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ORIGINAL ARTICLE

OUTCOME OF ELASTIC INTRAMEDULLARY NAILING IN OPEN DIAPHYSEAL FRACTURES OF THE HUMERUS IN ADULTS

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ABSTRACT

Background: Choosing the best treatment for open diaphyseal humerus fractures with soft tissue injury is a challenge. Open humerus fractures are conventionally treated with uniplanar external fixator in adults. Closed retrograde titanium elastic intramedullary nailing is a relatively new but an effective and safe alternative to treat open diaphyseal humerus fractures. The objective of our study was to determine the functional and radiological outcome of open diaphyseal humerus fractures treated with closed retrograde titanium elastic intramedullary nailing.

Materials & Methods: This descriptive cross-sectional study was conducted in Orthopaedic Division Lady Reading Hospital Peshawar Pakistan from 5th July 2024 to 20th November 2024. All patients with open diaphyseal humerus fractures fulfilling the inclusion criteria were treated with two closed retrograde titanium elastic intramedullary nailing under image intensifier. Radiological outcome was assessed with fracture healing on X-rays while functional outcome was assessed with Stewart and Hundley criteria and graded as excellent, good, fair and poor outcome

Results: We treated 35 patients**.** The mean age was 42±2.5 years. Male patients were 31(88.57%) and female were 4(11.42%). Radiological union was achieved in 32(91.42%) patients in an average 14.2±3 weeks time. Excellent functional outcome was achieved in 20(57.14%) patients, good in 9(25.71%), fair in 3(8.57%) and poor in 3(8.57%) patients. Younger patients(<40 years) achieved healing earlier than elderly patients(p=0.02). Transverse mid shaft Gustilo Anderson type I and II fractures achieved earlier union than other types(p=0.002).

Conclusion: Open diaphyseal humerus fractures treated with retrograde titanium elastic intramedullary nailing in adults achieved fracture union with excellent to good functional outcome in majority of our patients.

KEY WORDS: Humerus; Fracture; Retrograde; Titanium; Nailing; Union.

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INTRODUCTION

The overall frequency of humerus shaft fracture is 11.9 Per 100000 Person-Years with open fractures accounts for approximately 2.8%.[1] Humerus shaft fractures have a bimodal age distribution and men in the age range of 21 to 30 years suffer these fractures due to high energy trauma, comminuted in nature and associated with soft tissue injuries. The second peak of humerus fractures affects women in the age range of 60 to 80 years due to low energy trauma.[2] Recent literature favors operative intervention for closed and open humerus fractures to reduce higher nonunion rates reported with conservative treatment.[3] Many options are available for treating closed humerus shaft fractures including conservative treatment in brace, open reduction and plating, Minimally Invasive Plate Osteosynthesis(MIPO) and interlocking nails resulting in variable but acceptable results.[4] Open humerus fractures however have very limited treatment options and the presence of significant soft tissue injury predispose these fractures to poor functional and radiological outcome.[5] It has been reported that the frequency of post operative infection in closed low energy humerus fracture is 1% while open humerus fracture can have an infection rate as high as 15%.[6] Uni planer external fixator is the most commonly used technique to stabilize

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open humerus fractures in adults but complications like pin tract infection, Schanz pin breakage, pin loosening, mal union and nonunion are commonly reported.[7] The shaft of humerus can tolerate a large range of alignment within the acceptable range as it is a non-weight bearing bone and titanium elastic intramedullary nails can provide sufficient relative stability in adults humerus fractures.[8] Titanium Elastic Intramedullary Nailing is an excellent alternative to external fixator for treating open humerus shaft fractures in adults but seldom used. It has added advantages of being minimally invasive technique and potential for enhanced facture healing and adjacent joint mobility.[9]

The objective of our study was to determine the functional and radiological outcome of open diaphyseal humerus fractures treated with closed retrograde titanium elastic intramedullary nailing.

MATERIALS AND METHODS

We conducted this descriptive cross sectional study in Orthopaedic division Lady Reading Hospital Peshawar Pakistan from 5th July 2024 to 20th November 2024. Ethical approval was taken from Institutional Review Board(IRB). All adults' patients of both gender with open diaphyseal humerus fractures [Gustilo Anderson type I, type II, type III-A][10] presented within seven days were included. Pathological fractures and fractures with neurovascular injuries were excluded. Informed written consent was taken from all study participants for surgery and publication. The sample size for our study was calculated with the help of Naing and Winn formula[11], as follows:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

Where n=Sample size, Z=Level of Confidence (95%/1.96), P=Expected Prevalence/Proportions (2.8%/0.028)[1] and d=Precision (in proportion (5%, /0.05). The sample size was 31.68. By adding the possible lost to follow up (10%, n=3.16) the total sample size was 35.

The patients were enrolled from Accidents & Emergency Department Lady Reading Hospital Peshawar. All the included patients were resuscitated according ATLS protocol initially in the trauma room. After stabilization x-rays was taken. Complete history and physical examination was done. The wound was washed and splinted. Analgesics and intravenous antibiotics was started and patient was prepared for definitive surgery.

Operative Technique

All the surgeries were performed under general anesthesia and by the same team of Orthopaedic surgeons. A uniform surgical technique was adopted for all cases. The patient was be placed in lateral position. Under image intensifier through a small skin incision an entry point was made just above the lateral epicondyle and bone with a 4.5 mm drill bit and widened with an owl advanced at 45 degrees towards the medullary canal. An appropriate size titanium elastic nail is inserted and forwarded to the fracture site with T handle. The diameter of the titanium elastic nail was calculated in millimeter by measuring the diameter of the intramedullary canal at the narrowest portion of the canal multiplied by 0.4. Two identical diameter nails inserted in each case.[12] The fracture was manipulated closely and reduced under C arm to facilitate the upward motion of the nail inside the medullary canal. The nail was passed the fracture site and stopped at the proximal humerus near humeral head. A second elastic nail is passed through the entry point just above medial epicondyle taking care not to damage ulnar nerve by palpating it. The wound was thoroughly washed. A u-slab was applied for two weeks. Post operative follow up visits was scheduled at 2 weeks initially for 6 weeks and then monthly. Radiological union was assessed with X-ray AP & lateral view. All the patients had supervised physiotherapy at 2 weeks after removal of U slab. The functional outcome was assessed with modified Stewart and Hundley criteria [13,14] and graded as excellent, good, fair and poor outcome once radiological union was achieved.

We analyzed our data with SPSS version 27. Frequencies and percentages were calculated for qualitative variables like side of fracture while mean and standard deviation was calculated for quantitative variables like age of the patient. Important categorical variables were compared and P value calculated with Chi-square test while quantitative variables with Independent sample t test. $P<0.05$ was considered significant. Data was presented in table where necessary.

RESULTS

The total number of patients were 35. Mean age was 42±2.5 years. Male patients were 31(88.57%) and female were 4(11.42%). The aetiology of fracture was road traffic accidents in 19(54.28%) patients, fall in 9(25.71%) and gun shot in 7(20%) patients. Majority (51.42%, n=18) of fractures were Gustilo Anderson type II, followed by type I (28.57%, n=10) and Type III-A fractures (20%, n=7). Right humerus fracture was present in 26(74.28%) patients and left in 9(25.71%) patients. The location of fracture was mid shaft in 19(54.28%) patients, distal third in 11(31.42%) and proximal third in 5(14.28%) patients. The type of fracture was short oblique in 15(42.85%) patients, transverse in 12(34.28%) and comminuted in 8(22.85%) patients. The average union time was 14.2±3 weeks (Fig. I). Majority (57.14%, n=20) of our patients had excellent outcome as shown in table I. Younger patients (<40 years) achieved healing earlier than elderly patients(p=0.02). Transverse mid shaft Gustilo Anderson type I and II fractures achieved earlier union than other types(p=0.002).No

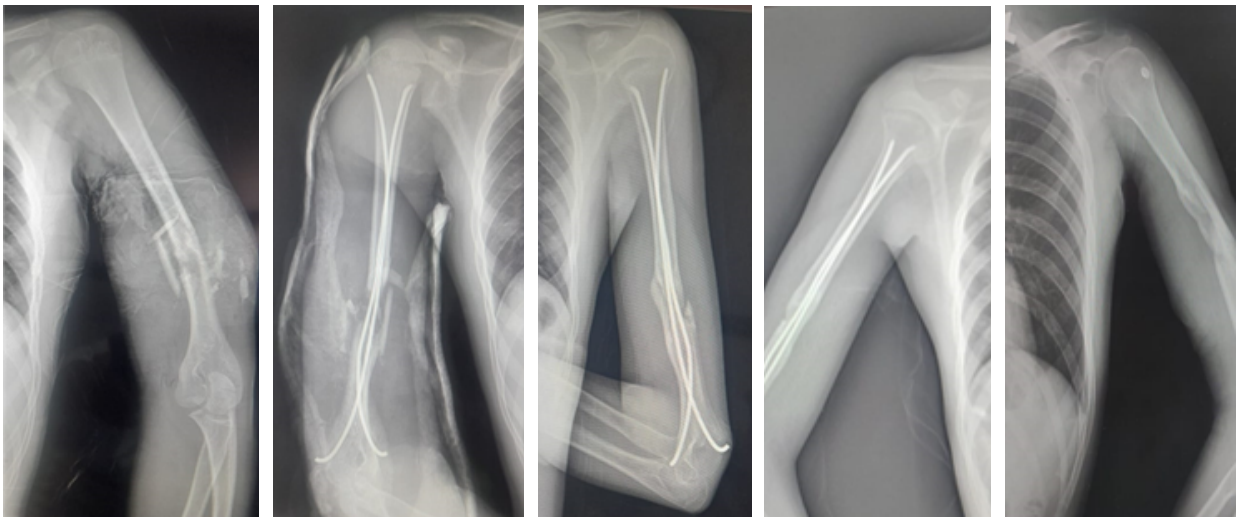

Fig 1: Radiographs of a 20 years old patient with Gustilo Anderson type II fracture treated with retrograde titanium elastic intramedullary nails.

Table I: Assessment of post operative functional outcome [modified Stewart and Hundley criteria]

Number of Patients	Percentage	Score	Pain	Limitation of Elbow or Shoulder mobility	Angulation
20	57.14%	Excellent	None	None	Good Alignment
9	25.71%	Good	Occasional	<20 degrees	<10 degrees
3	8.57%	Fair	After effort	20 to 40 degrees	>10 degrees
3	8.57%	Poor	Permanent	>40 degrees	Nonunion/iatrogenic radial nerve palsy

significant difference was noted($p>0.05$) in healing time and functional outcome when comparison was made for gender and side of fracture.

We documented superficial surgical site infection in 7(20%) patients and all cases were resolved with local wound dressing and antibiotics. Transient ulnar nerve palsy was noted in 5(14.28%) patients and resolved conservatively with physiotherapy. In our study 3(8.57%) patients had nonunion and treated with plating and bone grafting. Radial nerve injury was not reported in any case.

DISCUSSION

We achieved radiological union in 32(91.42%) patients with open diaphyseal fractures of the humerus treated with titanium elastic intramedullary nails. Excellent functional outcome was achieved in 20(57.14%) patients and good in 9(25.71%) patients. Upon extensive literature search we found only a limited number of studies which have specifically described retrograde titanium elastic nailing in open diaphyseal fractures in adults. Sagar and Ravi[15] treated 43 humerus shaft fractures including 35(81.4%) closed fractures and 8(18.6%) open (Type I) fractures. Radiological union was achieved in 12.4 ± 2.7 weeks in all cases. The functional outcome was excellent in 40(93.02%) patients, good in 2(4.6%) and fair in 1(2.3%) as assessed with Constant Shoulder Score. The post operative Mayo Elbow Score was excellent in 41(95.34%) and good in 2(4.6%) No major complication was noted. Mahmoud and colleague[16] treated 29 closed humerus fracture and one open humerus fracture with elastic intramedullary nails and reported excellent functional outcome in 18(60%) patients, good in 9(30%),fair in 2(6.66%) and poor in 1(3.33%) as assessed with Stewart Handly's scoring criteria. These authors reported that younger patients healed quickly than elderly when treated with flexible intramedullary nailing. One local study conducted by Haq and Iqbal[17] shared their results of 30 closed and type I open humerus treated with elastic intramedullary nailing and achieved radiological and clinical union in 23(76.7%) patients within three months. Two patients were treated with plating and 5 with bone grafting with nails in situ. They noted surgical site infection in 9(30%) patients. Barati and Afzal[18] reported in an interesting case report of a 40-year-old female patient with segmental Gustilo-Anderson type III-B fracture of the proximal humerus fracture

treated successfully with elastic intramedullary nailing. Tarng and Lin[8] are of the view that titanium elastic intramedullary nailing is indicated in adults in four conditions:1) the patient is intolerant to splint but has a higher risk for general anesthesia 2) the intramedullary canal of the humerus is narrow (< 7mm) 3) the fracture is oblique or long spiral and located at the junction of metaphysis and diaphysis 4) patient is obese. Based upon our results we are justified to add open humerus fracture as the fifth indication to this list.

In one recent study by Abdalla and colleagues[19] treated 18 closed and 2 open humerus shaft fractures in adult's adult with retrograde elastic nailing. These authors reported fracture union in majority (>90 percent) of their patients. The functional outcome was excellent in 60% patients, good in 30%, fair in 5% and poor in 5% of their patients as assessed with Stewart and Hundley scoring system.

Our study had few limitations. Our study had descriptive design and short follow up period. We recommend further studies to verify our results.

CONCLUSION

Open diaphyseal humerus fractures treated with retrograde titanium elastic intramedullary nailing in adults achieved fracture union with excellent to good functional outcome in majority of our patients. The technique is a safe and effective alternative to external fixator in open humerus fractures. It avoids reaming the intramedullary canal thus minimizing blood loss and least trauma to the surrounding soft tissue envelope. Shoulder and elbow joints are mobilized early. We recommend this technique as treatment of choice for open diaphyseal fractures in adults.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	FAS, AS
Acquisition, Analysis or Interpretation of Data:	FAS, AS, NU, SUR
Manuscript Writing & Approval:	FAS, AS, NU, SUR

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.