ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Comparative study of internal fixation of diaphyseal fractures of both bones of the forearm in adults between intramedullary nailing and plate osteosynthesis

Atin Biswas[1], Kanchan Kumar Sabui[2], Anindya Basu[3], Prasun Mandal[4]

[1]Medical Officer, Department of Orthopaedics, Naihati State General Hospital, [2]Associate Professor, [3]Assistant Professor, Department of Orthopaedics, Medical College, Kolkata, [4]Associate Professor, Department of Orthopaedics, Sarat Chandra Chattopadhyay Government Medical College, Howrah, West Bengal, India

Submission: 11-10-2022 Revision: 04-01-2023 Publication: 01-02-2023

ABSTRACT

Background: Diaphyseal forearm fracture is one of the most commonly encountered fractures of the upper extremity. The literatures comparing the outcome of plate fixation and intramedullary nailing in adults are scarce and therefore the consensus on superiority of one over the other is lacking. This study was undertaken to compare the outcome of these operative techniques in adults with diaphyseal fracture of both bone forearm. **Aims and Objectives:** This study was undertaken to compare the outcome of plate fixation and intramedullary nailing in adults with diaphyseal fracture of both bone forearm. **Materials and Methods**: Patients of 18–70 years of age, with diaphyseal fractures of both bones of the forearm of <21 days old, were recruited. Patients were randomly allocated to two treatment groups: intramedullary nailing and plate osteosynthesis. Patients were followed up at 4th week, 12th week, and 24th week post-operative period. Functional outcome was measured at the end of 24th week based on the Clinical and Radiological parameters by Anderson et al., Score, Grace-Eversman Score, and Disabilities of the Arm, Shoulder and Hand (DASH) Score. **Results:** This study comprised of 40 cases (n = 40) who completed the follow-up period of 24 weeks. Most of the patients treated with plate (80%) demonstrated excellent outcome as per Anderson et al., score while the outcome was unsatisfactory in 50% of those treated with nails. About 90% of the patients of plate group had excellent result in contrast to 50% in case of nail group following Grace Eversman criteria. Considering DASH score, the former group showed mostly excellent (40%) and good (45%) outcome while the latter exhibited mostly fair (55%) and good (30%) result. **Conclusion:** It may be stated that plate osteosynthesis is a better option in the treatment of diaphyseal fracture of both bones forearm in adults.

Key words: Both bone forearm; Diaphyseal fractures; Intramedullary nailing; Plate osteosynthesis; Internal fixation

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v14i2.48869

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Diaphyseal forearm fracture is one of the most commonly encountered fractures of the upper extremity.[1] Increase in road traffic accident and sports injury has caused worldwide increase in its incidence.[2] Goal of treatment is to regain length, apposition, axial, and rotational alignment and that is essential for achieving a good range of pronation and supination.[3] Open reduction followed by plate fixation is a commonly practiced surgical intervention in the treatment of both bone forearm fracture in adult.[4,5] Advantages of plate fixation include adequate reduction, satisfactory healing, and functional recovery.[6] Intramedullary nailing has recently gained popularity because of minimal invasion,

Address for Correspondence:
Dr. Prasun Mandal, Associate Professor, Department of Orthopaedics, Sarat Chandra Chattopadhyay Government Medical College, Howrah - 711 316, West Bengal, India. **Mobile:** +91-9830509272. **E-mail:** prasunortho81@gmail.com

no periosteal stripping, faster healing, and lower re-fracture rate compared to plate osteosynthesis.[7,8] The literatures comparing these two operative techniques in adults are scarce and therefore the consensus on superiority of one over the other is lacking.[9] This study was undertaken to compare the outcome of plate fixation and intramedullary nailing in adults with diaphyseal fracture of both bone forearm.

Aims and objectives

This study was undertaken to compare the outcome of plate fixation and intramedullary nailing in adults with diaphyseal fracture of both bone forearm.

MATERIALS AND METHODS

A prospective and observational study was conducted for 18 months in a tertiary care center of Eastern India. Patients of 18–70 years of age, with diaphyseal fractures of both bones of the forearm of <21 days old, were recruited. Those having pathological fractures, open fractures GA Type II and III, neurovascular injury or associated head, chest, or abdominal injuries arising out of polytrauma were excluded from the study.

Subject recruitment commenced once written approval was obtained from Institutional Ethics Committee. During screening of the subjects, all potential subjects who fulfilled the study selection criteria were informed by the investigator, verbally, in vernacular, about the study in details (including the rationale, aims and objective of the study, study related procedures, potential discomfort, and benefits of participation). Then, a copy of informed consent form and patient information sheet was provided to the subjects and they were requested to go through them. The investigator also answered any study related queries raised by the subjects. After the above-mentioned procedure, only those subjects who were willing to participate were asked to sign and write the date on the informed consent form expressing their voluntary participation in the trial. All study related activities started only after such consent was obtained. Subjects were duly explained that they would not receive any monetary remuneration for participation in the study. The investigator would ensure the confidentiality of the participants. The case record forms, study documents and biological samples collected were untitled and anonymous.

Patients were randomly allocated to two treatment groups: Intramedullary nailing (Titanium Elastic Nailing System) and plate osteosynthesis. Laboratory investigations included plain X-ray of involved forearm (posteroanterior view and lateral view) with wrist and elbow joint (to rule out associated fractures or dislocations), hemoglobin percentage (%), total count, differential count, erythrocyte sedimentation rate, fasting blood sugar, serum urea, serum creatinine, chest X-ray (P.A. view), electrocardiogram, HIV I and II, hepatitis B surface antigen, anti-HCV, clotting time, bleeding time, prothrombin time, activated plasma thromboplastin time, international normalized ratio, and platelet count.

Patients were followed up at 4th week, 12th week, and 24th week in the post-operative period. Pain at operation site, limb shortening, range of forearm rotation, range of elbow, and wrist motion were noted and X-ray forearm was obtained on each follow-up visit. Functional outcome was measured at the end of 24th week based on the clinical and radiological parameters by Anderson et al., Score, Grace-Eversman Score, and Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire Score.[10,11]

Statistical analysis

Data obtained from the study were analyzed using Graph Pad Prism version 5 (San Diego, California: GraphPad Software Inc., 2007). The data were analyzed by Chi-square test, Fisher's exact test, and unpaired t-test. $P<0.05$ was considered significant.

RESULTS

This study comprised of 40 cases (n=40) who completed the follow-up period of 24 weeks. Mean age was 33.05 years. The youngest patient was 19 years old and the oldest was 68 years old. The most common age group affected was 18–26 years (47.5%) and maximum (75%) numbers of patients were below the age of 45 years. About 25% of patients were female.

Twelve of the patients were above 40 years of age and few of them had pre-existing medical problems. The most commonest associated medical problems were hypertension, diabetes mellitus, renal dysfunction, and electrolyte dysfunction. About 65% of patients sustained injury on the right side. Most of the fractures resulted from RTA followed by domestic fall. Diaphyseal fractures were most common in the middle third. The minimum time lapsed or the setting up period was within 24 h for 16 cases and the maximum time was 4 days for six cases.

Out of 20 patients allocated in the plate group, 16 were treated with dynamic compression plate and screws, three with dynamic compression plate and semitubular plate and screws, and one with dynamic compression plate and reconstruction plate and screws. All the 20 patients with intramedullary nailing had TENS inserted.

Baseline characteristics of the patients, average union time, and the complications are shown in Table 1. The mean time required for union after plating was 12.35 weeks, with minimum duration of 9 weeks and maximum was found to be 20 weeks. The mean time required for union after plating was 16.30 weeks, with minimum duration 9 weeks and maximum was found to be 24 weeks. On comparing the results, it was noted that 16 patients of plate osteosynthesis group took 10–14 weeks for achieving union. The two groups differed significantly in time interval required for union. P-value comparing the union time in two treatment categories was found to be statistically significant.

Regarding the complications, superficial infection occurred in 1 (5%) patient treated with intramedullary nailing and 2 (10%) patients treated with plating. Deep seated infections were encountered in none of the patients of either group (Table 1). None of the patients in this study had delayed union or non-union. There was no significant difference in post-operative complications between these two groups.

Most of the patients treated with plate (80%) demonstrated excellent outcome as per Anderson et al., score while the outcome was unsatisfactory in 50% of those treated with nails. About 90% of the patients of plate group had excellent result in contrast to 50% in case of nail group according to the Grace Eversman criteria (Table 2). Considering DASH score, the former group showed mostly excellent (40%) and good (45%) outcome while the latter exhibited mostly fair (55%) and good (30%) result (Table 3).

Table 1: Baseline characteristics of the patients treated with plate or intramedullary nail

Parameters	Plate (n=20)	Nail (n=20)
Age (years)	30.60±14.03	35.50±15.84
Female	3	7
Patients with injury on the right side	15	11
Mode of injury		
RTA	13	11
Sports injury	4	2
Domestic fall	3	7
Site of fracture		
Proximal third	4	6
Middle third	11	10
Distal third	5	4
Type of fracture		
A3.1	5	5
A3.2	4	8
A3.3	4	5
B3.1	3	1
B3.2	1	1
B3.3	1	0
C1.2	1	0
C2.2	1	0
Post-operative complications		
No complications	12 (30)	10 (25)
Surgical site infections	2 (5)	1 (2.5)
Nerve palsy	3 (7.5)	1 (2.5)
Elbow stiffness*	3 (7.5)	10 (25)
Wrist stiffness	2 (5)	5 (12.5)
Union time#	12.35±2.368 weeks	16.30±4.462 weeks

Values are mean (SD) or no. (%); *P=0.041 (P-value obtained by Fisher's exact test). #P=0.001 (P-value obtained by unpaired t-test)

Table 2: Distribution of patients with respect to functional outcome according to Anderson et al., score and Grace Eversman score at 24 weeks

Functional outcome	Plate (n=20) No (%)	Nail (n=20) No (%)	P-value
Anderson et al., score			
Excellent	16 (80)	6 (30)	0.0051*
Satisfactory	2 (10)	4 (20)	
Unsatisfactory	2 (10)	10 (50)	
Failure	0 (0)	0 (0)	
Total	20 (100)	20 (100)	
GE score			
Excellent	18 (90)	10 (50)	0.022*
Good	1 (5)	6 (30)	
Acceptable	1 (5)	4 (20)	
Poor	0 (0)	0 (00)	
Total	20 (100)	20 (100)	

P value obtained by Chi-square test; *Indicates significance

DISCUSSION

Fracture both bones of forearm present a formidable challenge to the orthopedicians as the various muscle forces acting on the fracture tend to displace it. Hence, to provide the functional rehabilitation of the upper limb, anatomic reduction and stable fixation are mandatory. This is achieved by open reduction and internal fixation with dynamic compression plate and screws.[12] The relationship of the radiohumeral, radioulnar, ulnohumeral, radiocarpal, distal radioulnar joint, and the interosseous space must be perfect; otherwise, some functional impairment will result.[12] Malunion and non-union occur more frequently because of difficulty in reducing and maintaining reduction of two parallel bones in the presence of the pronating and supinating muscles that have angulatory as well as rotational influences. Because of these factors, surgical management for displaced diaphyseal fractures in the adult is generally recommended.[3]

There are various methods of surgical management of fracture both bone forearm but the open reduction and plate fixation are the commonly employed treatment of both-bone forearm fractures in adults.[13] The other common operative methods are intramedullary nailing, hybrid fixation of radius, and ulna with plate and intramedullary nail, conservative method being mainly

Table 3: Distribution of patients with respect to functional outcome according to DASH score at 24 weeks

Grading	Plate (n=20) No (%)	Nail (n=20) No (%)	P-value
Excellent	8 (40)	1 (5)	0.0056*
Good	9 (45)	6 (30)	
Fair	2 (10)	11 (55)	
Poor	1 (5)	2 (10)	
Total	20 (100)	20 (100)	

P value obtained by Chi-square test; *Indicates significance

reserved for pediatric both bone forearm fractures. All the methods of management have their own advantages and disadvantages. A high rate of union, low rate of complications, and the satisfactory return of rotation of the forearm have been described in plate fixation.[3] Complications include extensive soft tissue damage, periosteal damage, and re-fracture and infection following plate removal.[13,14] Greater union time in the nail group in this study agrees with the previous reports. Functional outcome has been found to be more favorable in plate fixation in some studies while others demonstrate similar results.[15,16] Intramedullary nailing is minimally invasive procedure with less periosteal damage, faster healing, and lower refracture rate as compared with plate fixation as found in several studies. Although the final results are mostly comparable for both the surgical techniques.[7,9,17,18] Zhao et al., in their study concluded that intramedullary nailing resulted in lesser operative time and decreased complications as compared to plating.[19] In skeletally immature patients aged between 10 and 16 years, it was also found that intramedullary nailing gave similar functional and radiological outcomes as compared to plating.[20-22]

There are lots of study on plate fixation and use of intramedullary nails in both bone forearm fractures in children and adolescents and adults. However, only a few has focused on the comparison between these two, especially in adults. Considering the paucity of data, our study compared the complications and functional outcome of these two surgical techniques. It would have been better if a larger number of patients could be recruited and followed up. Only 40 patients could be followed up to 24th weeks in this study.

In our study, there was no significant difference in post-operative complication between the two groups. Most of the patients belonging to the plate group required less time for union compared to those treated with the nail even though all achieved union eventually. Functional outcomes as per all three scoring systems were significantly better in those treated with plate at 24 weeks of follow-up.

Limitations of the study

In our study, the sample size was small and the follow-up period was also less.

CONCLUSION

It may be stated that plate osteosynthesis is a better option in the treatment of diaphyseal fracture of both bones forearm in adults. Use of intramedullary nail is a good alternative with acceptable outcome. A larger prospective study may be undertaken to determine the relative effectiveness and long-term complications of these two interventions.

ACKNOWLEDGMENTS

We solicit our gratitude to all the patients who agreed to participate in the study and all operation theater staff who helped immensely during the study.

REFERENCES

1. Tornetta P 3rd, Ricci WM, Ostrum RF and McQueen MM. Rockwood and Green's Fractures in Adults. 9th ed. Philadelphia, PA: Lippincott Williams and Wilkins; 2019.
2. Schmitt KU, Zürich PF, Muser MH and Walz F. Trauma Biomechanics: Accidental Injury in Traffic and Sports. Germany: Springer Science and Business Media; 2009.
3. Al-Sadek TA, Niklev D and Al-Sadek A. Diaphyseal fractures of the forearm in adults, plating or intramedullary nailing is a better option for the treatment? Open Access Maced J Med Sci. 2016;4(4):670-673.
https://doi.org/10.3889/oamjms.2016.138
4. Schulte LM, Meals CG and Neviaser RJ. Management of adult diaphyseal both-bone forearm fractures. J Am Acad Orthop Surg. 2014;22(7):437-446.
https://doi.org/10.5435/JAAOS-22-07-437
5. Lee SK, Kim KJ, Lee JW and Choy WS. Plate osteosynthesis versus intramedullary nailing for both forearm bones fractures. Eur J Orthop Surg Traumatol. 2014;24(5):769-776.
https://doi.org/10.1007/s00590-013-1242-x
6. Droll KP, Perna P, Potter J, Harniman E, Schemitsch EH and McKee MD. Outcomes following plate fixation of fractures of both bones of the forearm in adults. J Bone Joint Surg. 2007;89(12):2619-2624.
https://doi.org/10.2106/JBJS.F.01065
7. Lee YH, Lee SK, Chung MS, Baek GH, Gong HS and Kim KH. Interlocking contoured intramedullary nail fixation for selected diaphyseal fractures of forearm in adults. J Bone Joint Surg Am. 2008;90(9):1891-1898.
https://doi.org/10.2106/JBJS.G.01636
8. Saka G, Saglam N, Kurtulmus T, Avcı CC, Akpinar F, Kovaci H, et al. New inter-locking intramedullary radius and ulna nails for treating forearm diaphyseal fractures in adults: A retrospective study. Injury. 2014;45 Suppl 1:S16-S23.
https://doi.org/10.1016/j.injury.2013.10.040
9. Ozkaya U, Kilic A, Ozdogan U, Beng K and Kabukcuoglu Y.

Comparison between locked intramedullary nailing and plate osteosynthesis in the management of adult forearm fractures. Acta Orthop Traumatol Turc. 2009;43(1):14-20.
https://doi.org/10.3944/AOTT.2009.014

10. Grace TG, Eversmann WW Jr. Forearm fractures: Treatment by rigid fixation with early motion. J Bone Joint Surg Am. 1980;62(3):433-438.
https://doi.org/10.2106/00004623-198062030-00013
11. Hudak PL, Amadio PC and Bombardier C. Development of an upper extremity outcome measure: The DASH (disabilities of the arm, shoulder and hand) [corrected]. The upper extremity collaborative group (UECG). Am J Ind Med. 1996;29(6):602-608.
https://doi.org/10.1002/(SICI)1097-0274(199606)29:6<602:AID-AJIM4>3.0.CO;2-L
12. Anderson LD, Sisk D, Tooms RE and Park WI. Compression plate fixation in acute diaphyseal fractures of the radius and ulna. J Bone Joint Surg Am. 1975;57(3):287-297.
https://doi.org/10.2106/00004623-197557030-00001
13. Lee SK, Kim KJ, Lee JW and Choy WS. Plate osteosynthesis versus intramedullary nailing for both forearm bones fractures. Eur J Orthop Surg Traumatol. 2014;24(5):769-776.
https://doi.org/10.1007/s00590-013-1242-x
14. Zhang XF, Huang JW, Mao HX, Chen WB and Luo Y. Adult diaphyseal both bone forearm fractures: A clinical and biomechanical comparison of four different fixations. Orthop Traumatol Surg Res. 2016;102(3):319-325.
https://doi.org/10.1016/j.otsr.2015.11.019
15. Hidaka S and Gustilo RB. Refracture of bones of the forearm after plate removal. J Bone Joint Surg. 1984;66(8):1241-1243.
https://doi.org/10.2106/00004623-198466080-00012
16. Chapman MW, Gordon JE and Zissimos AG Compression-plate fixation of acute fractures of the diaphyses of the radius and ulna. J Bone Joint Surg Am. 1989;71(2):159-169.
https://doi.org/10.2106/00004623-198971020-00001
17. Gao H, Luo CF, Zhang CQ, Shi HP, Fan CY and Zen BF. Internal fixation of diaphyseal fractures of the forearm by interlocking intramedullary nail: Short-term results in eighteen patients. J Ortop Trauma. 2005;19(6):384-391.
https://doi.org/10.1097/01.bot.0000157911.76433.db
18. Weckbach A, BLattert TR and Weisser CH. Interlocking nailing of forearm fractures. Arch Orthop Trauma Surg. 2006;126(5):309-315.
https://doi.org/10.1007/s00402-006-0122-9
19. Zhao L, Wang B, Bai X, Liu Z, Gao H and Li Y. Plate fixation versus intramedullary nailing for both-bone forearm fractures: A meta-analysis of randomized controlled trials and cohort studies. World J Surg. 2017;41(3):722-733.
https://doi.org/10.1007/s00268-016-3753-1
20. Reinhardt KR, Feldman DS, Green DW, Sala DA, Widmann RF and Scher DM. Comparison of intramedullary nailing to plating for both-bone forearm fractures in older children. J Pediatr Orthop. 2008;28(4):403-409.
https://doi.org/10.1097/BPO.0b013e31816d71f2
21. Patel A, Li L and Anand A. Systematic review: Functional outcomes and complications of intramedullary nailing versus plate fixation for both-bone diaphyseal forearm fractures in children. Injury. 2014;45(8):1135-1143.
https://doi.org/10.1016/j.injury.2014.04.020
22. Shah AS, Lesniak BP, Wolter TD, Caird MS, Farley FA and Vander Have KL. Stabilization of adolescent both-bone forearm fractures: A comparison of intramedullary nailing versus open reduction and internal fixation. J Orthop Trauma. 2010;24(7):440-447.
https://doi.org/10.1097/BOT.0b013e3181ca343b

Authors' Contributions:
AB- Concept and design of the study and prepared first draft of manuscript; **KKS-** Interpreted the results; **AdB-** Reviewed the literature and manuscript preparation; and **PM-** Concept, coordination, statistical analysis and interpretation, preparation, and review of the manuscript.

Work attributed to:
Medical College and Hospitals, 88, College Street, Kolkata - 700 073, West Bengal, India.

Orcid ID:
Dr. Atin Biswas - https://orcid.org/0000-0001-9242-174X
Dr. Kanchan Kumar Sabui - https://orcid.org/0000-0002-6558-185X
Dr. Anindya Basu - https://orcid.org/0000-0002-9128-1797
Dr. Prasun Mandal - https://orcid.org/0000-0003-1517-5308

Source of Support: Nil, **Conflicts of Interest:** None declared.