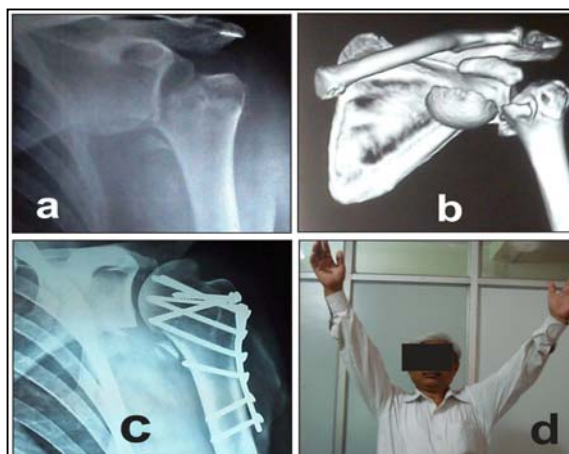
In our series, 16 patients (64%) had 3-part fracture type (Fig. 5). Four part fracture (Fig. 6) accounted for 16% (4 patients) of total patients and 5 patients (20%) had fracture dislocation. In our series both failure cases (8%) occurred in four part fracture and fracture dislocation type. (Table 2). In the study by Aggrawal S *et al* [3], five cases (10%) of poor result occurred in AO-OTA Types B and C. In another study [15], in cases with four-part fractures, the outcome was rated as excellent in 50%, good in 22%, fair in 13% and poor in 15%.

Complications were seen in 3 cases (12%). We had one case of superficial infection noted on day 7th post op day. The culture revealed *staph aureus* organism. Oral antibiotic were given based on sensitivity and the wound healed. There were no cases of deep infection in our study. In first case of screw loosening, 56 years old female had screw loosening at 8 weeks follow-up. 12 weeks post-operative follow up radiograph showed fracture union (Fig. 7a). Only the loosened screw was removed at 12 weeks. Patient abduction improved to 120 degree by 16 weeks. In second case, 59 years old male had one screw loosening at 3 month post-operative follow up (Fig 7b). The loosened screw was removed.

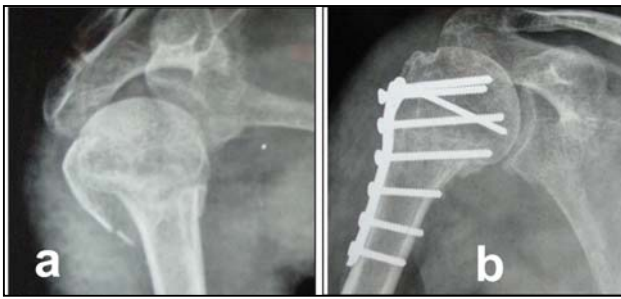
Limitations in our study include small sample size, retrospective and non randomized study design.

**Table 2:** Functional outcome according to fracture types

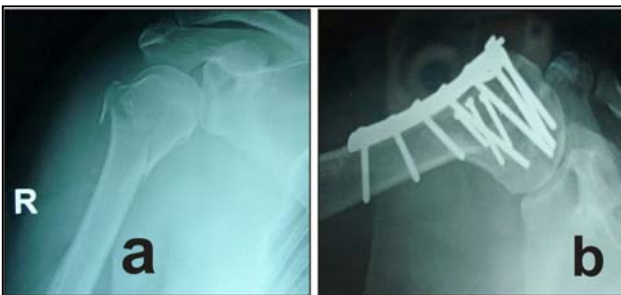
Type of fracture	No. of cases	Excellent	Satisfactory	Unsatisfactory	Failure
Three part	16	9	6	1	0
Four part	4	0	2	1	1
Fracture dislocation	5	0	4	0	1
Total cases	25	9	12	2	2



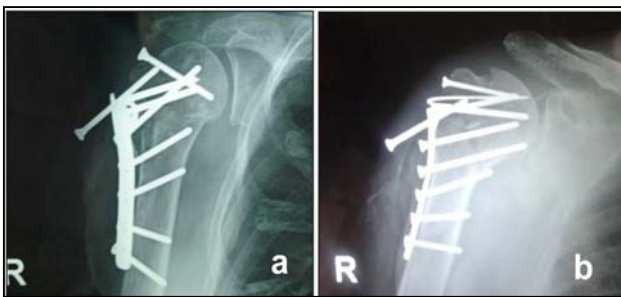
**Fig 4:** fracture dislocation type left proximal humerus fracture. a) Pre-operative x-ray b) Pre-operative 3d CT scan c) 1 year follow up x-ray d) abduction left shoulder up to 135°



**Fig 5:** Neer's type III proximal humerus fracture. a) Pre-operative x-ray b) 1 year follow up x-ray



**Fig 6:** Neer's type IV proximal humerus fracture. a) Pre-operative x-ray b) 1 year follow up x-ray



**Fig 7a:** first case of screw loosening in 56 year old female- 12 weeks post-operative follow up x-ray b) second case of screw loosening in 59 year old male- 12 weeks post-operative follow up x-ray

### 5. Conclusion

Single tine T-plate is a good alternative implant for treating complex fracture and fracture dislocation of proximal humerus. It is cost effective, and easy to use. The single tine T-plate offers good support against varus mal-reduction. Primary bone grafting is a powerful tool in managing complex fractures/ fracture-dislocation of proximal humerus.

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