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Use of intramedullary implants in adult diaphyseal fracture both bone forearm

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ABSTRACT

Background: Fractures of the forearm bones are very common. The most common form of stabilization is plate and screw fixation. The role of Intramedullary nailing of fractures of the shafts of the adult radius and ulna is still to be defined. This study was perform to analyze anatomical and function outcome of the patients treated by Talwarkar square nail.
Methods: We evaluated 46 patients (29 males and 17 females) had fracture both bone forearm treated by intramedullary nail. We analyzed patients in two broad group one with close fracture or grade I, II open fracture (34 patients) and other have open fracture grade IIIA or IIIB (12 patients). First group patients further analyzed weather close (22 patients) or open reduction (8 patients) required. Functional outcome was calculated by Grace and Eversman system.
Results: Out of 32 patients of close fracture or open grade 1 or 2 fracture, 29 (90.62%) have excellent or acceptable result. All the patients (100%) in whom close reduction succeeds achieved excellent result. 22 (64.70%) patients close nailing possible.12 patients in whom open reduction required 9 (75%) goes into union. Close nailing have overall success rate is 90.62% where it fail and open nailing require success rate bring down to 75%..
Conclusions: IM nailing gives satisfactory results. Advantages of close nailing are- early union, low incidence of infection, small scars, less blood loss, short operating time with minimal surgical trauma, easier implant removal. Even though plate and screw fixation is the gold standard for stabilization of both bone forearm fracture but intramedullay implant can be used in selected cases with good result. To achieve acceptable result – early surgery, proper selection of the case, pre-operative planning, proper assessment of diameter, length and radial bowing of the nail, is required.

Keywords: Fracture both bone forearm, Plating, Intramedullary implant, Forearm mal-union

INTRODUCTION

Fractures of the forearm bones are very common. Almost all both bone forearm fractures require surgery. The Goal is to reestablish the anatomical relationship between radius and ulna with rigid fixation. Anatomical reduction to maintain, the length of both bones, rotational alignment, radial bowing, and interosseous space between the radius and the ulna are important to restore the function of the forearm.[1,2]

There are various modes of internal fixations available, the selection of it rests with the treating surgeon.[3] The most common form of stabilization is plate and screw fixation which gives excellent result.

However, application of a plate itself have many disadvantages such as It can disrupt the periosteal blood supply, large skin incisions require that may be unsightly; more blood loss, intra-operative neurovascular injury is relatively common, compartment syndrome and large size incision requires during plate removal and there is also a risk of re-fracture after implant removal.[4]

The use of Intramedullary nailing for diaphyseal fractures of adult radius and ulna is not well defined. Lack of sufficient rotational stability has long been a factor against its use in adult forearm shaft fractures.

Intramedullary implants such as Ivory pins, the Küntscher nail, Rush nail, and Ender nails, have been used in past to stabilize forearm fractures.[5] In 1959, Dr. Talwarkar performed fixation of both bones of forearm fractures with a flexible square nail designed by him.[6] It change the management of forearm fracture more towards it.

The advantages of stabilization of forearm fractures by intramedullary devices are- less amount of blood loss, duration of surgery is less, minimal periosteal striping, lower infection rate, minimum scaring, implant removal is easier, rate of refractures after implant removal are less. The disadvantages are provide lack of rotational stability so supplementation with above elbow pop slab/cast require for few weeks, migration of nail leads to discomfort in elbow or wrist region, rate of non-union, mal- union are comparatively more.

This study was perform to analyze anatomical and function outcome of the patients treated by Talwarkar square nail for fracture both bone forearm. The aim of this study is to better predict outcome of forearm fractures treated by intramedullary device so that proper implant selection is possible.

METHODS

It is a retrograded observational study. After getting clearance from the ethics committee, this study was conducted in the department of Orthopaedics Bundelkhand Medical College, Sagar between 2015 to 2017. We evaluated 46 patients (29 males and 17 females) had fracture both bone forearm treated by intramedullary nail. The mean age of the male patients was 34.5 years (range 18-70) and female was the 42.5 (18- 65) years. The mode of trauma was road traffic accident (61%), assault (30%), and fall from height (7%), occupational injuries (2%). The mean follow up of the patients was 11 months (minimum 6 months, maximum 2 years) postoperative. Type of fracture pattern was short oblique, transverse, comminuted, segmental in different combination in radius and ulna

We analyzed patients in two broad group one with close fracture or grade I, II open fracture and other group have open fracture grade IIIA or IIIB (grade IIIC open fracture not included in the study). First group patients further analyzed weather close reduction succeed or open reduction required. On this bases 34 patients have close fracture or grade 1, 2 open fracture (modified Gastillo Anderson classification for open fracture). 12 patients have open fracture Grade 3A or 3B.

22 patients, close nailing were possible while 8 patients require open reduction of single bone (6 patients had duration of injury >10 days while 2 patients have duration of injury <10 days) and 4 patients require open reduction of both bones (all of them duration of injury >10 days).

Out of 34 patients, 24 patients have fracture less than 10 days old and 10 patients have fractured more than 10 days old. After nailing we applied above elbow pop slab/ cast for 6 weeks followed by arm sling for 4 week.

Out of 12 open fractures (type 3A & B), 8 patients (type 3A) were manage by thorough wash, debridement, primary closer without tension, stabilization by intramedullay nail in the same sitting and subsequent dressing (3 require superficial skin grafting later on). Of these, 5 patients union achieved, 2 patients require bone grafting and 1 patient require nail removal followed by plating with bone grafting. 4 patients (Type 3B open fracture) require flap application for wound coverage. 2 of these patients require bone grafting alone while 2 require plating with bone grafting.

None of the patients had any intraoperative complication. There was only one patient who developed superficial infection after open reduction and nailing. None of the close nailing patients developed infection. 2 patients had ulna nail and one had both radius and ulna nail back out occur. But all three patients union achieved thus just removal of implant required.

In this study we only included adult patients' age more than 18 years in whom distal physis is fused. We do not include patients where we not performed intramedullary nail for forearm fracture like narrow or uneven medullary canal, previous old forearm fracture, fracture of proximal or distal metaphysis of radius, ulna, fracture associated with disruption of proximal or distal radioulner joint and comminuted fracture where close nailing not succeed and fracture fragments wildly apart.

The result was assessed on the basis of union achieved or not (both clinically and radiologically), functional recovery and complications. Functional outcome was calculated by Grace and Eversman system.[7] According to the Grace and Eversmann rating system, an excellent result was defined as union of the fracture and at least 90% of normal rotation arc of the forearm, a good result was defined as union of the fracture and 80% to 89% of normal rotation arc of the forearm, an acceptable result was defined as union of the fracture and 60% to 79% of normal rotation arc of the forearm, and an unacceptable result was defined as nonunion or <60% of normal

rotation arc of the forearm. The subjective outcome was assessed with the disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.[8,9] This questionnaire was used with a score between 0 and 100, and a lower score indicated a more satisfactory recovery.

Implant used

For all patients for both radius and ulnar immobilization, 2.0 mm, 2.5 mm, 3.0 mm, or 3.5 mm, diameter, 16 cms to 36 cms length, 316L stainless steel Talwarkar Square nails were used. The ulnar nail is straight with a trocar tip, while the radius nail has a bevelled edge with a 1 cm notch for the tip. This provides more flexibility and ease of negotiation along the radial bow. The nails have a threaded end for ease of insertion and removal.

Preoperative planning

Appropriate nail length and contour them properly is very important for desirable outcome. Inappropriate nail selection or shape can result in malalignment, fracture distraction, pull back of implant, implant impingement and functional loss. Full length X-ray forearm AP and lateral view of both forearm (injured as well as normal) taking. Carefully examine fracture pattern, radioulnar joint sublaxation or dislocation, radial bowing, medullary canal diameter, canal evenness.

Radiographs were evaluated for each patient for type and location of fractures. The size of the nails was estimated on the normal limb radiograph. An ulnar nail was placed along the ulnar border of the uninjured forearm to estimate nail size. Alternatively, the length of the ulnar nail was measured from the tip of the olecranon to the ulnar styloid minus 1 cm. The radius nail was measured from the Lister's tubercle to the lateral epicondyle minus 3cm. The length of the radius nail is usually 2 cm shorter than the ulnar nail. The diameter of the nail is also estimated on the pre-op X-ray and verified intra-operatively under the c-arm.

During surgery length is further confirm by placing nail of known length against the injured bone, while pulling the limb to length using manual traction. Image intensifier views of the length and fit of the nail are used to calculate the desired length of the nail to be used.

Surgical procedure and follow up

Regional anaesthesia (axillary, supraclavicular block) and or general anesthesia used. The position of the patient was supine on operating table with forearm placed on image compatible side arm rest. The shoulder was abducted and the elbow flexed 90 degree for the nailing of the ulna whereas for the nailing of the radius, the arm was extended and wrist was in palmer flex position. Reduction of fracture fragment was achieved by traction and manipulation and checked under image intensifier. We routinely did not use tourniquet

Which nailed first depend upon fracture configuration where to introduce nail was easier we nailed that bone first. If both had same configuration than we nailed ulna first, thereby providing a more stable forearm for retrograde nailing of the radius.

The ulna was approached from the radial side of the olecranon tip. An incision of 1cm over the olecranon tip was made deep down to the bone. Entry was made with an awl suited for the radius-ulna nailing. The position of the awl was checked under C-arm image intensifier in the antero-posterior and lateral view. No reaming was performed with insertion of the square nails. An ulna nail of appropriate size was selected and introduced in entry point with the help of T-handle. Gentile hammering was done where the nail stuck it moves and pushed forward with the help of T- handle. The fracture fragment was reduced with the help of traction and manipulation. After reduction, nail passed through distal fragment. Everything was checked under image intensifier. The distal end of the nail was usually within 1 cm of the tip of ulna. The end of the nail was buried inside the olecranon.

The radius was approached through the Lister tubercle. 2 cm incision was made just ulnar to the Lister Tubercle on the dorsal surface and the soft tissue was divided. The 3rd extensor compartment was opened. The tendon of the extensor pollicis longus (EPL) was identified and retracted toward the ulna and the radial shaft was in view.

The entry was made with an AWL, 1 cm proximal to the articular surface. A radius nail of appropriate size was selected and pre-bent to match the radial contour. The radius nail was sliding over the volar surface of the radius with the help of T handle. Reduction was achieved by traction and manipulation assistant hold the reduction and nail pass through proximal fragment. Again everything was checked by image taken at frequently during entire procedure by image intensifier. If in any case the reduction was difficult to achieve, a miniopen reduction was performed for radius or ulna or both.

After surgery an above elbow slab was applied and patient asked to perform active finger movements. Movement of the thumb was especially checked for any injury to the EPL tendon during surgery. Patients were discharged on the 3rd to 4th day post-operative day once the patient was comfortable, finger swelling subside, pain minimal or absent. Suture removed on 12th day. After that another above elbow cast/ slab applied for 6 weeks. Prophylactic antibiotic given for 3 days in case of close fracture manage by close nailing. In case of open fracture or where open reduction was required, antibiotic given for 7 to 10 days. Physiotherapy was started soon after injury, with in the cast (shoulder and finger exercise) and more vigorous after removal of the cast (range of motion and strengthening exercises). Patients was evaluated clinically and radiographically soon after surgery and at 4- weekly intervals till union achieved. After that, follow up at 3-monthly intervals.

RESULTS

Using the rating system of Grace and Eversmann, out of 32 patients of close fracture or open Grade 1 or 2 fracture, 22 have excellent result, 7 have acceptable result (over all 90.62% have excellent or acceptable result), 2 patients require bone grafting for union and only 1 require nail removal plating and bone grafting. All the patients in whom close reduction succeeds achieved excellent result. Out of 34 patients, 22 (64.70%) patients close nailing possible. Close nailing was not possible in 12 patients. Out of which 10 (83.33%) had duration of injury >10 days and only 2 patients had duration of injury less than 10 days.12 patients in whom open reduction required 9 (75%) goes into union 2 (22.22%) require bone grafting and 1 (11.11%) require implant removal, plating and bone grafting.

Out of 12 grade 3A and 3B open fracture, 8 fractures were 3A in whom 5 (62.5%) unite and have acceptable result. 4 patients with type 3B fracture all of them require secondary procedure (flap for wound coverage, bone grafting, plating with bone grafting) for fracture healing.

Average operating time in close nailing was 40 minutes while open nailing was 80 minutes. In our study the mean disabilities of the arm, shoulder and hand (DASH) score is 14 points (3 to 40).

Table 1: Number of patients having close or open type 1 or 2 fracture (34 patients) with different variables like duration of injury, close or open IM nailing done and its outcome (union achieved or not).

Duration of injury	Close reduction and IM nailing possible (N. of patients)		Open reduction and IM Nailing required (N. of patients)	
	Union achieved	Non-union require procedure like bone grafting	Union achieved	Non-union require procedure like bone grafting
< 10 days	20	-	2	-
>10 days	9	-	-	3

Table 2: Type of fracture and its outcome.

Type of fracture	Union achieved. Excellent to acceptable result by Grace and Eversmann rating
Close/open grade 1 or 2	90.62%
Open grade 3A	62.5%
Open grade 3B	Non

Table 3: Duration of injury with success rate of close reduction.

Duration of injury	Close reduction possible
<10 days	90.90%
>10 days	16.66%

Table 4: Result of close and open IM nailing.

Type of reduction possible	Union achieved. Excellent to acceptable result by Grace and Eversmann rating
Close	100%
Open	75%

DISCUSSION

It is generally recommended that fracture both bone forearm should be treated surgically with open reduction and Plate fixation. Even though nonsurgical treatment can be applied in undisplaced fractures but it requires close monitoring with X-ray at frequent interval. Any amount of displacement is not acceptable and perfect anatomical reduction gives good result. The risk of delayed union, nonunion, malunion, or cross-union between forearm bones is relatively high among the patients treated non surgically.[10-12] Malunion of the forearm affects the range of supination- pronation. Matthews et al found that residual angulation of less than 10° was associated with little loss of forearm rotation and residual angulation of 20° or more was associated with a functionally important loss of forearm rotation.[2] Dumont et al describe that most marked limitation in supination and pronation of the forearm occur if radius and ulna malunited in opposite direction.[1] Thus anatomical reduction is required for desirable result and any amount of malrotation in opposite direction is not acceptable at all. The surgical treatments of choice for a simple diaphyseal fracture is dynamic compression plating and for a comminuted diaphyseal fracture bridge plate technique is used.[10,12]

Intramedullary nailing can also be performed for immobilization of fracture. Rush nail, Kirschner wire, Steinmann pin, or Lottes nail all were used in past for stabilization of isolated fracture shaft ulna. All had satisfactory outcome. But, when these are used for immobilization of fracture both bone forearm, because of the lack of rotational and axial stability and under-reduction of radial bowing these methods have a higher risk of nonunion or decreased pronation, supination of the forearm.[12,13] Recently, with the improvement of, IM nail design, it provides satisfactory results in the management of diaphyseal fracture of both-bone forearm.[14,15]

Plate fixation and IM nail fixation have its own advantages and disadvantages. Plate and screw provide rigid fixation. Open reduction performed during plating and can be well maintain by it. So perfect anatomical reduction (proper length, rotational alignment, interosseous space, radial bowing) can be possible. Which is essential for good result? It provides ridge fixation so early mobilization is possible, which is good for early functional recovery of forearm. Disadvantages of it include a large skin incision, excessive soft tissue handling, increase blood loss, increase periosteal striping, sepsis. Other Possible complications include compartmental syndrome, delayed union or nonunion; intraoperative neurovascular injuries.[16,17] Removal of plate requires large incision and after removal chances of, sepsis, delay healing, poor scar, neurological problem, refractures can occur.[18]

In contrast, IM nail fixation has advantages such as small skin incision, minimal soft tissue stripping, and a short operation time, less chances of refracture after implant removal and implant removal is easier. However, it is difficult to achieved anatomical relationships in comminuted or long oblique fracture with this technique. Other disadvantages include higher radiation exposure during achieving closed reduction, longer duration of immobilization (above elbow slab/cast application), and longer time to achieve complete union than plate fixation. Indications for this procedure are inappropriate surrounding soft tissue for plate fixation, severe swelling, segmental fracture, multiple fractures, and severe osteopenia. Contraindications include small diameter of the medullary canal, acute infection, open physis, and fracture extension to the metaphysis or articular surface.

Duncan et al found in their study that immediate internal fixation of open grade I, II, or III A diaphyseal fractures of the forearm (90%) had satisfactory results while patients with grade IIIB or IIIC had unacceptable results.[19] It is similar to our study where Open fracture grade IIIA union achieved in 62.5% cases while none of IIIB unite by nailing alone.

In our series using the rating system of Grace and Eversmann excellent to acceptable result was achieved in 90.62% of case (Group 1 patients having close fracture or grade 1 or 2 open fracture). It is comparable to Street et al who reported a 93% union rate with the use of square nails in forearm fixation.[20] Moerman et al, achieved 94% union.[17] 3 of our case develop nonunion. 2 required bone grafting and one required plating with bone grafting. All these had distraction at fracture site. All of them required open reduction and duration of injury more than 10 days. 83.33% of patients where close reduction not possible had duration of injury was >10 days. Those cases where open intamedullary nailing required to be performed acceptable result was achieved in 75% of cases compare to overall 90.62% success rate. Hence it is important to perform surgery as early as possible because probability of close reduction and success rate of close nailing will be high. Very late presenting cases better to perform platting.

In our experience, the main complications during surgery were due to improper nail size, diameter and radial bowing, poor selection of cases. Several factors affected the choice of implant. A more simple fracture, transverse, short oblique, segmental fracture, fracture in osteoporotic bone, recent trauma is fixed with IM nailing. Second, we prefer IM nailing than plating if soft tissue problem is around the skin incision for plating. For primary stabilization in open fracture we prefer nailing than external fixator. External fixator is used if wound is heavily contaminated or acute infection is present. Long oblique fracture or comminuted fracture (where close reduction not possible and fracture fragment is wide apart), where duration of injury is long and chance of close reduction is dim, sublaxation or dislocation of superior or inferior radio-ulnar joint we prefer plating than nailing.

CONCLUSION

Even though it is a small study and further large study is required but still it can be concluded that intramedullay implant can be used for diaphseal fracture both bone forearm in adult. Closed nailing has many advantages, including early union, low incidence of infection, small scars, less blood loss, and, frequently a relatively short operating time with minimal surgical trauma. To achieve acceptable result– early surgery, proper selection of the case, pre-operative planning, proper assessment of diameter, length and radial bowing of the nail, is required.

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REFERENCES

1. Dumont CE, Thalmann R, Macy JC. The effect of rotational malunion of the radius and the ulna on supination and pronation. J Bone Joint Surg Br. 2002;84(7):1070–4.
2. Matthews LS, Kaufer H, Garver DF, Sonstegard DA. The effect on supination-pronation of angular

malalignment of fractures of both bones of the forearm. J Bone Joint Surg Am. 1982;64(1):14–7.
3. Rao MR, Kader E, Sujith SV, Thomas V. Nail-plate combination in management of fracture both bone forearm. J Bone Joint Surg (Br). 2002;84(B):252–3.
4. Lee YH, Lee SK, Chung MS, Baek GH, Gong HS, Kim KH. Interlocking contoured intramedullary nail fixation for selected diaphyseal fractures of the forearm in adults. J Bone Joint Surg Am. 2008;90(9):1891–8.
5. Barry M, Paterson JMH. Flexible intramedullary nails for fractures in children. J Bone Joint Surg Br. 2004;86:947–53.
6. Talwalkar AK, Talwalkar CA. internal fixation of fractures of radius and ulna in adults with Talwalkar intramedullary nails. Indian J Orthop. 1967;1(1):26–30.
7. Grace TG, Eversmann WW Jr. Forearm fractures: treatment by rigid fixation with early motion. J Bone Joint Surg Am. 1980;62:433–8.
8. Dowrick AS, Gabbe BJ, Williamson OD, Cameron AP. Does the disability of the arm, shoulder and hand (DASH) scoring system only measure disability due to injuries to the upper limb. J Bone Joint Surg Br. 2006;88:524–7.
9. Gummesson C, Atroshi I, Ekdahl C. The disabilities of the arm, shoulder and hand (DASH) outcome questionnaire: longitudinal construct validity and measuring self-rated health change after surgery. BMC Musculoskelet Disord. 2003;4:11.
10. Moss JP, Bynum DK. Diaphyseal fractures of the radius and ulna in adults. Hand Clin. 2007;23(2):143–51.
11. Jones DB, Jr, Kakar S. Adult diaphyseal forearm fractures: intramedullary nail versus plate fixation. J Hand Surg Am. 2011;36(7):1216–9.
12. Rehman S, Sokunbi G. Intramedullary fixation of forearm fractures. Hand Clin. 2010;26(3):391–401.
13. Sage FP, Smith H. Medullary fixation of forearm fractures. J Bone Joint Surg Am. 1957;39(1):91–8.
14. Droll KP, Perna P, Potter J, Harniman E, Schemitsch EH, McKee MD. Outcomes following plate fixation of fractures of both bones of the forearm in adults. J Bone Joint Surg Am. 2007;89(12):2619–24.
15. Lee YH, Lee SK, Chung MS, Baek GH, Gong HS, Kim KH. Interlocking contoured intramedullary nail fixation for selected diaphyseal fractures of the forearm in adults. J Bone Joint Surg Am. 2008;90(9):1891–8.
16. Jones DJ, Henley MB, Schemitsch EH, Tencer AF. A biomechanical comparison of two methods of fixation of fractures of the forearm. J Orthop Trauma. 1995;9(3):198–206.
17. Moerman J, Leneart A, Deconinck D, Haeck L, Verbeke S, Uyttendaele D. Intramedullary fixation of forearm fractures in adults. Acta Orthop Belg. 1996;62(1):34–40.
18. Langkamer V G,Ackroyd C E. Removal of forearm plate.journal of Bones Joint Surgery (Br.). 1990;72:601-4.
19. Duncan R, Geissler W, Freeland AE, Savoie FH. Immediate internal fixation of open fractures of the diaphysis of the forearm. J Orthop Trauma. 1992;6(1):25–31.
20. Street DM. Intramedullary forearm nailing. Clin Orthop Relat Res. 1986;212:219–30.

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