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## Management of Diaphyseal Humeral Fracture by using Interlocking Medullary Nail versus Plate Fixation

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Analysis of fractures of the humeral diaphysis reveals the effect of the muscular forces acting on the shaft at varying levels. The energy absorbed by the humerus during fracture is an important determinant of the amount of displacement. Low energy fractures may be held in position by the internal splinting effect of the intermuscular septa. The weight of the arm aids in preserving alignment and length in these low-velocity injuries. High-energy fractures result in comminution of the bone and disruption of the soft tissues with loss of this internal splinting effect. This study aimed to compare the results of plate osteosynthesis and interlocking nailing in the treatment of diaphyseal humeral fracture with reference to rate healing, functional outcome and complications. A prospective study that included 18 patients with closed fractures in both groups due to road traffic accidents (RTA) in 7 patients were in group I, 4 patients in group II. Falling from height in 3 patients were in group I and 4 patients were in group II. 9 cases of them were fixed by plates (group 1) and the other 9 by IM nails (group 2). Plate and nailing was done within few days after injury. Patients were followed post operatively for union, and clinical assessment was done using constant scoring system including; shoulder function, elbow function, union and pain. Compression and lag screws should be inserted when possible. Fixation of 8 to 10 cortices proximal and distal to the fracture should be used. The nail was inserted in antegrade fashion. There was significant relation between age and the final results, that the younger the patient the more rapid the fracture healing occurs. Also type C fractures. However there was no statistically significant relation between genders, side affected, type and the presence of associated injuries and final score. The functional outcome in elbow between two groups was assessed through Stewart and Hundley's scoring system 15 patients (83.33 %) had a full range of motion; 2 patients good in group I (11%) had loss of less than 20 degrees of elbow extension, one patient fair (5.5%) had loss of less than 40 degrees of elbow extension. The time elapsed before surgery was significant as the shorter the trauma-surgery interval the better the results. A healing outcomes assessed between humeral diaphyseal fractures treated with IM nails and those treated with plates. Plating was associated with a higher incidence of elbow pain and stiffness as well as a slightly higher incidence of infection, although stiffness was no statistically significant. Plating is preferred than interlocking medullary nail in fixation of diaphyseal humeral fracture.

**Keywords:** Humeral Fracture, Interlocking Nail and Plate Fixation

## INTRODUCTION

Routine surgical management of humeral shaft fractures is probably not always indicated since the results of non-operative treatment are generally satisfactory. However, there are many situations where surgical treatment is more appropriate (van Riet and Morrey,2017). Percutaneous plate fixation of segmental fractures of the humeral shaft is an alternative to standard open surgery and intramedullary fixation, reducing surgical impact and yielding an excellent functional result ( Pharaon et al. 2018).

Intramedullary fixation has gained popularity over the last several years. The initial reports revealed a higher non-union rate than that associated with conservative treatment or open reduction and internal fixation (ORIF) with plates and screws. However, newer implant and improved technique; locked intramedullary nailing can have a success rate as high as other methods ( Maheshwari and Mhaskar, 2019). Intramedullary nailing of shaft fractures of the femur, tibia, and humerus is generally accepted as a standard treatment. Indirect reduction and fixation without opening of the fracture site, implant insertion along the mechanical loading axis of the bone, good bone-implant interface and early load sharing to allow weight bearing are clear advantages of intramedullary nailing. The design and application of intramedullary nails have rapidly evolved since the pioneering work of Küntscher in World War II (Egol et al. 2010). However, a considerable rise in intramedullary pressure and temperature, increasing the risk of bone necrosis and infection. In the past, these disadvantages limited the use of reamed nailing to fractures with only minor soft-tissue injury (da Silva,2015).

The addition of interlocking screws to the intramedullary nail, introduced by Grosse and Kempf, enhanced the mechanical properties of the intramedullary implant. It widened the range of indications to include more proximal or distal fractures, as well as more complex and unstable fracture patterns. However, if the fracture is more distal ,more proximal, or more complex, its fixation will mainly depend on the interlocking screws and much less on the principle of circular press fit (Zhao et al. 2017). Plate remains the corner stone of operative treatment of Diaphyseal humeral fracture. Either open reduction and internal fixation or minimally invasive plate osteosynthesis (Stoffel et al. 2007).

Minimally invasive plate osteo-synthesis

(MIPO) which have more advantages and lower complication than old one. Time for full union and for full weight bearing are short with rapid mobilization of the limb and the patient, as it maintains the appropriate climate for fracture healing with relatively a stable fixation. Its disadvantages are high incidence rate of soft tissue irritation symptoms and malunion (Steed,2017).

Locking plates function differently biomechanically compared with nonlocking plates. Locking plates and screws acts like an external fixator due to the screw is rigidly connected to the plate that creates a fixed angle device, which do not depend on bone quality as much as conventional plate screws because each screw of locked plate acts as a fixed implant ( Gautier,2016). In addition, locking plates construct provide more stability in comminuted fractures, in which cortical apposition and compression at fracture site are difficult to achieve and mechanical stability of the comminuted fracture occurs mainly from the implant. This advantage is useful in osteoporotic bone (Bogner et al. 2016). Therefore, the present study was aimed to compare the results of plate osteosynthesis and interlocking nailing in the treatment of diaphyseal humeral fracture with reference to rate healing, functional outcome and complications.

## MATERIALS AND METHODS

A prospective comparative study that included 18 patients in the period from December 2018 to July 2019 with follow up 8 months were operated up on at the Orthopedic Surgery Department of Zagazig University Hospitals. All patients had closed fractures in both groups.

Approval for performing the study was obtained from orthopedic surgery Departments, Zagazig University Hospitals after taking Institutional Review Board (IRB) approval, and also informed written consent was taken from patients and/or their caregivers.

### Inclusion criteria and technical design:

The commonest mechanism of injury was road traffic accidents (RTA) in 7 patients were in group I, 4 patients in group II. Falling from height in 3 patients was in group I and 4 patients were in group II. 9 cases of them were fixed by plates (group 1) and the other 9 by IM nails (group 2).

A full history taking, clinical examination, and radiological evaluation as well as laboratory investigations was performed for

every patient on admission. All patients underwent the surgical procedure under general anesthesia as soon as possible for every case according to general condition, time of operation was done from 1 to 5 days after injury.

Plate and nailing was done within few days after injury. The surgery was performed under general anesthesia. plates (DCP, LCP) are used in the stabilization of humeral shaft fractures selected according to the average size of the patient. Compression and lag screws should be inserted when possible. Fixation of 8 to 10 cortices proximal and distal to the fracture should be used. The nail was inserted in antegrade fashion. The patients encouraged gradually to start elbow and shoulder exercises.

All patients were put in an arm sling immediately post-operatively and were examined for vascular and neurological status. Check X-rays were obtained to assess the reduction and the position of nails. Patients were followed post operatively for union, and clinical assessment was done using constant scoring system including; shoulder function, elbow function, union and pain. The arm sling was removed after three to six weeks and active shoulder exercises were allowed. Heavy weight loading not allowed till complete and solid radiological bone union was achieved. Anteroposterior and lateral X-rays were obtained after two, six, and twelve weeks, then monthly till radiological union, then at the end of follow up.

### Statistical analysis

All statistical analyses using the SPSS 18 ( Inc., Chicago, IL, USA). T-test was conducted to compare continuous variables and the chi-square and Fisher's exact tests were performed to compare categorical variables. Variables are expressed as mean  $\pm$  SD and categorical variables as frequency and percentage. P values less than 0.05 were considered significant

### RESULTS

The prospective study included 18 patients were assessed after two weeks, six weeks, twelve weeks and twenty-four weeks. Results were assessed according to Constant's scoring system. Regarding injury characters distribution among studied group, the left side injury represented 72.2% and right side injury represented 27.8% (Table 1).

Time before management was distributed as  $1.88 \pm 1.13$  with minimum 1 day and maximum 5 days (Figure 1). Time of union was distributed as

$3.22 \pm 0.77$  with minimum 2.5 and maximum 5 days (Figure 2).

Patients managed with plate (n=7) with satisfactory response (43.8%), while patients managed with plate (n=9) with satisfactory response (56.2%). Unsatisfactory result group significantly associated with higher time before surgery and longer union time also with fair pain and movement and with infection (Table 2).

### DISCUSSION

Fractures of the humeral shaft are relatively common injuries approximately 3 % of all fractures. For the treatment of the humeral shaft fractures, conservative treatment still competes with the operative approach to a much greater degree than is the case of fractures of the long bones of the lower extremity. The trend towards the operative treatment continues unabated ( Bogner et al. 2016).

There are three main reasons for the preference now given to operative methods for the treatment of humeral shaft fractures: (1) the frequent absence of necessary prerequisites for successful conservative therapy; (2) preferences expressed by patients; (3) the inherent and recent advantages of surgical treatment in surgical treatment in particular, intramedullary osteosynthesis (Hickman et al. 2018).

So, internal fixation of the humerus must first emphasize the excellent results that can be expected with nonoperative treatment of humeral shaft fractures Most studies report nonunion rate with conservative methods approximately 1% to 10% following humeral shaft fractures (Raby et al. 2014). Polytraumatized patients, open fractures, spiral fracture, floating elbow, segmental fractures, pathological fractures and patients of poor compliance for bracing are classical indications for operative treatment of humeral fractures (Cole and Horazdovsky, 2016).

The result of open reduction and internal fixation (ORIF) of humeral shaft fractures using dynamic compression plate shows high rates of good radiological and functional result and low rates of nonunion, malunion or other serious complication. Therefore, the aim of fixation is to obtain an upright patient with pain free extremities, establish bone union with acceptable humeral alignment and restore patient to preinjury level of activity (Ali et al. 2014).

Plates (DCP, LCP) are used in the stabilization of humeral shaft fractures selected according to the average size of the patient compression and lag screw should be inserted when possible.

Fixation of 6 to 10 cortices proximal and distal to the fracture should be used (Zhao et al. 2017).In comparison with plate fixation, intramedullary

nailing offers all advantages of intramedullary implants for the treatment of humeral shaft fractures (Morton,2017).

(Table 1) Injury characters distribution among studied group (N=18)

		Time before surgery/ Day	
<b>Mean± SD</b>		1.88±1.13	
<b>Median (Range)</b>		2.0 (1-5)	
		N	%
<b>Side</b>	Left	13	72.2
	Right	5	27.8
<b>Mechanism of injury</b>	FH	7	38.9
	RTA	11	61.1
<b>AO classification</b>	A	8	44.4
	B	7	38.9
	C	3	16.7
	Total	18	100.0

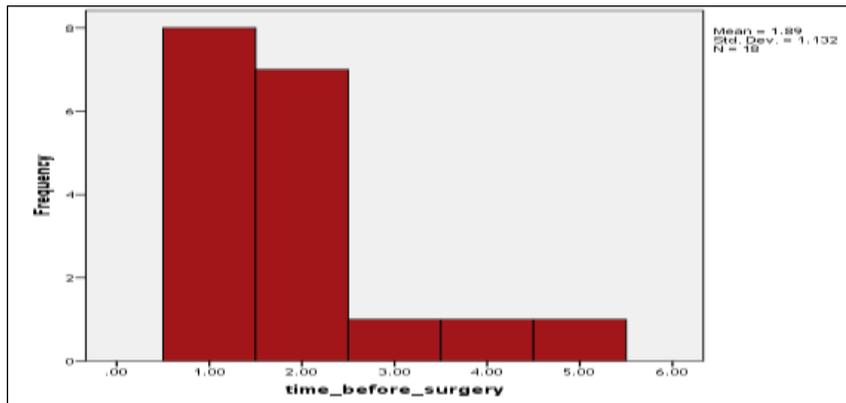


Figure 1: Time before management among studied group.

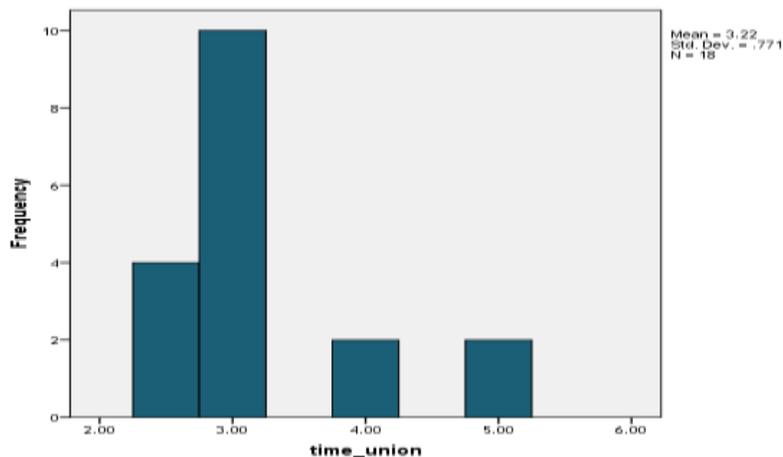


Figure 2: Time of union among studied group.  
Table 2: Relation and association with satisfaction

			Satisfactory	Unsatisfactory	t/ X2	P
<b>Age</b>			35.25±9.46	40.0±18.38	-0.618	0.545
<b>Sex</b>	Female	N	6	0	1.12	0.28
		%	37.5%	0.0%		
	Male	N	10	2		
		%	62.5%	100.0%		
<b>Heavy work</b>	.00	N	6	1	0.11	0.73
		%	37.5%	50.0%		
	1.00	N	10	1		
		%	62.5%	50.0%		
<b>Management</b>	Nail	N	9	0	2.25	0.13
		%	56.2%	0.0%		
	Plate	N	7	2		
		%	43.8%	100.0%		
<b>Pain</b>	Fair	N	2	2	7.87	0.019*
		%	12.5%	100.0%		
	Good	N	5	0		
		%	31.2%	0.0%		
	Excellent	N	9	0		
		%	56.2%	0.0%		
<b>Shoulder movement</b>	Fair	N	0	1	12.93	0.002*
		%	0.0%	50.0%		
	Good	N	1	0		
		%	6.2%	50.0%		
	Full	N	15	0		
		%	93.8%	0.0%		
<b>Elbow movement</b>	Fair	N	0	1	12.93	0.002*
		%	0.0%	50.0%		
	Good	N	1	0		
		%	6.2%	50.0%		
	Full	N	15	0		
		%	93.8%	0.0%		
<b>Infection</b>	No	N	15	0	11.25	0.001**
		%	93.8%	0.0%		
	Yes	N	1	2		
		%	6.2%	100.0%		
<b>Total</b>		N	16	2		
		%	100.0%	100.0%		

The most important of these are: minimal surgical trauma, biological osteosynthesis, high stability of osteosynthesis (Makhni et al. 2017). Use of intra-medullary nailing provides with advantage of biological fracture healing such as preservation of fracture haematoma, minimal handling of soft tissue and stripping of periosteum. Nailing also provides advantage in terms of lesser operative time and decreased blood loss (Hedgeland et al. 2019). Thus, the current study aimed to compare the results of plate osteosynthesis and interlocking nailing in the treatment of diaphyseal humeral fracture with reference to rate healing, functional outcome and complications.

In our study on 18 patients with diaphyseal

fractures of humerus, Among the 9 patients in the plating group the age varied from 21 to 53 years (average being 37 years). Posterior approach was used in 4 patients and an anterolateral approach was used for 3 patients and anterior approach was used for 2 patients (MIPO). Among the 20 patients in the interlocking Nail group, the age varied from 30 years to 51 years (average being 40.05 years). A 7 mm nail was used in 7 patients, whereas 6mm nail was used for 2 patients. Only antegrade nailing was done in nailing group.

Our results are in agreement Abdallah et al. (2018) who revealed that forty patients with humeral shaft fractures were selected randomly for treatment by either an antegrade interlocking nail or by a DCP plate and screws; after obtaining

consent, 20 patients were included in each group. They ranged in age from 19 to 56 years, both men and women. In terms of the sex distribution, there were 33 (82.5%) men, and seven (17.5%) women.

Also, our results concur with Kodandapani et al. (2016) who conducted a study on 38 patients with diaphyseal fractures of humerus. Among the 18 patients in the plating group, the age varied from 22 to 60 years (average being 37.28 years). Posterior approach was used in 12 patients and an anterolateral approach was used for the remaining 4 patients. Among the 20 patients in the interlocking group, the age varied from 23 years to 70 years (average being 35.05 years). A 7 mm nail was used in 16 patients, whereas a 6 mm nail was used for 4 patients. Only ante grade nailing was done in the nailing group (21).

Our results are in agreement with Venkata Naga et al. (2018) who stated a study consisted of 28 adult patients of fracture shaft of humerus. In the plating group, 12 (86.67%) patients recovered completely and  $n = 3$  (20%) cases had complications. There was an incidence of post-operative radial nerve palsy and fully recovered following the use of neurotrophic drugs for 3 and 6 weeks after surgery. 1 (6.67%) case had non-union as the patient lifted heavy weight leading to hypertrophic non-union and resulted in a poor result. The IMN group had no non-union.

Our results concur with Sandhu et al. (2018) who concluded that 30 cases post management by either plate and nail, 9 patients (20%) 5 patients in plate and 4 patients nail, 7 patients (20 – 40%) 1 patient in plate and 6 patients nail, 1 patient (40%) in nail only, 13 patients full range motion excellent 9 patients (60%) plate and excellent 4 (27%) patients nail.

## CONCLUSION

Plating is preferred than interlocking medullary nail in fixation of diaphyseal humeral fracture.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## AUTHOR CONTRIBUTIONS

All authors contributed in all parts of paper.

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