Original Research Article

Comprehensive study of the outcome of diaphyseal fractures of humerus treated by locking plate fixation

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Abstract

The present study consisted of 75 cases of age group 18 years or above of either sex, with closed diaphyseal fracture of humerus, admitted in the Orthopaedics department of Dr. B.S.A. Hospital, Rohini, New Delhi. All of these patients were operated upon by open reduction and internal fixation using a locking compression plate. Conservative methods have inherent limitation that it can lead to malunion, joint stiffness and of limited value in poly-trauma patients. Open reduction and internal fixation of fractures with locking plates attains anatomical reduction, enhanced union rate, low complication rate, and a rapid return to function. In our study excellent results were obtained in 76 % of the cases and good in 24 % patients.

Key Word: Diaphyseal, Humerus, Locking, Plate, Osteosynthesis, Fractures.

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INTRODUCTION

Diaphyseal fracture of humerus is easily amenable to conservative methods as the humeral shaft is well enveloped in muscle with excellent blood supply and can be easily splinted[1]. Moreover it is a non-weight bearing bone with some acceptability for shortening and angulatory, axial or rotational deformity due to mal-union. Conservative methods have inherent limitation in poly-trauma patients. Besides many other complications are associated with conservative methods like:

1. Non-union
2. Mal-union
3. Joint stiffness

Open reduction and internal fixation of fractures with metal plates attains anatomical reduction, enhanced union rate, low complication rate, and a rapid return to function. The exploration and treatment of associated neurovascular injuries is possible and the fixation is stable enough to allow early usage of upper extremity in the multiply injured patients. Thus, Plate Osteosynthesis is the gold standard for operative treatment of diaphyseal fractures of humerus[2, 3]. Locking Compression Plates (LCP) represent the newest advance in plate technology. Locking Compression Plates are fracture fixation devices which are basically a modification of Dynamic Compression Plates, wherein they have threaded screw holes. These threaded holes allow screws to thread to the plate and the implant then functions as a fixed angled device[4]. These plates may also have a mixture of holes that allow placement of both locking and non-locking screws. The screws that are inserted into these combination holes (combi-plate) can act in a conventional compression fashion or in locking mode.[5]

MATERIAL AND METHODS

The present study consisted of 75 cases of age group 18 years or above of either sex, with diaphyseal fracture of humerus, admitted in the Orthopaedics department of Dr. B.S.A. Hospital, Rohini, New Delhi.

Exclusion criteria:

1. Patients not willing for surgery.
2. Patients with associated medical problems which made them unfit for surgery.

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3. Patients with compound fractures.
4. Patients with pathological fractures (neoplasm and metastatic).

As per individual patient's pre-anaesthetic evaluation and associated medical condition, brachial block or general anaesthesia was given. After proper painting and draping, the fracture site was exposed; using the anterio-lateral or posterior approach depending upon the type and pattern of fracture, the fracture was reduced and fixed by means of locking compression plate. Wound was closed in layers, leaving a negative suction drain in place. Intravenous antibiotics, analgesics, calcium carbonate and ascorbic acid were given post-operatively.

Check radiographs were taken and passive physiotherapy was started at the earliest possible. Sutures were removed on the fourteenth day.

All patients were subsequently assessed, after every 3-4 weeks in OPD, clinically as well as radiologically, for evidence of union and complications if any and the obtained data recorded and tabulated. The patients in study were evaluated clinically, radiologically and functionally for fracture union time, complications and functional outcomes. The Stewart and Hundley criteria were used to assess functional outcome[6].

Stewart And Hundley Criteria

Excellent	No pain, full range of motion and proper alignment.
Good	Occasional pain, limitation of adjacent joint mobility less than 20° and angulation at fracture site less than 10°.
Fair	Pain following effort, limitation of adjacent joint mobility ranging between 20° and 40° and angulation at fracture site more than 10°.
Poor	Continuous pain, limitation of adjacent joint mobility more than 40° and non-union.

RESULTS AND CONCLUSION

The following inferences were drawn:

1. In our study excellent results were obtained in 76 % of the cases and good in 24 % patients.
2. It was concluded that locking compression plate osteosynthesis in diaphyseal fracture humerus is the treatment of choice as it offers the advantage of early joint mobilization due to strong rigid fixation on the principle of internal splintage along with remarkable reduction in incidence of complications like mal-union and non-union.
3. No cases of implant reaction, implant breakage, implant loosening or screw pullout was seen due to inherent implant design and strength.
4. Locking compression plates provides fixed angle anchorage of the screw to the plate, thereby enhancing screw-plate-bone construct stability.
5. Locking compression plate provides a solution to the problems associated with conventional plating of screw cut out, late collapse and mal-alignment since the stability of the construct does not depend on the quality of the bone entirely.
6. Locking compression plate reduces bone contact and minimizes vascular damage as the screws lock in the threaded hole in the plate and do not press the plate to the bone thereby preserving periosteal blood supply and promoting biological healing.
7. Locking compression plate by maintaining bone perfusion, decreases infection rate, bone resorption, secondary loss of reduction and non-union.
8. Locking compression plate is implant of choice in patients with osteoporotic bones and in those who have been operated with dynamic compression plating earlier and presenting with implant failure or peri-implant fractures with eventual osteolysis underneath.
9. Early surgery and early post-operative mobilization are essential for good union and good range of motion at the shoulder and the elbow joints.
10. Iatrogenic radial nerve palsy is a rare yet definite complication of humeral plating, which resolves spontaneously without surgical intervention which can be avoided by gentle handling of soft tissues and avoiding electro-cautery in the vicinity of radial nerve.

To conclude, Locking compression plate is a useful implant with good results in the treatment of diaphyseal fractures of humerus, especially when fracture is comminuted, in osteoporotic and in peri-implant fractures.

DISCUSSION

In the present study the age incidence ranged between 19-70 years with an average age of 42.64 years. McCormack *et al*[7] reported 44.25 years as an average age while Kumar *et al*[8] observed average age of 36.6 years in their study which is comparable to the findings of our study. In our study diaphyseal fracture of humerus was most frequently seen in the 4th and 5th decade of life. 63 patients (84%) were less than 50 years of age which can be explained on the basis of maximum outdoor activity being undertaken by this age group. Amongst the 75 patients included in our study, 24 patients (32%) had associated injuries. Radial nerve palsy was present in 15 patients (20%). Amongst these 15 patients having radial nerve palsy there were 8 poly-trauma patients. Sharma *et al*[10] in their study reported associated injuries in 21% patients with 10% patients having associated radial nerve palsy. Radial nerve exploration was done in 15 cases followed by cock-up splint application. Radial nerve recovered in all 15 cases with an average time interval of around 6 weeks. Bell *et*

al[9] reported recovery in 7 out of 8 cases of radial nerve palsy in their study and Sharma *et al*[10] reported recovery in 9 out of 10 cases of radial nerve palsy in 3-12 weeks in their study. This may be explained by the fact that in all 15 cases of radial nerve palsy in our study, on exploration, the nerve was found to be macroscopically intact indicating neuropraxia or axonotemesis as the underlying pathology. Moreover radial nerve being a predominantly motor nerve carries excellent prognosis in case of any injury in continuity. Complete fracture union (consolidation) is defined as complete healing with ossified callus with near obliteration of fracture line. In our study of 75 patients, 51 patients (68%) had union within 16 weeks, 21 patients (28%) between 17-20 weeks and 3 patients (4%) between 21-24 weeks. The average time for union was 16.1 weeks. No patients had non-union. Kumar *et al*[7] by using internal fixation and plate osteosynthesis obtained union in an average of 12.4 weeks. Singh *et al*[12] in their study observed fracture union in 17.2 weeks with a range of 10-48 weeks using locking compression plate while Bell *et al*[9]obtained union in their study in an average of 19 weeks. As regarding the range of motion at the elbow joint, we observed in our study that 57 patients (76%) had full movement at elbow while 18 patients (19%) had slight limitation of movements of elbow. As for the shoulder too, 57 patients (76%) had full range of movement in flexion at the shoulder while 18 patients (24%) had deficient movement at the shoulder. Bell *et al*[9] in their study observed normal shoulder function in 76.5% patients. Abalo*et al*[11] reported normal shoulder function in 89% and normal elbow function in 65% patients. Celebi*et al*[13] in their study documented normal elbow function in 91% patients. In our study, 6 patients (8%) had superficial infection which responded to antibiotics alone while 3 patients (4%) developed iatrogenic radial nerve palsy. Bell *et al*[9] reported iatrogenic radial nerve injury in 1 case among the 34 cases operated in their study. Sharma *et al*[10] reported incidence of same in 1 case amongst the 44 cases undergoing plating. Singh *et al*[12] in their study observed iatrogenic radial nerve palsy in 3.63% patients undergoing surgery for diaphyseal fracture of humerus using locking compression plate. The incidence of iatrogenic radial nerve palsy was 4.24% in a study by Wang *et al*[14] As regarding the functional results, by applying the Stewart and Hundley criteria we obtained excellent results in 56 patients (76%) and good results in 18 (24%) patients. Abalo *et al*[11]reported excellent results in 52.2% patients and good results in 30.4% patients applying the Stewart and Hundley criteria. Celebi *et al*[13] too, applying the same criteria, obtained excellent results in 83.3% patients and good results in the remaining 16.7% patients in their study. In our study, we did not have any case of implant failure in the form of plate loosening or breakage or bending or any screw loosening or breakage or bending, which can be attributed to the inherent strength of the locking screw and plate. We did not encounter any case of peri-implant fracture or osteolysis which can be ascribed to principle of internal splintage working in locking compression plate vis-a-vis rigid stable fixation in dynamic compression plate. There was no case of delayed union, mal-union or non-union which can be attributed to meticulous surgical technique and implant design. Thus, the highlights of the present study are consolidated union in all 75 patients with an average time of 16.1 weeks, no case of implant reaction, no implant failure in the form of implant loosening, implant breakage or screw pull-out, minimal superficial infection with excellent overall results.

Age Incidence: The youngest patient encountered in our study was 19 years old and the oldest was 70 years of age as shown in table 1.

Table 1: Age Incidence

Age In Years	No. Of Patients	Percentage
18-20	3	4%
21-30	12	16%
31-40	21	28%
41-50	27	36%
51-60	6	8%
61-70	6	8%
TOTAL	75	100%

Time For Complete Union (Consolidation): Complete fracture union (consolidation) is defined as complete healing with ossified callus with near obliteration of fracture line. As shown in table 2, out of 75 patients, 51 patients (68%) had consolidation within 16 weeks, 21 patients (28%) between 17-20 weeks, and 3 patient (4%) between 21-24 weeks. The average radiological complete union time was 16.1 weeks. No patient had implant failure or non-union.

Table 2: Time For Complete Union (Consolidation)

Union (Weeks)	No. Of Patients	Percentage
<12	NIL	0%
13-16	51	68%
17-20	21	28%
21-24	3	4%
Delayed Union	NIL	0%
Non-union	NIL	0%

COMPLICATIONS: In our study, 6 patients (8%) had superficial infection and 3 patient (4%) developed iatrogenic radial nerve palsy as shown in table 14. The superficial infections responded to antibiotics alone while the iatrogenic radial nerve palsy recovered spontaneously between 11-12 weeks.

Table 3: Complications

Complication	No. Of Patients	Percentage
Superficial infection	6	8%
Deep infection	NIL	0%
Mal-union	NIL	0%
Iatrogenic radial nerve palsy	3	4%
Delayed union	NIL	0%
Non-union	NIL	0%
Loosening of screws	NIL	0%
Implant failure	NIL	0%
Stress fracture	NIL	0%

RESULTS

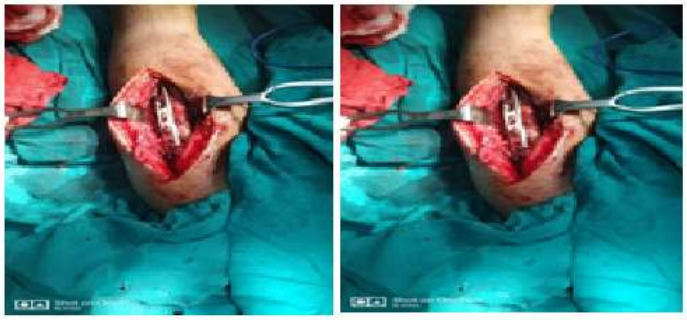
By applying the Stewart and Hundley criteria the following results were obtained we obtained excellent results in 57 patients (76%) and good results in 18 patients (24%).

Table 4: Results (Using Stewart And Hundley Criteria)

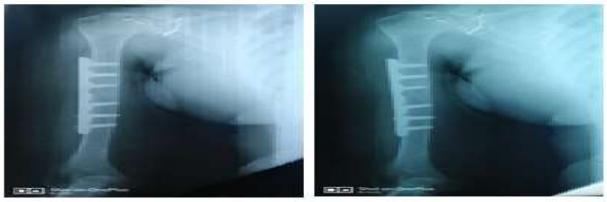
Results	No.Of Patients	Percentage
Excellent	57	76%
Good	18	24%
Fair	NIL	0%
Poor	NIL	0%
TOTAL	75	100%

PRE-OP

INTRA-OP



POST-OP



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