International Journal of Research in Orthopaedics
Shivakumar GV et al. Int J Res Orthop. 2016 Dec;2(4):229-233
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20164005

A study on patients treated with interlock nailing in the forearm fracture bones

Shivakumar G. V.[1]*, Naveen P. R.[1], Manjunath M. L.[2]

[1]Department of of Orthopaedics, [2]Department of Physiology, Shivamogga Institute of Medical Sciences, Shimoga, Karnataka, India

Received: 03 September 2016
Accepted: 03 October 2016

***Correspondence:**
Dr. Shivakumar G. V,
E-mail: gvshivakumar@gmail.com

ABSTRACT

Background: Fractures involving the bones of the forearm present unique problems not encountered with fractures of other long bones and may significantly affect the function of the upper limb. The purpose of the present study was to evaluate the functional outcome of patients treated with interlock nailing in the fracture forearm bones.
Methods: Thirty two patients included after their consent. With the patient supine on a radiolucent table, and under general or regional anesthesia the extremity was prepared and the surgery was performed using a standard procedure. If secure rigid fixation is achieved forearm POP splint is applied and kept in place for 2 weeks, thereafter a removable sugar-tong orthosis is worn until bridging callus is present, and the orthosis is removed frequently for exercise.
Results: The average age of the patients was 38.90 years. The major mode of injury was RTA (59.09%) followed by assault (36.36%). 41% of patients were operated within week of injury, only three patients were operated after a week and one patient after 3 weeks. More than half of patients had closed fractures and rest was open fractures, of which Gustilo Anderson type II were in majority. In 3/5 of patients locking at nondriving end was not done cause of stable fixation. There was statistically significant difference in the surgical time ($P < 0.05$) and duration of postoperative immobilization differed statistically significantly ($P < 0.001$) between the group of patients in whom locking was done and not done.
Conclusions: Advantages of Interlocking nail are high rate of bony consolidation along with minimized surgical approaches, cosmetically better suited and little risk of refracture after removal of the implant.

Keywords: Forearm fracture, Interlock nailing, Gustilo Anderson type, Postoperative immobilization

INTRODUCTION

The human forearm is adapted more for mobility than stability, it serves an important role in upper extremity function, facilitating placement of the hand in space thus helping to provide the upper extremity with its unique mobility. The presence of the proximal and distal radioulnar joints allows pronation, supination and such movements are important to all in the usual activities of daily living.[1]

Moreover, the forearm serves as the origin for muscles for inserting on the hand. Therefore, fractures involving the bones of the forearm present unique problems not encountered with fractures of other long bones and may significantly affect the function of the upper limb.

Forearm fractures are as important as articular fractures as slight deviations in the spatial orientation of the radius and ulna will decrease the forearms rotational amplitude and thereby impair the positioning and function of the hand.[2] Thus the management of these fractures and their associated injuries deserve special attention, imperfect treatment of fractures of the radius and ulna diaphyses leads to a loss of motion as well as muscle imbalance and poor hand function. Mechanism of injury is blunt trauma mainly road traffic accident (RTA) assault and industrial injuries.

In diaphyseal fractures of radius and ulna normal rotational alignment is necessary if a good range of pronation and supination is to be restored and in addition to regaining of length, apposition and axial alignment. Any axial or rotatery mal-alignment or change of interosseous space or encroachment of callus into it or loss of normal configuration of radius especially the lateral bow leads to proportionate loss of supination and pronation.[3,4]

Success in the treatment of diaphyseal fractures of one or both long bones of the forearm means that union of the fractures are achieved with minimum restriction of motion in the forearm, wrist and elbow and with restoration of good muscle strength without pain. A satisfactory device for internal fixation must hold the fracture rigidly, eliminating as completely as possible angular and rotary motions to lower the incidence or delayed union and non-union and better the functional result this is accomplished by either a strong intramedullary nail or compression plate.[5]

Interlock nail has been used in femur, tibia and humerus for many years; it's relatively newer method of fixation in forearm bones. Segmental fractures, poor skin condition (e.g. burns, large abrasions), multiple injuries, selected non-union or failed compression plating, diaphyseal fractures in osteopenic patients, selected type I and type II open diaphyseal fractures, massive compound injuries for which ulnar nails used as an internal splint to maintain forearm length, are the indications of interlock nailing.[6-9] The purpose of the present study was to evaluate the patients treated with Interlock nailing in the fracture forearm bones.

METHODS

The present study was a hospital based prospective interventional study on patient with fracture of diaphyses of forearm bones, admitted in department of orthopaedics of a tertiary care hospital. A total of 22 patients were included in the present study. The procedures followed were in accordance with the ethical standards of the responsible committee on institutional human experimentation and with the Helsinki Declaration of 1975, as revised in 1983 with informed and written consent from all the patients. All patients of fracture of forearm bones were included in this study. Whereas, patients with open physes (<18 years), Infected cases, open cases type IIIB and IIIC Gustilo-Anderson fracture, medullary canal <3 mm, failed earlier orthopaedic intervention and fracture near articular margin of the bone were excluded.

All patients were evaluated clinically at the time of admission, with special reference to neuro-vascular status and first aid treatment was given. X-ray with true AP and true lateral view of full length forearm including wrist and elbow was obtained. Patients were investigated completely for operative and anaesthesia purpose, any associated medical problems were taken care of before the patient taken up for surgery.

Preoperative preparation

Pre-operative counselling of the patient and relatives regarding the both the method of treatment of fracture forearm bones was done, consent for surgery and for research study was taken for the patient included in the study group, X-ray of uninjured forearm full length in biggest film with distance between the forearm and x-ray tube 100 cm was obtained, templating was done before getting the instruments autoclaved.

Surgical procedure

With the patient supine on a radiolucent table, and under general or regional anaesthesia the extremity was prepared. With the elbow flexed at 90 degrees, a 1 cm incision is made at the olecranon. Under fluoroscopic control, a 1.9 mm Kirschner wire is driven into the ulnar medullary canal following closed reduction of the fracture. Using a 6 mm reamer, the entry point is drilled for approximately 2.5 cm. The medullary canal is enlarged using manual reamers wit 0.5 mm increments. Then a 2.4 mm guide wire is used to temporarily fix the fracture to enable reduction of the radial fracture. Another incision of 2 cm long was made on the ulnar side of Lister's tubercle with the wrist and forearm prone. The medullary canal of radius is entered approximately 5 mm from articular surface and beneath the extensor pollicis longus tendon. Using a 1.9 mm Kirschner wire and a 6 mm cannulated reamer, the medullary canal is reamed. The last manual reamer was left in place. Using the X-ray of the uninjured forearm as a template, the length of intramedullary nail is calculated. Both nails are pre-bent to conform to the radial bow and the gentle S-shape of the ulna. First, a fully threaded 3.5 mm self-tapping screw is used to interlock the nearest hole to the insertion handle and the stability is checked; a 1.5 mm unicortical screw or k-wire may be used to lock the nail at the non-driving end if satisfactory stability is not achieved. The temporary ulnar wire is then removed and the ulna is fixed in the same fashion.

Postoperative care

If secure rigid fixation is achieved forearm POP splint is applied and kept in place for 2 weeks, thereafter a removable sugar-tong orthosis is worn until bridging callus is present, and the orthosis is removed frequently for exercise. If fixation is not secure, a long arm cast is applied with the forearm in neutral rotation and the elbow in 90 degree of flexion for fracture in the distal half of the forearm, in supination when the fracture is in proximal half of the bone, the cast is worn until bridging callus is present, the patient is kept at guarded activity until fully healed with a follow-up every 2 weeks for 3 months.

Statistical analysis

The data obtained was expressed as percentages and Mean±SD. The comparison of surgical time period and Post-op immobilization with surgical time and type of reduction in non-driving end was done using student t-test. The p <0.05 was considered significant.

RESULTS

The average period of follow up in the present study was 10.2 months. The average age of patients was 38.90 years (range 19-71 years) and the males were predominant by seven times. The major mode of injury was RTA (59.09%) followed by assault (36.36%). Open fractures were operated on the same day of presentation, 41% of patients were operated within week of injury, only three patients were operated after a week and one patient was operated after 3 weeks as patient presented late to hospital. Almost three fifth of the patients had right side involvement; all of our patients were right handed. More than half of patients had closed fractures and rest was open fractures, of which Gustilo Anderson type II were in majority as presented in Table 1.

Table 1: Patient characteristics.

Patient characteristics	n (%)
Age group (in years)	
< 40	Male: 10 (45.45), Female: 2 (9.09)
≥ 40	Male: 9 (40.91), Female: 1 (4.54)
Mode of Injury	
RTA	13 (59.09)
Assault	8 (36.36)
Fall	1 (4.54)
Interval between Injury & Operation	
≤1day	9 (40.91)
2-7 days	10 (45.45)
≥8 days	3 (13.64)
Side involvement	
Right side	13 (59.09)
Left side	9 (40.91)
Nature of injury	
Closed	12 (54.54)
Open	
type-I	3 (13.64)
type-II	6 (27.27)
type-III	1 (4.54)

Distribution of patient characteristics according to the fracture, bone involvement and associated injury was shown in Table 2. In the present series half of the patients had type B pattern of fracture.

Types B3 pattern i.e. wedge fracture of one bone, with a simple or wedge fracture of the other; was seen in one third of patients. In our study involvement of isolated ulna outnumbered isolated radius by 5:1. Almost half of the patients in our study had associated injuries like head injury, fracture of patella, tibial condyle, fracture of humerus and eye injury; cause of RTA and assault. Closed reduction of fracture was done in one third of patients, however more than half of patients had open fractures which were addressed by thorough debridement and open reposition of fractures on the same day of admission. Of 32 forearm bones, including 20 ulna and 12 radius; 9 radius and 10 ulna were reduced by open method. In 3/5 of patients locking at non-driving end was not done cause of stable fixation. Average duration of surgical time was 50 minutes. Duration of surgical time was more in patients in whom locking of non-driving end and closed reduction of fracture was adopted as seen in Table 3.

Table 2: Distribution of patient characteristics according to the fracture, bone involvement and associated injury.

Type of (AO) fracture	n (%)
A1	5 (22.73)
A2	1 (4.54)
B1	4 (18.18)
B3	7 (31.82)
C1	4 (18.18)
C2	1 (4.54)
Bone involvement	
Radius alone	2 (9.09)
Ulna alone	10 (45.45)
Both bone	10 (45.45)
Associated injury	
Head injury	6 (27.27)
Patella	1 (4.54)
Tibial condyle	2 (9.09)
Humerus	1 (4.54)
Eye injury	1 (4.54)
Nil	12 (54.54)
Type of reduction	
Open	12 (54.55)
Closed	8 (36.36)
Closed & open radius	2 (9.09)

Duration of surgical time was more than half an hour in patients mainly who had both bone involvement and where closed reduction was done. The period of immobilization was primarily dependant on the status of the locking of the non-driving end of nail and stability of fixation. The average duration of immobilization in our study was 4.9 weeks as shown in Table 4. There was statistically significant difference in the surgical time (P <0.05) as it was almost double in patients where locking of non-driving end was done. Duration of postoperative immobilization differed statistically significantly (P

<0.001) between the group of patients in whom locking was done and not done as in Table 5.

Table 3: Distribution of patient according to the percentage of reduction, locking of non-driving end and surgical time and interlocking.

Percentage Reduction and bone involvement	
Radius	n (%)
Open	2 (9.09)
Close	0 (0.00)
Both	0(0.00)
Ulna alone	
Open	5(22.73)
Closed	5(22.73)
Both	0 (0.00)
Radius and Ulna	
Open	5 (22.73)
Closed	3 (13.64)
Both	2 (9.09)
Locking of non-driving end	
Done	9 (40.91)
Not done	13 (59.09)
Surgical time and interlocking	
<30 minutes	
Done	2 (9.09)
Not done	7 (31.82)
≥30 minutes	
Done	7 (31.82)
Not done	6 (27.27)

Table 4: Distribution according to surgical time and type of reduction.

Surgical time (in minutes) vs % reduction	
<30 min	n (%)
Open	7 (31.82)
Close	2 (9.09)
Closed & open radius	0 (0.00)
≥ 30 min	
Open	5 (22.73)
Closed	6 (27.27)
Closed & open radius	2 (9.09)
Post-op immobilization (in weeks) vs locking of non-driving end	
<2 weeks	
Locking done	9 (40.91)
Locking not done	0 (0.00)
3-5 weeks	
Locking done	0 (0.00)
Locking not done	3 (13.64)
≥6 weeks	
Locking done	0 (0.00)
Locking not done	10 (45.45)

The comparison of surgical time period and postoperative immobilization with surgical time and type of reduction in nondriving end was done using student t-test.

Table 5: Comparison of surgical time period and postoperative immobilization with surgical time and type of reduction of locking non-driving end.

	Locking (Mean±SD)		P-value
	Done	**Not done**	
Surgical time (in min)	61.00±28.9	34.92±15.62	<0.05
Post op immobilization (in weeks)	2.00±0.00	6.92±2.56	<0.001

DISCUSSION

Currently, long-bone shaft-fractures are preferably being treated by means of intramedullary nailing due to its superior biomechanical behaviour. While all of this is true for the humerus, femur and tibia, intramedullary nailing has not yet been able to establish itself for the treatment of fractures of the forearm due to a variety of unsolved problems. In the present study, 22 patients with an average age of 38.90 years, including 19 male and 3 female patients. Average follow up was of 10.2 months. In a study conducted by Visna et al, of 78 patients, 50 male and 28 female, including 79 fracture diaphyseal forearm bones were nailed.[10] This study was comparable to Gao et al, Lee et al in number of patients and in average duration of follow up and number of patients.[11,12] Present study included 13 patients with right side injury and 9 with left sided injury, all the patients were right handed. Right side involvement was seen more commonly in most of studies.[10-12] 32 forearm bones were nailed (radius 12 and ulna 20), in 22 forearm fractures, isolated fracture radius was seen in 2 patients and ulna alone in 10 patients whereas both bone involvement seen in 10 patients

Present study was also comparable to other studies in total number of bones nailed.[13] In the literature involvement of isolated radius was less frequent than isolated ulna, which was also glaring in the present study. Most common mode of injury in our series was RTA in 13 patients followed by assault in 8 patients and fall in 1 patient.

Open fractures were classified according to Gustilo and Anderson, this was originally designed to classify soft tissue injuries associated with open tibial shaft fractures and was later extended to all open fractures.[14] While description includes size of skin wound, the subcutaneous soft tissue injury that is directly related to the energy imparted to the extremity is of more significance, so final typing of the wound was done at the time of operative debridement.

In the present study, more than half of patients had closed fractures 12 (54.54%) and rest 10 (45.45%) were open fractures, of which Gustilo Anderson type II were in majority i.e. 6 (27.27%), type I 3 (13.64%) and type IIIA one patient. In all the above mentioned studies, their patients had open injuries varying from type I to IIIA; our study was comparable to Gao et al in fraction of patients having had open injuries, in other series compound injuries were less common than us.[11] All the open injuries were dealt on the same day of presentation, with through debridement and internal fixation with interlock nail under cover of antibiotics.

Fracture pattern was classified according to AO classification system. AO system uses alphanumeric system, as the grade and number increase it signify the severity of trauma and thus poor prognosis, pattern C type include the complex injuries which are challenge to the treating surgeon. In our series half of patients had type B pattern, in rest half of patients almost equal number had type A and type C pattern of fracture, one pt had disruption of proximal radioulnar joint with segmental fracture of ulna (case no 13). In a study conducted by Gao et al maximum number of patients in his series had type B injury -10, type A-3 and type C-5 patient, 5 patients in their study had disruption of radioulnar joint and in a study done by Weckback et al, 55% of patients had type A, which also included 2 Galeazzi fractures, type B- 32% and C- 13%.[11,14]

In contrast, unacceptably high rates of non-unions (7% and more) have been reported without additional immobilization. In these nail systems, torsional stability is theoretically provided by the nail profile. An obviously more stable type of stabilization is gained by bundle nails with a non-union rate of 3%. The nailable spectrum of injuries in respect to fracture location, however, is smaller due to the biomechanical principle of elastic capturing.

Therefore, from this study we can conclude that, closed reduction of forearm favoured. Advantages of interlocking nail are high rate of bony consolidation along with minimized surgical approaches, cosmetically better suited and little risk of refracture after removal of the implant. Mainly complex fracture pattern AO (C type injuries) is stabilized in an elegant manner without additional damage to soft tissues.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. McFarlane AG, Macdonald LT. Parameters of the ulnar medullary canal for locked intramedullary nailing. J Biomed Eng. 1991;13(1):74-6.
2. Hidaka S, Gustilo RB. Refracture of bones of the forearm after plate removal. J Bone Joint Surg Am. 1984;66:1241-3.
3. Schemitsch EH, Richards RR. The effect of malunion on functional outcome after plate fixation of fractures of both bones of the forearm in adults. J Bone Joint Surg (Am). 1992;74:1068-78.
4. Crenshaw AH, Zinar DM, Pickering RM. Intramedullary nailing of forearm fractures. Instr Course Lect. 2002;51:279-89.
5. Anderson LD, Sisk D, Tooms RE, Park WI III. Compression-plate fixation in acute diaphyseal fractures of the radius and ulna. J Bone Joint Surg (Am). 1975;57:287-97.
6. Eggers GWN, Shindler TO, Pomerat CM. Clinical significance of contact compression factors in bone surgery. Arch surg. 1951;62:467.
7. Dodge HS, Cady GW. Treatment of fractures of radius and ulna with compression plates. JBJS. 1942;54:1167-76.
8. Mih AD, Cooney WP, Idler RS, Lewallen DG. Long-term follow-up of forearm bone diaphyseal plating. Clin Orthop. 1994;299:256-8.
9. Bolton H, Quinlan AG. The conservative treatment of fractures of the shaft of the radius and ulna in adults. Lancet. 1952;1:700-5.
10. Visńa P, Beitl E, Pilnı J, Cizmár I, Vlcek M, Kalvach J, et al. Interlocking nailing of forearm fractures. Acta Chir Belg. 2008;108:333-8.
11. Gao H, Luo CF, Zhang CQ, Shi HP, Fan CY, Zen BF. Internal fixation of diaphyseal fractures of the forearm by interlocking intramedullary nail: short-term results in eighteen patients. J Othop Trauma. 2005;19:384-91.
12. Lee YH, Sage FP. Medullary fixation of fractures of the forearm. A study of the medullary canal of the radius and a report of fifty fractures of the radius treated with a prebent triangular nail. J Bone Joint Surg (Am). 1959;41:1489-516.
13. Klemm KW, Borner M. Interlocking nailing of complex fractures of the femur and tibia. Clin Orthop. 1986;212:89-100.
14. Weckbach A, Blattert TR, Weisser Ch. Interlocking nailing of forearm fractures. Arch Orthop Trauma Surg. 2006;126:309-15.

Cite this article as: Shivakumar GV, Naveen PR, Manjunath ML. A study on patients treated with interlock nailing in the forearm fracture bones. Int J Res Orthop 2016;2:229-33.