International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 201-204

https://www.orthopaper.com
Received: 22-04-2023
Accepted: 17-06-2023

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A prospective analysis of both bone forearm diaphyseal fractures treated by compression plating in adults

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DOI: https://doi.org/10.22271/ortho.2023.v9.i3c.3428

Abstract
Objective: To evaluate the functional and radiological outcome of both bone forearm fractures treated with open reduction and internal fixation with compression plates and screws.
Materials and Methods: A prospective study of cases of both bone forearm fractures meeting the inclusion criteria who were admitted to Government Medical College, Thrissur between 1-01-2021 to 1-01-2022 was carried out. Anatomical reduction of fragments was attempted through open reduction and internal fixation using compression plates and screws. After a minimum follow-up period of 6 months, the functional and radiological outcomes were studied using the Anderson scoring system. The values were evaluated using Microsoft Excel Software.
Results: A series of 26 patients with both bone forearm fractures were studied comprising of 17 males and 9 females. The largest contribution came from the age group of 20-35 years (65%). Road Traffic Accidents were the most commonest mode of injury (69%). 2 cases were found to develop a post-operative infection. Postoperatively excellent scores were achieved in 20 cases (77%) and satisfactory results in 5 cases (19%) and 1 case (4%) showed unsatisfactory results. The average time of union of fracture was 10.23 weeks.
Conclusions: This single centre with a small to medium size population series demonstrated good to excellent results in the majority of patients after open reduction and internal fixation of both bone forearm fractures with compression plating in adults, with outcomes and complications comparable to other studies in the literature. This study supports the finding, that treatment of both bone forearm fractures by compression plating in adults results in an improved functional and radiological outcome.

Keywords: Plating, internal fixation, forearm fractures, functional and radiological outcome, Anderson scoring system

Introduction
Fractures of both radius and ulna constitute one of the most common injuries in the upper limb [1]. In today's world fast increasing industrialization and commercialization, increasing vehicular accidents, and sporting activities, the incidence of fractures of the bones of the forearm is increasing in frequency [2]. It is essential to reconstitute length, contact, axial alignment and normal rotational alignment while treating diaphyseal fractures of the radius and the ulna to gain a good range of motion, particularly, supination and pronation. The chances for the occurrence of malunion and non-union are higher due to the difficulties faced in reducing as well as maintaining the reduction of two parallel bones in the presence of the pronation and supination muscles, which have regulatory and rotatory influences [3].
For an optimal result, the basic rule is to achieve a stable and anatomic reduction with the preservation of mobility in the adjoining joints. [4] Internal reduction is generally required in maintaining reduction and helping in healing of such fractures. Healing occurs relatively after closed treatment but the occurrence of malunion with resultant decreased rotation of the forearm is fairly common and has been associated with poor outcomes. Loss of rotation hinders the function of the upper limb and activities of daily living [5].
The management of displaced fractures of shafts of radius and ulna in adults is primarily surgical [6]. The closed reduction and cast immobilisation for the displaced fractures is indicated only if there is a specific contraindication to operative treatment [7].

Open reduction and compression plating have become the treatment of choice for diaphyseal fractures of forearm bones in adults. Compression-plate fixation results in high union rates, low rates of complications and a satisfactory return of function of the limb. Thus excellent results of this method of treatment have been reported in many studies [8].

The AO (Association for the Study of Internal Fixation)-group has reported the successful use of compression plates and screws in the forearm shaft fractures in the earlier days of the advent of operative management of fractures. Since then it has been one of the most widely used and well-established methods of treating forearm bone fractures [8, 9]. The advantages of the plate and screw fixation are that the reduction is done under direct visualization with the plates being applied to achieve compression at the fracture site. Bone grafting can be done if required, in the presence of severe comminution and bone loss endangering the fracture to go into non-union or malunion.

The disadvantages are, the risks of any open surgical fixation that is higher chances of infection, disruption of the soft tissues, periosteal stripping, and loss of fracture hematoma [10]. This study aims at analysing the functional and radiological outcome of both bone forearm diaphyseal fractures treated with compression plating in adults.

Materials and Methods

Study population: All the patients attending the Orthopaedics Department of Government Medical College, Thrissur who sustained both bone forearm fractures treated with compression plating fulfilling inclusion criteria during the study period.

Inclusion criteria

1. Age 18 years and above.
2. Closed and Type 1 open fracture after wound healing.
3. Fresh fractures (1 to 15 days old) involving diaphyses of both radius and ulna.

Exclusion criteria

1. Pathological fractures.
2. Polytrauma with head chest and abdominal trauma.
3. Crush injuries.
4. Associated neurovascular injury.

Procedure

An informed written consent will be taken from all the patients involved in the study. A careful history and examination of injured forearm, anteroposterior and lateral radiographs will be obtained. The operative procedures, its benefits and risks will be explained in detail to all patients. All patients will be operated using standard operative guidelines. Patient being treated with plating will be followed up on 6th week, 3rd month and 6th month.

Study tool

1. A self-made questionnaire containing questions on socio-demographic details-age, gender, education and details of injury such as mode of injury, open/closed, another bony injury, head/chest trauma, associated neurovascular injury, follow-up examination and radiological findings.
2. Radiographs anteroposterior and lateral views at admission and postop, 6th week, 3rd month and 6th month abiding by the department protocol.
3. Functional outcome is evaluated using the Anderson scoring system in the 6t^{h} month [6].

Result	Union	Flexion and extension at the wrist joint	Supination and pronation
Excellent	Present	< 10° Loss	< 25% Loss
Satisfactory	Present	< 20 Loss	< 50% Loss
Unsatisfactory	Present	< 30° Loss	> 50% Loss
Failure	Non-union	with or without loss	of motion

Fig 1: Anderson Scoring System [6]

Results

In our present study of 26 patients, 20 to 62 years in our study and the mean age was 36.4 years with a standard deviation of 11.82. Most of the cases are between 20 to 35 years of age, i.e. 65%%. The least number of cases was seen in the range of 51 to 65 years, i.e. 16%.

Table 1: Age Distribution

Age (years)	Frequency	Percentage
20-35	17	65
36-50	5	19
51-65	4	16
Total	26	100

Among these 17 males and 9 females sustained both bone diaphyseal fractures and required compression plating. In this study, a maximum number of cases happened to be males, i.e. 65%. The sex ratio is nearly 1.9:1.

Table 2: Gender Distribution

Gender	Frequency	Percentage
Male	17	65
Female	9	35
Total	26	100

The most common mode of injury is found to be Road Traffic Accidents (RTA), 18 out of 26 cases i.e. 69%. Rest of the cases were due to slip and fall, 5 cases i.e. 19% and sports injury, 3 cases i.e. 12%

Table 3: Mode of Injury

Mode of Injury	Frequency	Percentage
RTA	18	69
Slip and fall	5	19
Sports Injury	3	12
Total	26	100

In our study, functional and radiological grading was done by the Modified Anderson scoring system. [6] It is based on flexion and extension of wrist joint as well as supination and pronation of the forearm and Radiographic results. There are four grades namely Excellent, Satisfactory, Unsatisfactory, and Failure. There was anatomical union in all 26 cases with the average time of union at 10.2 weeks.

In our study, based on Anderson scoring system [6], 20(77%) cases had excellent results, 5(19%) cases had satisfactory results and 1(4%) case had an unsatisfactory result.

Table 4: Functional and Radiological result

Result	Frequency	Percentage
Excellent	20	77
Satisfactory	5	19
Unsatisfactory	1	4
Failed	0	0
Total	26	100

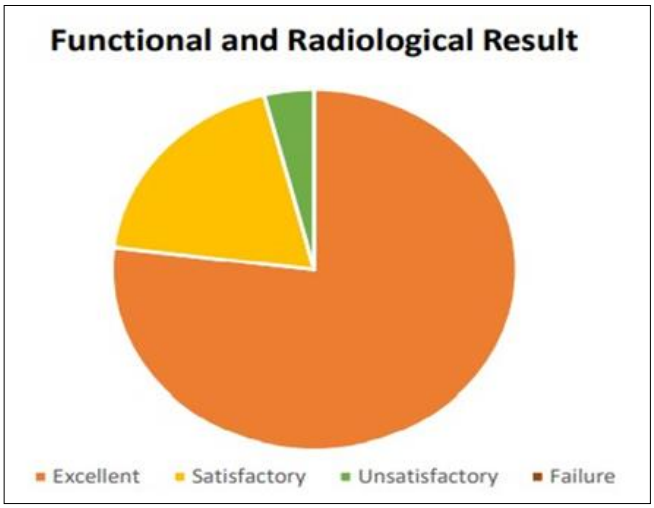

Fig 2: Functional and radiological outcome results

In our study, 2 (7%) cases developed an infection, treated by debridement and parenteral antibiotics.

Discussion

Fractures of both radius and ulna constitute one of the most common injuries in the upper limb [1]. In today's world fast increasing industrialization and commercialization, increasing vehicular accidents, sporting activities, the incidence of fractures of the bones of forearm are increasing in frequency [2]. It is essential to reconstitute length, contact, axial alignment and normal rotational alignment while treating diaphyseal fractures of the radius and the ulna to gain a good range of motion, particularly, supination and pronation. The chances for the occurrence of malunion and non-union are higher due to the difficulties faced in reducing as well as maintaining the reduction of two parallel bones in the presence of the pronation and supination muscles, which have regulatory and rotatory influences [3].

For an optimal result, the basic rule is to achieve a stable and anatomic reduction with the preservation of mobility in the adjoining joints. [4] Internal reduction is generally required in maintaining reduction and helping in healing of such fractures. Healing occurs relatively after closed treatment but the occurrence of malunion with resultant decreased rotation of the forearm is fairly common and has been associated with poor outcomes. Loss of rotation hinders the function of the upper limb and activities of daily living [5].

The management of displaced fractures of shafts of radius and ulna in adults is primarily surgical [6]. The closed reduction and cast immobilization for the displaced fractures is indicated only if there is a specific contraindication to operative treatment [7]. Open reduction and compression plating have become the treatment of choice for diaphyseal fractures of forearm bones in adults.

Compression-plate fixation results in high union rates, low rates of complications and a satisfactory return of function of the limb. Thus excellent results of this method of treatment have been reported in many studies [8].

MW Chapman, JE Gordon, AG Zissimos study on Compression-plate fixation of acute fractures of the diaphyses of the radius and ulna showed that 98% of fractures united and 92% had an excellent or satisfactory functional outcome. The infection rate was 2.3 per cent. Refractors occurred after the removal of an implant in two patients, but there were no refractors after the removal of a 3.5-millimetre plate. [11] L D Anderson, D Sisk, RE Tooms, WI Park 3rd study on Compression-plate fixation in diaphyseal fractures of the both bone forearm showed an overall union rate for the radius of 97.9 per cent and for the ulna, 96.3 per cent. [6] Leung *et al*. achieved excellent and good results in 98% of the patients who had undergone open reduction and internal fixation with DCP [12] Moed et al reported excellent and good results in 85% of the 50 patients who were managed with plate osteosynthesis. [13] Nonunion in six and deep infection in two were noted. Schemitsch *et al*. [14] reported excellent and good functional results in 80% of the 55 patients who were managed with plate osteosynthesis. Anderson *et al*. in 1975 published a case series of forearm fractures managed with compression plating. In a cohort of 244 patients, more than 95 percentage patients healed at an average of less than 2 months. [6] Goldfarb *et al*. studied the post-operative functional outcome after compression plating in adult forearm fractures correlated with the subjective patient-reported scores [20]. Bot *et al*. did a similar study in postoperative forearm fractures treated with compression plating and found that disability is more closely related to pain than objective outcome measures. [19] Lindvall and Sagi described the use of 4 cortex fixations on each side of a fracture and found similar outcomes to 6 cortex fixations on each side [18]. Mih *et al*. reviewed 175 patients treated with compression plating of the forearm fractures. In 62 patients, plates were removed at an average of 19 months after fixation. Of these patients, 58% reported no significant improvement after plate removal and 9% believed they were made worse than the previous state. The overall complication rate in patients who had the plates removed was significantly higher than that in the study group with retained devices (P 0.008). Refracture occurred in 11% of patients after removal of the implant. At an average of 6 months following the removal of implants, refractures in the device removal group occurred at the original site, distal to the plate location, or through a screw hole [17].

Conclusion

This single centre small to medium size population series demonstrated good to excellent results in the majority of patients after compression plating following diaphyseal forearm fractures, with outcomes comparable to other studies in the literature. This study corroborates the finding of other well-designed studies showing an association between radiographic and functional outcomes in a patient population with both bone forearm fractures as an improved outcome noted in those cases where good anatomical reduction could be achieved. This study also led to the conclusion that compression plating guarantees a high standard of reduction besides eliminating the chance of loss of reduction.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Financial support

Not available.

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How to Cite This Article
Sajeevkumar H, Manoj MK, Zacharias VB. A prospective analysis of both bone forearm diaphyseal fractures treated by compression plating in adults. International Journal of Orthopaedics Sciences. 2023;9(3):201-204.