



Treatment Of Fracture Shaft Humerus By Intramedullary Interlocking Nail

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Abstract:

The goal of this study is to evaluate surgical treatment outcomes of fracture shaft humerus by using intramedullary interlocking nail. Fifteen patients (ages ranged from 51 to 70 with an average age of 64.20 ± 6.338 years, (10 males and 5 females) with shaft humeral fractures from Beni-Suef University and General hospitals during the period from December 2012 to June 2014. The selected participants were treated with intramedullary interlocking nail. Patients were followed up for a mean of 9 (range 6–12) months. The mean length of hospital stay was 3 (range 1–5) days. All the fractures united radiographically after a mean of 14 (range, 12–20) weeks. Conclusion: That the majority of humeral shaft fractures can be treated safely and effectively by non-operative methods. However, for the subset of patients requiring surgical treatment, intramedullary nailing provides predictable means of achieving fracture stabilization and ultimate healing. Poor outcome in intramedullary interlocking nailing is attributable to rotator cuff tear and shoulder impingement and lack of expertise of surgeon.

Keywords: Shaft Humerus, Intramedullary, Interlocking Nail.

1. Introduction:

Humeral shaft fractures make up approximately 3% of all fractures. [1] Typically, they are the result of direct trauma but also occur in sports where rotational forces are greater, for example, baseball or arm wrestling. Fractures of the middle or distal third of the shaft put the radial nerve at risk. [2] Most humeral shaft fractures can be successfully treated by non-operative methods. [3] The indications for operative treatment include unacceptable alignment after closed reduction, multiple injuries, radial nerve palsy after manipulation, bilateral humeral fractures and open fractures. [4]

Compression plate fixation, which is a widely accepted operative method gives a high union rate and allows early active motion of the joints, however, is technically demanding and requires extensive surgical dissection with risk of injury to the radial nerve. [5]

An interlocking intramedullary nail has been reported to produce satisfactory results with less soft tissue injury, relatively percutaneous insertion as well as biomechanical advantages; however its entry may lead to rotator cuff tear and

proximal the nail may create shoulder impingement and decrease shoulder abduction and distally may lead to problem of elbow extension. [6]

As a result of technical advancement, minimally invasive plate Osteosynthesis (MIPO) has gained popularity in recent years with Satisfactory clinical outcomes. [7] The plate is inserted by a percutaneous approach with separate proximal and distal incisions. This method requires less soft tissue disruption and preserves the fracture haematoma and blood supply to the bone fragments, although percutaneous plate insertion in humeral shaft fractures seems to be a less dangerous procedure regarding radial nerve injury. [8]

The aim of this work is to evaluate surgical treatment outcomes of fracture shaft humerus by using intramedullary interlocking nail.

2. Patients And Methodes:

The study was approved by the ethical committee of the Faculty of Medicine, Beni-Suef University. Written informed consent was obtained from all participants before recruitment in the study, after explaining the

objectives of the work. Confidentiality was guaranteed on handling the data base.

This study was a prospective cross-sectional study conducted on fifteen patients with shaft humeral fractures (10 males and 5 females) in Beni-Suef University General hospitals during the period from December 2012 to June 2014.

The selected participants were treated with intramedullary interlocking nail according to the following inclusion and exclusion criteria:

Inclusion criteria: All patients with fractures of humeral shaft that met the criteria for operative interventions intramedullary interlocking nailing presenting to the department of Orthopedics in Beni-Suef University and General Hospitals. **Exclusion criteria:** (1) Open fractures (Gustilo & Anderson grade IIIA & B & C), (2) Associated ipsilateral fracture head and neck of the humerus, 4) AO types C3. **The Follow up period was at least 6 months.**

The following was done for all studied participants:

2.1. Pre-operative evaluation: Initial management is usually directed toward

general patient stabilization. The skin and soft tissue around the fracture were carefully examined for abrasion, bruises, contusion and laceration. The antero-posterior and lateral radiographs of the whole limb must be done including shoulder, elbow and wrist joints. Neurological and vascular assessment of the whole affected limb was a must. Surgery was performed as early as possible.

2.2. Operative technique:

Preoperative antibiotics were used to prevent the risk of postoperative wound infection. The basic requirements for this technique included (power drill, humerus interlocking nail set and scalpel). General anesthesia was used in all cases of this study. The patient was positioned supine 45° (5 cases) or lateral decubitus (10 cases) positions.

2.3. Post-operative management: Patients were examined for vascular and neurological state. Intravenous antibiotics (a third generation cephalosporin) were given for 72 hours postoperatively. Then changed to oral antibiotics and continued until wound healing was completed. Intramuscular anti-edematous (alpha chymotrypsin) was given every 12 hours for the first three days then changed to oral anti-edematous for the

remaining period till subsidence of edema. Analgesics were given as intramuscular non-steroidal anti-inflammatory drugs (NSAIDS) in the first few days postoperatively then changed to oral (NSAIDS) when needed.

2.4. Follow up and assessment: Active shoulder and elbow exercises were started. The patients were followed up for at least six months. Every week for the first month; follow up of wounds and the skin condition, then every month for the rest five months. Every time the patient was examined clinically and radiologically and encouraged to continue active exercises to reach normal range of motion and to resume the activity again. We used **Stewart & Hundley criteria** [9] for clinical and functional assessment 6 months post-operative.

2.5. Statistical Analysis:

The collected data were coded then entered and analyzed using the SPSS version 22 (Statistical package for social science). Descriptive statistics was done for categorical variables by frequency and percentage, and for numerical variables in the form of mean and standard deviation (mean \pm SD). Suitable statistical tests of significance were used for non-parametric analysis: (Mann-Whitney-test for two

unrelated samples, Chi-Square (χ^2) test for categorical data). P-values equal to or less than 0.05 were considered statistically significant. Simple graphs were used to illustrate some information.

3. Results:

This present study includes 10 males (66.6%) and 5 females (33.3%), with ages ranged from 20-60 years old (average 40 years old). Twelve cases presented with right side humeral shaft fractures and three cases with left side humeral shaft fractures. Two patients have DM and two patients were HCV positive. As regard their occupations; two patients (13.3%) were farmers, four others (26.6%) were drivers, eight patients (53.3%) were employees and only one patient (6.6%) was manual worker. Regarding the associated fractures; one patient (6.6%) had ipsilateral shaft femur fracture and one patient (6.6%) had contralateral both bones forearm fracture. The mechanism of energy was variable in all fractures; the cause of fracture was road traffic accident (R.T.A.) in 10 cases while in the remaining five cases it was due to direct trauma; (Table-1)

In the current study we classified the cases according to AO classification, which

is the classification currently used by most North American surgeons. It gives a precise anatomic description of the fracture. It also serves as a basis for treatment and for evaluation of the results. According to the AO classification we have three cases type A 1 (20%), three cases type A2 (20%), and five cases type A 3 (33.3%), two cases type B2 (13.3%) and two cases type C2 (13.3%); (Table-2).

Patients were followed up for a mean of 9 (range 6–12) months. The mean length of hospital stay was 3 (range 1–5) days. All the fractures united radiographically after a mean of 14 (range, 12–20) weeks.

According to Stewart & Hundley criteria, clinical results were assessed as follow: 9 patients (60%) were classified as excellent, 5 patients (33.3%) were classified as good and one patient (6.6%) was classified as fair. (Figure-1)

Due to the random distribution of patients in this study, patients' age was not an important variable in predicting fracture outcome. The female patients reviewed in this study had excellent results in 4 patients while 1 patient was good. The male patients reviewed in this study had excellent results

in 5 patients while 4 patients were good and 1 patient was fair.

There were two patients suffering from associated fractures; the first was ipsilateral femoral shaft fracture which managed by intra medullary nail. The second was contra lateral BB forearm fracture which managed by plates and screws. The final results of the 2 patients were good

There were three cases (AO) type (A1) all of them were excellent. Three cases of (AO) type (A2) two were excellent and the other was good. Five cases of (AO) type (A3) two were excellent, two were good and the other was fair. Two cases of (AO) type (B2) were excellent. Two cases of (AO) type (C2) were good.

Two diabetic patients in this study had excellent results, despite one of them developed superficial infection. The 2 HCV patients one of them was excellent and the other was good.

There were 9 cases united in 10-14 weeks, all of them had excellent results. There were 5 cases united in 14-16 weeks all of them had good results. There was 1 cases united in 20 weeks and had fair result. (Figure-2)

Regarding post-operative complications; one patient (6.6 %) was diabetic and developed superficial infection in the skin wound and subsided after repeated dressings and antibiotics. The final result in this case was excellent. By tracing the healing process

among patients; no patients had delayed union. The average time of union in this study was 14 weeks with maximum union time was 20 weeks. There were 9 cases had excellent, 5 had good and 1 case had fair results regarding shoulder stiffness.

Table (1): Basic Characteristics of the studied population; (N= 15):

| Characteristics | Descriptive Statistics |
|------------------------------------|------------------------|
| Age (years); N (%) | |
| 20-35 YS. | 3 (20%) |
| 36-45 YS. | 9 (60%) |
| 46-60 YS. | 3 (20%) |
| Gender; N (%) | |
| Male | 10 (66.5%) |
| Female | 5 (33.5%) |
| Affected Side; N (%) | |
| Left | 3 (20%) |
| Right | 12 (80%) |
| Associated fractures; N (%) | |
| Shaft femur fracture | 1 (6.6%) |
| contra lateral BB forearm fracture | 1 (6.6%) |
| None | 13 (86.8%) |
| Mechanism of Injury; N (%) | |
| R.T.A | 10 (66.5%) |
| Direct Trauma | 5 (33.5%) |

Table (2): Fracture classification:

| Fracture type | N (%) |
|---------------|-----------|
| Type A1 | 3 (20%) |
| Type A2 | 3 (20%) |
| Type A3 | 5 (33.3%) |
| Type B2 | 2 (13.3%) |
| Type C2 | 2 (13.3%) |

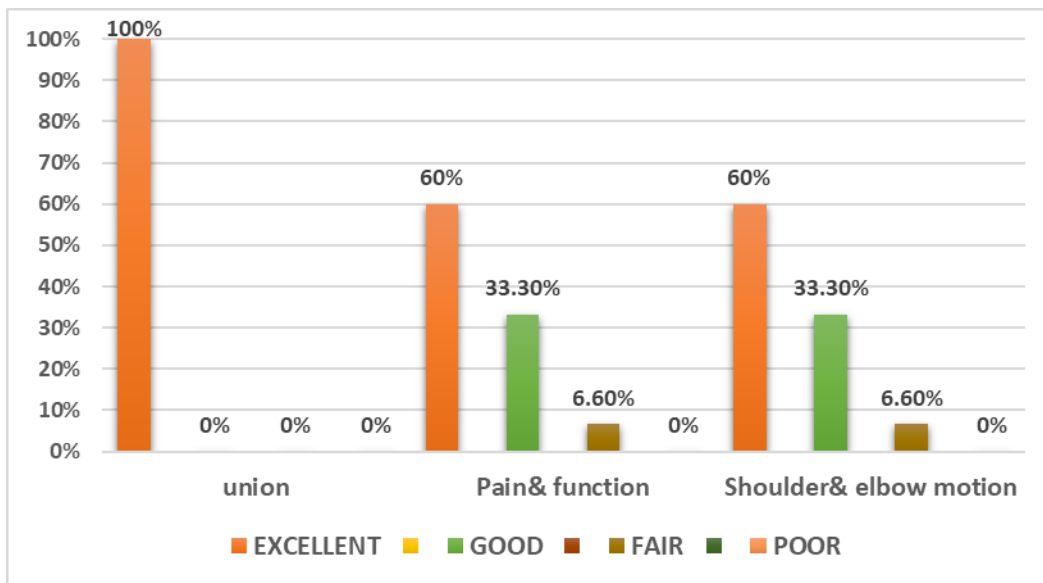


Figure (1): The result of the Stewart & Hundley criteria

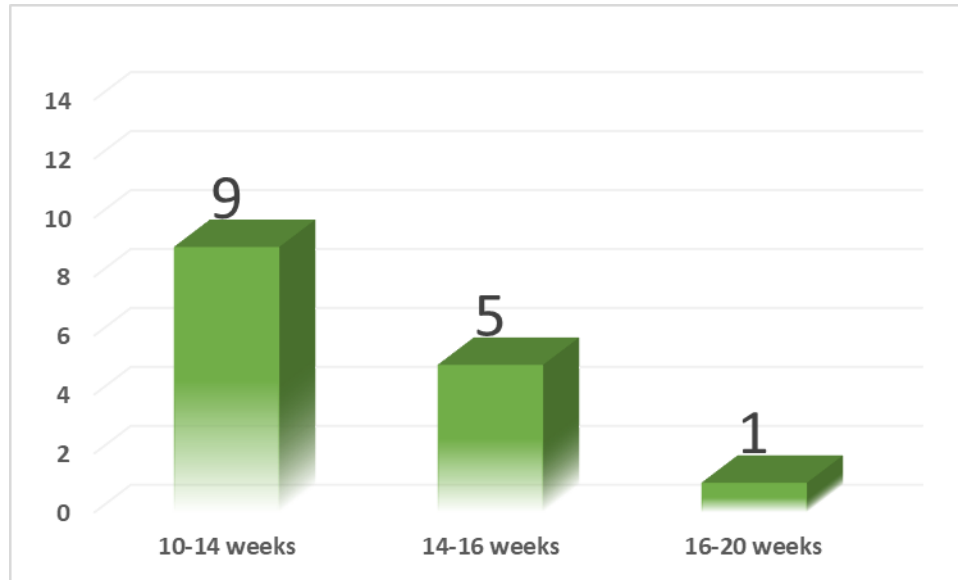


Figure (2): Distribution of cases by time of union according to radiological assessment.

4. Discussion:

Most current operative methods for stabilization of humeral shaft fractures have acceptable rates of the union. The current study included 15 patients with fracture humerus; nine cases of them united in 10-14 weeks, all of them had excellent results. There were five cases united in 14-16 weeks all of them had good results. And only one case united in 20 weeks and had fair result.

Hunter, 1982 reported 60 humeral shaft fractures treated with a cooptation splint. [10] The arm was suspended by a collar and cuff after application of the splint. Treatment success was based on fracture

union, residual deformity and limb function. Fifty-six fractures (93%) united; all had less than 30° angulations. The average time to union was 40 days for males and 42 days for females. There was no correlation between healing and patient sex, fracture level, or need for fracture manipulation. With one exception, all patients younger than age 40 recovered full extremity function by 10 weeks. In older patients, functional return was slower. The authors concluded that a cooptation splint could be used effectively to treat patients with humeral shaft fractures. [10]

In another study; 44 elderly patients aged 50-75 years (Average 58.6 years) who had closed or type 1 open humeral diaphyseal fractures were treated conservatively in the orthopaedic department of Government Medical college university of Kashmir with a follow up of 12 to 18 months (average 15 months). Among 41 patients available for follow up, 28 (68.3%) were female and 13 (31.7%) were male patients. Cause of injury was domestic fall in 31(76%), road traffic accident in 7(17%) and direct trauma in 3(7%) patients. 4 patients had type 1 open fracture, 22 (54%) were right and 19(46%) were left sided fractures. There were 9-A1, 12-A2, 10-A3, 7-B1, 1-B2 and 2-B3 fractures. There were 13 distal third, 19 middle third and 9 proximal third fractures. Fractures were reduced and stabilized by coaptation splint for 2 weeks when a prefabricated humeral brace was applied with cuff and collar for additional comfort. Results were interpreted in terms of radiological union, clinical outcome (Severity of pain and Range of motion of shoulder and elbow) and functional outcome (system of American Shoulder and Elbow surgeons shoulder score). Radio logically ununited fractures were graded as poor results. 14 (34%) patients who showed union within first 3

months of treatment with no pain, grade 1 ROM and ASES score of greater than 45 were graded as excellent. 9 (21%) patients united between 3 to 4 months with mild pain, grade II ROM and ASES score of 35 to 45 and were graded as good. Union was delayed in 6(14%) patients with grade III ROM, severe pain and ASES score of <35 ,were graded as poor result. 12(29%) patients failed to show the signs of union and were again grade as poor results. [11]

Regarding open reduction and internal fixation of fracture shaft humerus, a study compared the results of two types of implants, dynamic compression plates (DCPs) and locking compression plates (LCPs), [12] applied to correct mid- humeral shaft fractures using minimally invasive plating osteosynthesis (MIPO). The mean time of fracture union was 16.77 ± 6.01 weeks in group A and 14.59 ± 5.73 weeks in group B ($p < 0.05$). Seven (26.9 %) patients had postoperative complications in group A and 3 (17.6 %) in group B ($p = 0.05$). The mean UCLA End-Result score in group A was 34.31 ± 1.26 points and 33.12 ± 2.76 points in group B ($p = 0.05$). The mean MEPI was 100.00 ± 0.00 points in group A and 97.35 ± 7.52 points in group B ($p = 0.05$). [12]

A similar study conducted on thirty-five patients who underwent MIPO of humerus shaft fractures. Fifteen patients had an open fracture, six a preoperative radial nerve palsy, and nine a concomitant thoracic, musculoskeletal or vascular injury. At an average 12-month follow-up, 91% of fractures healed after a mean of 12 weeks (range, 8–16). Two infections occurred. Final alignment averaged 4° of varus (range, 5° of valgus to 20° of varus). Active elbow ROM averaged 114° (range, 60–135°) and was less than 100° in nine elbows. Five of six preoperative radial nerve injuries recovered spontaneously. Healing and infection rates in this study are consistent with those reported in the literature. Lower elbow ROM and higher fracture angulation at healing were nevertheless found. MIPO is technically demanding and requires adequate intraoperative imaging and surgical experience in order to obtain adequate fracture alignment. Brachialis muscle scarring and inadequate postoperative rehabilitation may be involved in limited elbow range of motion. [13]

A study conducted to treat 200 patients of shaft humerus fractures of various fracture patterns by closed multiple elastic Rush nails with promising results; the medullary cavity was filled with Rush nails

of unequal lengths and diameter. Post-operative radiographs showed a near anatomical fracture reduction in 88% of patients. The patients were followed up at an average of 12 months. Ninety-six percent of the cases showed good union with the mean duration of 4 months. Complications were observed in eight patients. [14] Other study done on 20 cases by using intramedullary nail; 13 cases showing evidence of union before 16 weeks, one case had non-union (5%) with bending of a nail which was treated by closed exchange nailing with reaming. [15]

Two-hundred thirteen adult patients with a humeral shaft fracture who satisfied inclusion criteria were treated at 2 level 1 trauma centers with either a functional brace (nonoperative treatment group) or compression plating (operative treatment group). Main outcome measures were evaluated retrospectively and included time to union, nonunion, malunion, infection, incidence of radial nerve palsy, and elbow range of motion (ROM). [16] The occurrence of nonunion and malunion was statistically significant and more common in the non-operative group. No statistically significant difference regarding infection and radial nerve palsy. No difference in time

to union or ultimate ROM was found between the 2 groups. [16]

Impairment of shoulder function is the main drawback of interlocking nailing. Shoulder pain in these patients may be related to violation of the rotator cuff, prominent nail end, adhesive capsulitis or unknown causes [17]; in the current study we had shoulder problems in 20 % of patients. One patient with protruding nail required a second surgery for the removal of implant. This finding was comparable to a similar study with three patients with proximal protrusion of the nail. [18] This usually arises from not pushing the nail distal enough, possibly from fear of producing a distal fracture, or from migration of an unlocked nail. We suggest assessing the length accurately before passing the nail and using C-arm till the procedure ends. Similar findings have been reported by many studies. [19]

There is still a controversy whether to use reamed or unreamed nail. Reaming can improved vascularity of fracture fragment and soft tissue can provide the reamed material as source of bone grafts. But disadvantages of reaming are radial nerve injury and heat necrosis. [20]

The limitation of the present study is that it is done in just two centers and had small sample size of patients; so further randomized control trials on larger sample is needed.

5. Conclusion:

Intramedullary interlocking nailing is less invasive procedure with advantages of less blood loss for fracture shaft of humerus. There may be delay in union in nailing due to distraction at the fracture site which usually occurs during nail insertion. Poor outcome in intramedullary interlocking nailing is attributable to rotator cuff tear and shoulder impingement and lack of expertise of surgeon.

Locking humeral nails were introduced with hope that results from their use would parallel the clinical success seen with similar devices used for femoral and tibial fractures.

Unfortunately, despite favourable initial reports, these devices have not enjoyed the unparalleled success of lower extremity locking nails.

6. References:

- [1] Putnam, Jill G., et al. "Early post-operative outcomes of plate versus nail fixation for humeral shaft fractures." *Injury* 50.8 (2019): 1460-1463.
- [2] Lyu, Fei, et al. "Management of dislocation of the shoulder joint with ipsilateral humeral shaft fracture: initial experience." *Orthopaedic Surgery* 12.5 (2020): 1430-1438.
- [3] Ozan, F., Gürbüz, K., Uzun, E., Gök, S., Dođar, F., & Duygulu, F. (2017). The inflatable intramedullary nail for humeral shaft fractures. *Journal of orthopaedics*, 14(1), 137-141.
- [4] O'Shaughnessy, M. A., et al. "Management of paediatric humeral shaft fractures and associated nerve palsy." *Journal of children's orthopaedics* 13.5 (2019): 508-515.
- [5] Tolani, Avinash, Nadeem A. Lil, and Shashank Ranka. "Management of humeral shaft fractures with anterior bridge plating-A minimally invasive approach." *National Journal of Integrated Research in Medicine* 9.5 (2018).
- [6] Sears, Benjamin W., Armodios M. Hatzidakis, and Peter S. Johnston. "Intramedullary Fixation for Proximal Humeral Fractures." *JAAOS-Journal of the American Academy of Orthopaedic Surgeons* 28.9 (2020): e374-e383.
- [7] van de Wall, Bryan JM, et al. "Minimally invasive plate osteosynthesis: An update of practise." *Injury* (2020).
- [8] Kelany, Omar Ab-Wahab, et al. "Interlocking Medullary Nail Versus Plate Fixation in Management of Diaphyseal Humeral Fracture." *The Egyptian Journal of Hospital Medicine* 80.3 (2020): 1067-1073.
- [9] Dembélé, B., et al. "Aseptic humeral shaft non-union predisposing factor and evaluation treatment." *SM J Orthop* 3.2 (2017): 1055.
- [10] HUNTER, SAM G. "The closed treatment of fractures of the humeral shaft." *Clinical Orthopaedics and Related Research*® 164 (1982): 192-198.
- [11] Bohm, E. R., T. V. Tufescu, and J. P. Marsh. "The operative management of osteoporotic fractures of the knee: to fix or replace?." *The Journal of Bone and Joint*

Surgery. British volume 94.9 (2012): 1160-1169.

[12] Shen, Longxiang, et al. "Internal fixation of humeral shaft fractures using minimally invasive plating: comparative study of two implants." *European Journal of Orthopaedic Surgery & Traumatology* 23.5 (2013): 527-534.

[13] Concha, Juan M., Alejandro Sandoval, and Philipp N. Streubel. "Minimally invasive plate osteosynthesis for humeral shaft fractures: are results reproducible?." *International orthopaedics* 34.8 (2010): 1297-1305.

[14] Gadegone, W. M., and Y. S. Salphale. "Antegrade Rush nailing for fractures of humeral shaft: an analysis of 200 cases with an average follow-up of 1 year." *European Journal of Orthopaedic Surgery & Traumatology* 18.2 (2008): 93-99.

[15] Singiseti, Kiran, and M. Ambedkar. "Nailing versus plating in humerus shaft fractures: a prospective comparative study." *International orthopaedics* 34.4 (2010): 571-576.

[16] Denard, Antony, et al. "Outcome of nonoperative vs operative treatment of humeral shaft fractures: a retrospective

study of 213 patients." *Orthopedics* 33.8 (2010).

[17] Bhandari, Mohit, et al. "Compression plating versus intramedullary nailing of humeral shaft fractures—a meta-analysis." *Acta orthopaedica* 77.2 (2006): 279-284.

[18] Brumback, ROBERT J., et al. "Intramedullary stabilization of humeral shaft fractures in patients with multiple trauma." *JBJS* 68.7 (1986): 960-970.

[19] Raghavendra, S., and Haresh P. Bhalodiya. "Internal fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail: A prospective study." *Indian journal of orthopaedics* 41.3 (2007): 214.

[20] McCormack, R. G., et al. "Fixation of fractures of the shaft of the humerus by dynamic compression plate or intramedullary nail: a prospective, randomised trial." *The Journal of Bone and Joint Surgery. British volume* 82.3 (2000): 336-339.