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Evaluation of treatment of diaphyseal fracture of humerus: Dynamic compression plate versus interlocking nail: A prospective randomized controlled study

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Abstract

Fracture shaft of the humerus is a common injury in orthopaedic practice. Conservative management with plaster gives good result but this method cannot be applied in situations which necessitates internal fixation. There always a question arises which kind of implant to be used for surgical intervention. A prospective comparative study for the management of acute diaphyseal humeral shaft fractures with dynamic compression plate and antegrade interlocking nail fixation was undertaken over a period of three years. In each category Twenty five patients had undergone above implant fixation after considering the inclusion and exclusion criteria. Rate and time of union, functional scoring criteria (ASES) and complication rate were used for postoperative assessment with an average follow-up period of one year. A higher rate of union with excellent to good functional outcome was seen with the plating group in our series.

Keywords: Diaphyseal humerus fracture, Dynamic compression plate & Interlocking nail, Union and functional outcome (ASES score)

1. Introduction

Diaphyseal fracture of humerus is a common entity accounts for 3% to 5% of all fractures. Most closed fractures of humeral shaft can be treated conservatively with union rate more than 90% [1-6]. However prolonged immobilization [7, 8] unstable fractures (spiral/long oblique), comminuted fractures, segmental fractures, pathological fractures, open fractures, fractures with radial nerve injury or vascular injury, multiple injury are not ideal for conservative management [5, 9-11]. Failure to maintain the adequate reduction with time is also an indication for surgery [12].

Surgical stabilization can be achieved with plates & screws, intramedullary nails or external fixators [13]. External fixator is generally reserved for compound fracture following high energy gunshot wounds, fractures with significant soft tissue injuries. Both plating and intramedullary nailing have their own anatomical and biomechanical advantages and disadvantages.

In view of various modalities of management with controversies regarding their use, it is quite difficult to select a right implant for internal fixation of fracture shaft of humerus. Thus the purpose of this prospective study is to compare the results of plates and intramedullary nails in the treatment of humeral shaft fractures to determine the best fixation devise in current scenario.

2. Materials and methods

2.1 Subjects

Fifty-five patients with informed consent having acute humeral shaft fractures were treated with either plating or interlocking nailing procedures over a period of three years (2010 to 2013) with average follow-up period of one year (range 10–24 months). 5 patients were lost during follow up and they were excluded from the study. A prospective randomisation attempt was made by allocating each patient to either of the groups using a sealed envelope technique.

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Adult patients with fracture of humeral shaft within 3cm proximal to the olecranon fossa to 2cm distal to the surgical neck of the humerus were included in the study. Polytraumatized patients, unacceptable reduction following closed reduction, compound fracture of grade 1 & 2, fracture associated with radial nerve palsy were included in the study. Pathological fractures, segmental fractures were excluded from the study.

2.2 Operative details

Most of the patients were operated within a week of trauma with an average time interval from injury to surgery was 4.66 days. In 25 cases, DCP was done through an anterolateral or posterior approach. The plates were AO 4.5 mm DCP plates, with the length depending upon the type of fracture. Minimum 3 screws on either side of fracture was fixed. Intramedullary interlocking nail was used in 25 cases. Antegrade technique was used in all cases. Nails were inserted following reaming and locked up screws both proximally and distally.

Almost all except one case of plating were operated under brachial anesthesia and most of the cases of nailing were done under GA. The commonest diameter of nail used was 7 mm (52 %) followed by 6 mm (36 %) and 8 mm (12%) respectively. Nail size 26 cm was most commonly used (40 %) followed by 24 cm (28 %), 22 cm (24 %), 20 cm and 28 cm (each 4%) respectively. Most commonly 7 hole broad DCP was used in plating procedure (48%). Lag screw for reduction was used in 28% cases.

2.3 Follow up

Subsequently patients were followed up clinically and radiologically at 3 wk, 6 wk, 3 month, 6 month and 1yr. Data were collected by verbal communication, clinical examination and radiographic features. Both functional and anatomical assessment was done. The outcomes were assessed in terms of functional outcome using the American Shoulder and Elbow Surgeons' Score, ability to return to previous jobs, union time, union rate and the incidence of complications. The results were analyzed statistically using the SPSS software version 16 with p value less than 0.05 to be significant.

3. Results

3.1. Demographic details

Demographic profile of the study in table 1.

Table 1: Clinical details of the patients. (SD= Standard Deviation)

Mean age(yrs)	39.78 (SD= 13.869)
Range	19-72
Male: Female	34:16
Right : left	28:22
Mode of injury	
RTA	52%
Fall	30%
Others	18%

3.2 Intraoperative findings

Time taken for surgery was more in plating (mean 90.2 min, SD= 9.946) compared to nailing (mean 62.6min, SD= 17.919). This comparison is statistically significant with two-tailed P value is <0.0001, considered extremely significant, t= 7.992 with 24 degrees of freedom.

Operative blood loss in plating (mean 154.16 ml, SD= 13.924) was more compared to nail group (mean 29.8, SD= 15.308) and this comparison is statistically significant. ($p < 0.0001$). Intraoperative Radial nerve injury was most

common complication in plating, where as in nailing it was opening of fracture site during difficulty in nail insertion. (Table 2 showing intraoperative complications)

Table 2: Showing intraoperative complications

Complication	Plating	Interlocking nail
Distraction	--	02(8%)
Conversion to OR from closed reduction	--	04(16%)
Difficulty in locking	--	02(8%)
Iatrogenic fracture	01(4%)	02(8%)
Drill bit broken	01(4%)	--
Radial nerve injuries	03(12%)	01(4%)
Reamer broken	--	01(4%)

3.3 Union and functional outcome

There was no tenderness at fracture site at the end of 2 month in 88% cases in both the groups, (mean for plating 1.46 month, SD=0.676 & mean for nailing 1.58, SD=0.6874). This comparison is considered to be significant with two tailed p value 0.04072.

In one case of plating there was no callus at all since the point of fixation; finally it ends up with non-union. Callus appearance was most commonly seen in 2nd month in both the group.

Three cases from each group did not show any sign of complete radiological or clinical evidence of union. They were ended with delayed union and non-union. Excluding these cases in plating group, fracture of most of the patients (95%) united within < 16 weeks. The average time of union was 13.09 weeks, SD= 1.743. In nailing group, fracture of 73% of the patients united in less than 16 weeks, and 95% of patients united within 20th weeks. The average union time being 15.5 weeks, SD= 2.54.

88 % of our patients in plating and 76% of nailing group had excellent external rotation of more than 45 degree. One case of either group had external rotation less than 20°. However elbow range of motion in both groups was excellent. Mean American Shoulder and Elbow Surgeons (ASES) score in plating group was 46.88 (SD= 4.693) compared to nailing group was 45.72 (SD= 4.258). 80% of the patients in plating group had excellent upper limb functional status at the end of the treatment, compared to 56% of the patients in nailing group with ASES 47-52. Only 4% of both the group had ASES 32-36 which implies fair functional status of upper limbs. The two-tailed P value is 0.3646, considered not significant.

3.4 Post-operative complications

Average post-operative complication (table 3) in nailing group was more than that of plating group, with a mean in nailing group 1.4 (SD= 0.9661) and in plating group 1.0 (SD= 0.8165).

Table 3: Showing post op complications

	Plating	Interlocking nail
Superficial Infection	02 (8%)	01(4%)
Deep infection	02(8%)	01(4%)
Delayed union	01(4%)	02(8%)
Non-union	02(8%)	01(4%)
Radial nerve palsy (not recovered)	01(4%)	01(4%)
Implant failure	01(4%)	01(4%)
Shoulder pain	00	03(12%)
Shoulder stiffness	00	03(12%)
Elbow stiffness	01(4%)	00
Screw breakage	00	01(4%)

4. Discussion

Different studies [12, 14-16] on diaphyseal fracture of humerus showed the commonest age group affected are 3rd and 4th decade with a male [12, 15, 16, 17] predominance. Right side is [12, 13, 18, 19] affected more often than the left. This age group represents the actual earning period in the life time of an individual. Due to early mobilization following injury these patients gain full range of movement with minimal loss of productivity. RTA followed by fall is the major leading cause of such injuries [12, 15, 16, 20]. Polytrauma is the leading cause of such morbidity followed by isolated compound fracture and unstable reduction in conservatively managed patients [19, 21]. In our study pre-existing radial nerve palsy was seen in 7 cases (14%). Except one case (02%) all recovered within 6 month. In that case, on exploration nerve was found to be lacerated by the hook of the distal segment. This case did not recover till 1 yr and was managed by tendon transfer. Lin *et al.* [19] in their study found 4 cases (21%) of nerve palsy, from which 3 cases recovered completely. Similarly Flinkkila *et al.* [22] in their study described 5 cases required nerve exploration out of 10 cases (08%) of pre-existing nerve palsy.

Average blood loss was more in the plating group. Mohammad Iqbal *et al.* [13] found similar loss, where average blood loss was 200ml in plating group compared to nail group 10-20 ml. Iatrogenic radial nerve palsy is seen in different studies [4, 12, 15-17]. In our series we had 4 postoperative cases of radial nerve palsy (16%). 3 cases (12%) in plating group and 1 in nailing group. All injuries in plating group were neuropraxia type and eventually recovered completely within 6 month post-operatively. Palsy in the nailing group did not recover even after 1 yr. This was associated with Lewis-Holostein fracture [26]. EMG and Nerve conduction study revealed complete nerve palsy. Finally it was treated by tendon transfer. In plating, due to wide dissection at the fracture site, there is higher chance of damage to the radial nerve because of stretching. Iatrogenic fracture was encountered during surgery [4, 12, 15-17]. We encountered three cases (12%) of intraoperative fracture comminution but this did not affect fracture healing and all the fractures united well within four months of period.

A higher rate of excellent to good results with a tendency of early union was seen in plating (75% in <16 wks) than in interlocking nailing group (50% in <16 wk). Union time in our series is comparable to Singsetty *et al.* [23] and Garnal Hosny *et al.* [20] study. In other series union time in nailing is better than plating [12, 16, 17].

Union rate in both the group is similar to other study [12, 16, 17]. In our study, the two tailed p value was 0.0008, considered to be extremely significant. In spite of extensive stripping of periosteum and drainage of fracture haematoma time of union in plating group is earlier. This may be attributed to its rigid dynamic compressive fixation. Union time of both the group is also comparable to conservative mode of treatment, but here the patient is able to use the arm without external splintage so that it helps in preventing osteoporosis, muscle atrophy, joint stiffness and limb oedema.

Functional outcome as measured by ASES score favours plating in our series, though the difference is not statistically significant (p= 0.83) similar to other study [15, 17, 20]. In nailing group ASES score was poor related to shoulder morbidity due to antegrade nailing. In a meta-analysis by Bhandari *et al.* [24] reported that plate fixation may reduce the risk of shoulder impingement but the cumulative evidence remained inconsistent and that a larger trial might be needed to confirm the findings.

Shoulder impingement and stiffness is a common entity in nailing group [12, 15-17, 23, 25]. The causes of stiffness are protrusion of nail at the entry point, damage to the rotator cuff, inadequate removal of bone debris after nailing from the entry point, adhesive capsulitis and lack of patient's cooperation with the postoperative physiotherapy regimen. The percentage of impingement is less in our series (12%). This might be due to the reason that proximal tips of the nails were counter-sunked into the head of humerus. Impingement occurred because of lack of experience with this type of nailing in initial phase and this complication was minimized later on. In nailing, residual fracture site distraction can lead to increased risk of delayed union/non-union, whereas in plating higher rate of nonunion is due to excessive periosteal stripping, loss of biological substances etc [15-17, 23, 25]. In our series three cases from each group had gone for non-union and delayed union, out of which one in each group was infected non-union, which were treated with implant removal, debridement, insertion of vancomycin impregnated PMMA beads. Later these cases were revised by plating and bone grafting once the infection was settled.

Limitation of our study includes short term follow up with small number of patients. We believe that a larger sample size with a longer period of follow-up may draw a clear comparison between the two.

5. Conclusion

In acute diaphyseal humerus fracture no single treatment option is superior in all circumstances and each case has to be individualized. Plating has shown to have overall better results as compared to the interlocking nail clinically, functionally, radiologically with shorter union time and minimal complications. However there appears to be no significant difference in both the groups with respect to functional outcome.

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