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**ORIGINAL ARTICLE**

## Surgical Treatment of Proximal Humeral Fracture Using Proximal Humeral Nail

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**ABSTRACT:**

**Background:** Proximal humeral fractures are caused by low-speed injuries in elderly patients and by osteoporosis. Bad over all condition make it more complex. In patients above 65 years proximal humeral fracture considered as third most common fracture and represent 6% of all fractures in adults. The aim of our study is to assess the use of proximal humeral nail in patents with Neer's two and three-part proximal humeral fractures by early radiological and functional outcomes.

**Methods:** The study includes 15 patients with two and three parts fracture of the proximal humerus seen at Orthopedic Surgery Department, Zagazig University Hospital and in Tripoli Trauma Hospital between August 20018 and May 2019. All patients had clinical and radiological evaluation at regular periods during their follow up.

**Results:** proximal humeral nail is an effective method to treat two and tree parts fracture of proximal humerus.

**Conclusions:** Minimally invasive method for reduction of proximal humeral fractures and fixation with antegrade proximal humeral nail can be a successful technique in two and three parts fracture of proximal humerus and have satisfactory early functional result with low incidence of complications.

**Keywords:** Proximal humeral nail; Proximal humeral fractures; Neer's classification

### INTRODUCTION

**P**roximal humeral fractures represent 6% of all fractures and 7<sup>th</sup> most frequent fracture in adult and the 3<sup>rd</sup> in patients above 65years. Only 15-20% of these fractures are displaced and require surgery <sup>[1-2]</sup>. The incidence of proximal humeral fracture in old age patients makes the reduction of fracture in anatomical position and stable fixation difficult and challenging procedure to ensure healing of fracture and allows early activity and reliable function. The most important prognostic factor is the blood supply of the head of humerus, High incidence of avascular necrosis has been reported in patients operated by highly invasive

technique and exposure of fracture site and fixed with big metal devices <sup>[3-4]</sup>.

In patients with displaced fracture, many surgical treatment methods are available, Orthopedic surgeons have the decision to choose between percutaneous schanz screws, k (wires) or humerus block device and locked anatomical plate or proximal humeral nail in fixation of two and three part fractures <sup>[2]</sup>. The closed reduction techniques and minimally invasive fixation of fractures is used to decrease the damage of the humeral head, like percutaneous K-wires <sup>[4-5]</sup> or by cannulated screws and proximal humeral nail <sup>[5-6]</sup> are considered as reliable techniques <sup>[7]</sup>. In surgical neck humeral

fractures proximal intramedullary nailing provide a good stability and fixation without damaging the blood supply of the fragments of fracture, leaving the soft-tissue layers around the shoulder is undamaged [7].

Whatever the choice of fixation method, the fixation of proximal humeral fracture is still a challenge and the worst complication is the malunion of the greater tuberosity leading to shoulder function impairment and restriction of range of movement due to impingement of displaced tuberosity under the acromion. Rotator cuff dysfunction adds to this impairment [5].

This study presents the features of surgical reduction and fixation of proximal humeral fractures using proximal humeral nail.

The proximal humeral nail (PHN) design has multiple 5 –mm proximal locking holes and two distal holes. Every proximal hole is placed in different level and direction in the humeral head following the anatomical position of the main fragments; one of the distal holes is dynamic (oblong in shape). It is useful to close the fracture gap intra-operatively by inserting the locked screw in proximal end of oblong hole and pushing the distal part of fracture toward the Proximal part which allow up to 4 mm of dynamization in fracture site. The other hole is static (round in shape) to decrease the risk of nail protrusion and fracture rotation.

The aim of the study is to evaluate the result of surgical treatment of two and three part proximal humeral fractures by using the proximal humeral nail.

#### METHODS

This is a clinical trial study that included 15 patients. Their age ranged from (24 years to 68 years) with a mean of (46.4) years with closed displaced proximal humeral fractures. Fractures were diagnosed between August 2018 and May 2019 at Zagazig University hospital and Tripoli trauma hospital. Fixation was done with proximal humeral nail. Written informed consent was obtained from all participants and the study was approved by the research ethical committee of Faculty of

Medicine, Zagazig University. The work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

**Inclusion criteria:** Adult patients (aged 18 years and above), Acute fractures (present in less than 14 days), Closed two and three part displaced proximal humeral fractures.

**Exclusion criteria:** Patients aged below 18 years, Patients with open fractures, Delay in presentation of patient for more than 14 days from trauma, Four part fracture of proximal humerus.

#### Methods:

On admission all patients were subjected to history taking, clinical examination and laboratory investigations. Full counseling of participants in this research and informed consent was obtained with full privacy of participants and confidentiality of the data.

**General examination:** Blood pressure, Pulse, Temperature, Respiration and other body systems. Examination of the chest and cervical spine is very important for associated injury.

#### Local examination:

Inspection: deformity, skin conditions and presence of Ecchymosis around the proximal humerus and wounds or associated injuries.

Palpation: skin temperature and radial pulse  
Neurovascular examination is essential with particular attention to axillary nerve function.

Radiological studies: Plain X-ray (Antero-posterior and Lateral views in scapular plane as well as axillary view).

Laboratory investigations: CBC. Renal function test, liver function test, random blood sugar and coagulation profile. Preoperative preparation ranged from 1 to 3 days. Mean time before surgery was 2 days.

**Surgical technique:** Systemic broad spectrum intravenous antibiotic was given an hour before the operation. All operations are done under general anesthesia. The patients were placed in the chair-beach position on a radiolucent table. The patient head is fixed to the operating table following the axis of the chest. All the affected

upper limb was included in the surgical sterilization technique. The limb was set along the chest and the elbow was flexed. During the surgery, the patient's hand was fixed continually to the abdomen which decreases the risk of rotational malposition. The imaging intensifier is placed at the head of patient and the arch was tilted to take a proper anteroposterior (AP) view to the shoulder and the screen in the opposite side of the affected limb.

*Postoperative care;* All Patients are immobilized in arm sling for 45 days.

Active shoulder movement started on the third day post-operatively to decrease the risk of intra-articular and sub-acromial adhesions. The patient is trained in self-assistance of shoulder movement specially flexion and abduction with the unaffected limb guiding the movement of the injured shoulder. Hospital stay after surgery ranged from 2 to 4 days.

#### **Follow up:**

Functional and radiological evaluation were done for the patients at 2 weeks to remove the stitch and in 1 month, 3 months and 6 months searching for any complication of the device or technique of fixation. Physiotherapy done two to three times per week to assist the progression of joint range of motion.

Rotational shoulder motion was started 3 weeks postoperatively. The arm sling was removed 45 days after operation.

#### **Radiological assessment**

**Early radiological evaluation:** A series of radiographs in three planes AP, trans-scapular and axillary view was taken at each follow-up in first 3 months. Implant position, fragment alignment, and bone consolidation were evaluated.

**Late radiological evaluation:** Signs of union, Signs of device complication like Backing out

of proximal screws, Complications of fracture such as malunion and avascular necrosis of head of humerus.

**Statistical analysis:** Statistical analysis was performed using SPSS software (SPSS, Chicago, IL, USA). Data were expressed as mean  $\pm$ SD for quantitative variables. For categorical variables Fisher's exact test or chi-square was used. P-value less than 0.05 were considered significant.

#### **RESULTS**

Age was distributed as **46.4 $\pm$ 15.58** with minimum 24 and maximum 68 years, regarding BMI it was distributed as **27.02 $\pm$ 2.59** with minimum 23.5 and maximum 32.5 kg/m<sup>2</sup>, sex was distributed as male 53.3% and female 46.7%, there were 4 patients with history of smoking representing about (26.7%) of study group, and comorbidity was present in 6 cases (40%). **Table (1)**

Flexion, abduction, internal rotation, external rotation and extension were distributed as 142.66 $\pm$ 26.58, 136.0 $\pm$ 21.97, 72.0 $\pm$ 20.42, 50.0 $\pm$ 11.95 and 36.0 $\pm$ 11.05. **Table (2)**

According to Neer's classification system, 9 patients (60%) had 2 parts fractures and 8 patients (40%) had 3 parts fractures. Constant score was 78.0 $\pm$  15.21 points and time to operation was 2.46  $\pm$  0.89 days. Operation duration was distributed as 85.0  $\pm$  27.6 with minimum 45 and maximum 140 minutes, blood loss was distributed as 100.67 $\pm$  36.9 with minimum 50 and maximum 150ml. In this study, 2 cases representing 13% of all patients had malunion with unsatisfactory results (fair) and 87% had satisfactory results (excellent and good). **Table (3)**

Series of radiographical views were taken pre operatively, immediately post operatively and 6 months after operation. **Figure (1), Figure (2), Figure (3), Figure (4)**

**Table 1:** Socio-demographic distribution of studied group (N=15)

Socio-demographic distribution of studied group (N=15)			
Age / Year	Mean± SD	46.4±15.58	
	Median (Range)	47.0 (24-68)	
BMI	Mean± SD	27.02±2.59	
	Median (Range)	27.3 (23.5-32.5)	
Sex		N	%
	Male	8	53.3
Smoking	Female	7	46.7
	No	11	73.3
Co morbidity	Smoker	4	26.7
	No	9	60.0
	DM	4	26.7
	DM & osteoporosis	1	6.7
	HTN	1	6.7
	Total	15	100.0

**Table 2:** Range of movement distribution among studied group

	Flexion	Abduction	Internal rotation	External rotation	Extension
Mean± SD	142.66±26.58	136.0±21.97	72.0±20.42	50.0±11.95	36.0±11.05
Median (Range)	150.0 (80-170)	140.0 (90-160)	80.0 (30-90)	50.0 (20-60)	40.0 (15-45)

**Table 3:** Relation between basal demographic and clinical data with outcome

			Satisfactory	Unsatisfactory	t/X <sup>2</sup>	P
Age			44.66±16.14	53.33±13.3	-0.853	0.409
BMI			26.85±2.7	27.7±2.4	-0.489	0.633
Time to operation			2.0±0.65	4.33±0.57	-5.048	0.00**
Operation duration			73.75±21.65	130.0±10.0	-4.293	0.001**
Blood loss			92.5±33.41	133.3±28.86	-1.893	0.086
Constant score			81.66±13.37	67.33±15.27	2.026	0.052
Sex	Male	N	7	1		
		%	58.3%	33.3%		
	Female	N	5	2	0.6	0.43
		%	41.7%	66.7%		
Smoking	No	N	9	2		
		%	75.0%	66.7%		
	Smoker	N	3	1	0.085	0.77
		%	25.0%	33.3%		
Co morbidity	No	N	8	1		

			Satisfactory	Unsatisfactory	t/X <sup>2</sup>	P
	DM	%	66.7%	33.3%		
		N	3	1		
	DM& osteoporosis	%	25.0%	33.3%		
		N	0	1	4.75	0.19
		%	0.0%	33.3%		
Side affected	Left	N	1	0		
		%	8.3%	0.0%		
	Right	N	5	1	0.069	0.79
		%	41.7%	33.3%		
		%	58.3%	66.7%		
Mechanism of trauma	FD	N	5	3		
		%	41.7%	100.0%		
	RTA	N	7	0	3.28	0.07
		%	58.3%	0.0%		
Neer's classification	II	N	8	1		
		%	66.7%	33.3%		
	III	N	4	2	1.11	0.29
		%	33.3%	66.7%		
Complication	No	N	13	0		
		%	100.0%	0.0%		
		N	0	2	15.0	0.00**
		%	0.0%	100.0%		
		N	2	2		
aaTotal	%	100.0%				



**Figure 1:** Pre- operative radiography



**Figure 2:** Pre- operative radiography

**Figure (1) and (2):** A 47 year's old female patient, with history of RTA with proximal humeral fracture two parts according to Neer's classification.



**Figure 3:** Post –operative radiography

**Figure (3):** the same patient was operated and fracture fixed after 2 days from trauma, by closed reduction and proximal humeral nail.





**Figure 4:** Follow up after 6 months radiography

**Figure (4):** Follow up for the same patient after 6 months duration with excellent healing and good range of movement.

## DISCUSSION

Proximal humerus fractures are result of low velocity injuries and are complicated by osteoporosis and poor general condition. In younger population, they usually involve a high-velocity injury and the fractures are usually complex with greater tuberosity comminution and soft tissue injury. These fractures need to be fixed in a stable manner, especially in younger patients to allow early mobilization, faster recovery and minimize loss of function. Surgical options for two, three and four parts fractures of the proximal humerus include percutaneous fixation techniques, plating, trans-osseous wiring and hemiarthroplasty<sup>[8]</sup>.

Primary shoulder hemiarthroplasty should be limited to fractures with articular comminution of the head and greater tuberosity more than 40%.

Proximal fractures of the humerus, with 2 and 3 displaced fragments according to Neer's classification, showed serial of serious difficulties for orthopedic surgeons such as complicated proper anatomical reduction technique and use appropriate choice for fixation specially in osteoporotic patients as postmenopausal women which has a very low bone stock, and risk of avascular necrosis of

femoral head because of blood supply injury during procedure<sup>[9]</sup>.

Surgical treatment is one of the most commonly acceptable ways of management for displaced and unstable proximal humeral fractures and a variety of fixation devices are available<sup>[10]</sup>.

The classical Surgical techniques for treatment and fixation of two and three parts fragment fracture of proximal humerus showed multiple complications during their use in the past years as in percutaneous pinning fixation which can be problematic, especially in osteoporotic elderly patients, in whom loss of fixation and related pin problems as pin tract infection and pin migration<sup>[11]</sup>.

The proximal humeral nail is a new device specially designed for use with proximal humeral fractures. Currently, this nail is widely used to treat patients with 2-part and 3-part surgical neck fractures.

In this study, we examined a group of patients with fractures of the proximal humerus, operated with proximal humeral nail. Each patient in this study was carefully assessed clinically by taking a detailed clinical history and performing a thorough examination. Radiological evaluation consisted mainly of plain radiography and CT scans.

The age of patients range from (24 – 68) years with a mean age of 46.4 years. It is demonstrated in our study that there were 8 males (53.3%) and 7 females (46.7%). There were 4 patients with history of smoking. Comorbidity was in 6 cases (40%), 4 patients with history of diabetes mellitus, one patient with history of diabetes mellitus and osteoporosis and another patient with history of hypertension.

In our study, 9 patients had fractures on right side (60%) while 6 patients were fractured on left side (40%). According to mode of injury, 8 patients fell down (53.3%) and 7 patients had road traffic accidents (46.7%). According to Neer's classification system, 9 patients (60%) had 2 parts fracture and 8 patients (40%) had 3 parts fracture. Constant score was  $78.0 \pm 15.21$  points and time to operation management was  $2.46 \pm 0.89$  days.

The results obtained by **Gerber et al.** [9] included 15 patients with three parts fractures. Those 15 patients were treated by open reduction and internal fixation. The mean age of patients was 44.9 years and the mean follow-up period was 63 months. The mean final Constant score for those patients was 80.4 points.

The effect of the patient's age on the results of the operation was discussed by **Owsley and Goreczyca (2008)** in their study that included fifty-three adult patients with a displaced proximal humeral fracture fixed by proximal humeral nail. The mean age of the patients was 52 years (range of 18 to 89 years). They showed that the average age of the patients with radiographic evidence of a complication was higher in patient's age below 60 years, compared with patient's age above 65 years with evident of complications.

**Mittlmeier et al.** [11] evaluated the clinical and radiographic results in patients with displaced proximal humeral fractures that were treated with antegrade proximal humeral nail. They concluded that stabilization of proximal humeral fractures with antegrade proximal humeral nail represents a minimally invasive

procedure that gives a high degree of stability even in osteoporotic patents and allows for early mobilization postoperatively . The technique is easy to perform and it leads to a good or excellent result in most of cases even though postoperative complications are common. Early postoperative physiotherapy is essential in order to achieve a good result.

**Sforzo and Wright** [12] reported acute displaced proximal humerus fracture treated with a proximal locked antegrade humeral nail and concluded that proximal locked antegrade intramedullary nailing used in treatment of displaced proximal humerus fractures resulted in predictable union and good alignment and function.

**Hessmann et al.** [13] confirmed good clinical results with the use of the MultiLoc nail that has short and long nail options with angular stable fixation in the humeral head. For their 2- to 4-part fractures, mean Constant score at follow-up was 66 points.

**Liu et al.** [14] evaluated the functional results of using the antegrade intramedullary PHN to treat of proximal humeral fractures in 64 elderly patients. Their age was more than 60 years. They had displaced proximal humeral fractures that were treated using proximal humeral nail. A complete 12-month postoperative follow-up was available for 54 patients. All fractures were united. The Constant-Murley score data indicated that the patients experienced improvement from 6 to 12 months postoperatively. The mean Constant-Murley score on the injured side increased from  $71.2 \pm 11.2$  points at 6 months to  $82.4 \pm 16.4$  points at 12 months ( $P = 0.01$ ). In conclusion, intramedullary fixation using the proximal humeral nail represents a less-invasive procedure that gives adequate stability and bony healing while allowing for early shoulder movement even in osteoporotic elderly patients.

**Hao and Huat** [15] evaluated the early functional and radiological outcomes (up to 12 months) of displaced Neer's two- to three-fragments proximal humeral fractures using a proximal locking intramedullary nail. They



demonstrated that intramedullary nailing using the proximal humeral nail is a reliable method for fixation of Neer's two and three parts proximal humeral fractures, with good early results and low rates of complications.

### CONCLUSION

Closed reduction and internal fixation with a proximal humeral nail can be an effective surgical method of fixation of two-part and three -part proximal humeral fractures. It has sufficient early functional and radiological results and low percentage of complications. The type of fracture, an adequate and correct entry point for the nail and early and adequate postoperative physiotherapy are the keys to obtain a successful result.

**Conflict of Interest:** None.

**Financial Disclosures:** None.

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