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A study on management of both bone forearm fractures with dynamic compression plating

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Abstract
Background: Forearm diaphyseal fractures in adults are commonly encountered in orthopaedic practice. Operative treatment has become the gold standard in the management of these fractures. The purpose of this study was to evaluate the effectiveness of open reduction and internal fixation with dynamic compression plates in the management of both bone forearm fractures, in relation to achievement of union and functional results.
Methods: This was a prospective observational study conducted on 36 patients of either sex with an average age of 36.38 years presenting to the Orthopaedic department of SHKM Government Medical College Hospital, Nalhar, Nuh, Haryana between March 2016 and March 2018, with a diagnosis of fracture both bone forearm. All the patients underwent open reduction and internal fixation with dynamic compression plates. The patients were followed up for a period of 1 year. Anderson et al. scoring system was used for assessment of results.
Results: All the fractures united and the average time of union was 9.46 weeks. According to Anderson et al. scoring system, we had 30(83.33%) patients with excellent results, 4(11.11%) patients with satisfactory results, 1(2.78%) patient with unsatisfactory result and 1(2.78%) with failure.
Conclusions: Thus results of our study demonstrate that open reduction and internal fixation with dynamic compression plates is a safe and effective surgical procedure for the treatment of both bone forearm fractures.

Keywords: both bone forearm fracture, open reduction, internal fixation, dynamic compression plate, union

Introduction
Forearm fractures are one of the common musculoskeletal injuries encountered in orthopaedic practice. Forearm fractures can be regarded as articular fractures as slight deviations in the spatial orientation of the radius and ulna will significantly decrease the forearm's rotational amplitude and thereby impair the positioning and function of the hand. The relationship between the radius and ulna in the forearm is critical for function, especially pronation and supination. This relationship is so critical that the forearm has been called a functional joint. Malunited fractures can impair this functional joint, with resulting impairment of pronation and supination. It is important to re-establish length, alignment,and rotation for the forearm to maintain its dynamic function [1, 2, 3].
The diaphyseal fractures of the forearm in adults, are managed almost exclusively by surgical methods with little or no role of conservative methods of treatment. The goal of the surgical management of these fractures is to regain length, apposition, axial alignment and normal rotational alignment of the radius and the ulna to gain good range of pronation and supination. The various surgical modalities of treatment for these fractures include plate and screw fixation, intramedullary fixation and external fixation. Open reduction and internal fixation with plates and screws is now considered the treatment of choice for the management of diaphyseal forearm fractures in the adults. The effectiveness of this surgical technique in attainment of union and excellent functional results has been demonstrated by several studies [4, 5, 6], over the years. Dynamic compression plate designed first by Bagby and Denham[7] is an excellent implant for the fixation of forearm fractures. These plates produce compression at the fracture site, provide rigid stable fixation, have excellent rates of union and have been found to hasten rehabilitation with very little joint stiffness [8].
In the present study we evaluated the effectiveness of open reduction and internal fixation with dynamic compression plates in the management of both bone forearm fractures, through the assessment of attainment of union and functional results using the Anderson et al [4] scoring system.

Methods
After approval by the institutional ethics committee and informed written consent, the study was started. This was a prospective observational study conducted on 36 patients of either sex with an average age of 36.38 years presenting to the Orthopaedic Department of SHKM Government Medical College Hospital, Nalhar, Nuh, Haryana between March 2016 and March 2018, with a diagnosis of fracture both bones of the foerarm. The sex distribution was 20 males and 16 females.

Inclusion criteria

1. Age greater than 18 and less than 55 years.
2. Closed both bone forearm diaphyseal fractures.
3. Open grade 1 and 2 fractures.
4. Injury to presentation interval less than 3 weeks.

Exclusion criteria

1. Age less than 18 and greater than 55 years**.**
2. Open grade 3 fractures**.**
3. Injury to presentation interval greater than 3 weeks.
4. Fractures with intra-articular extension.
5. Monteggia and Galeazzi fractures.
6. Floating elbow injuries.
7. Poly-trauma patients.
8. Non-unions.

At presentation all the patients were thoroughly examined and neurovascular assessment of the limb was done. Standard anteroposterior and lateral radiographs of the injured forearm, along with the ipsilateral elbow and wrist joints were obtained. Above elbow plaster of Paris slab was applied. In the case of open fractures, thorough lavage of the wound with normal saline was done, intravenous antibiotics and tetanus toxoid were administered. The patients were admitted and preoperative anaesthetic checkup was done. The surgery was done as soon as the patients obtained anaesthetic clearance. The surgical procedure was explained to the patients in detail and informed written consent was taken.

Surgical technique

After administration of anaesthesia (regional anaesthesia in most of the patients, with general anaesthesia reserved for those patients in whom regional blockade could not be obtained), the patients were placed in supine position on a standard fluorescent operating table with the forearm resting on an arm rest. Tourniquet was applied. The painting and draping of the surgical site was done. Volar Henry approach was used for the distal radial shaft fractures, while dorsal Thompson approach was used for proximal fractures. The ulna was exposed using the subcutaneous approach. The radius was fixed first in most of the cases, while in cases in which radius was more communited than ulna, the ulna was fixed first. The fractures were exposed with minimal periosteal elevation and preservation of as much soft tissue as possible. The two fracture fragments were held by bone holding forceps and reduced into position by careful manipulation. Once the reduction was achieved, fixation was done by 3.5 mm low contact dynamic compression plates. The first screw in the plate adjacent to the fracture was inserted in the neutral hole while the second screw was inserted in an eccentric fashion away from the fracture to produce compression at the fracture site. Rest of the screws were inserted in the neutralization mode. At least four cortical purchase was achieved on either side of the fracture. In case of fractures with large butterfly fragments, lag screws were used to fix the fragments before application of the plate. Touniquet was deflated and haemostasis was achieved. Thorough lavage of the wounds was done and closure was done in the standard fashion, leaving the fascia open. Antiseptic dressing was done and the patient was shifted out of the operation theatre. The patients were advised about strict limb elevation. Standard postoperative care pathway was followed for these patients. Antiseptic dressing was done after 48 hours and anteroposterior and lateral radiographs of the forearm were obtained. The average duration of hospital stay was 3 days. At the time of discharge patients were instructed about physiotherapy and range of motion protocols. Range of motion exercises were started at 3 days after surgery. The patients were instructed to avoid lifting heavy weights till radiographic evidence of healing. The sutures were removed after 10 days of surgery. For the first 2 months, patients were asked to follow up at 2 week intervals and later on once a month for a period of 1 year following surgery. At the follow up examinations, standard AP and lateral radiographs of the forearm were taken. The fracture was defined as united if a minimum of 3 cortices showed obliteration of the fracture gap with trabeculae or bridging callus on radiographs. The patients were followed up for a period of 1 year and after this period all the data collected was subjected to analysis.

Statistical methods

The data was analysed with SPSS version 17.0 software. The demographic variables were assessed by number and percentage. Simple arithmetic mean was used for the description of the values of the time taken for union in weeks. Anderson et al. scoring system (Table1.) was used for assessment of results.

Table 1: Anderson et al. scoring system for assessment of functional outcome

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

Results

This was a prospective observational study. The fractures of most of the patients in this study united with an average duration of 9.46 weeks. According to Anderson et al. scoring system, we had 30(83.33%) patients with excellent results, 4(11.11%) patients with satisfactory results and 1(2.78%) patient with unsatisfactory result and 1(2.78%) with failure. Two patients developed superficial skin infections which resolved with antibiotics and local drainage. One patient had residual stiffness and more than 50% loss of supination and pronation, which improved with physiotherapy. One patient, who was a heavy smoker developed nonunion, and required revision plating and bone grafting for attainment of union.

Table 2: Age Distribution

Age in years	No. of patients	Percentage (%)
18-20	3	8.33
21-25	4	11.11
26-30	7	19.44
31-35	2	5.56
36-40	5	13.89
41-45	5	13.89
46-50	5	13.89
51-55	5	13.89
Total	36	100

Table 3: Sex Distribution

Gender	No. of patients	Percentage (%)
Male	20	55.56
Female	16	44.44
Total	36	100

Table 4: Table depicting the results of the study

Parameters	Mean age of the patients in years.	Mean time taken for union in weeks	Anderson et al criteria at follow up in various patients by number and percentage.			
			Excellent	Satisfactory	Unsatisfactoty	Failure
Values of the parameters	36.38	9.46	30(83.33 %)	4(11.11%)	1(2.78%)	1(2.78%)

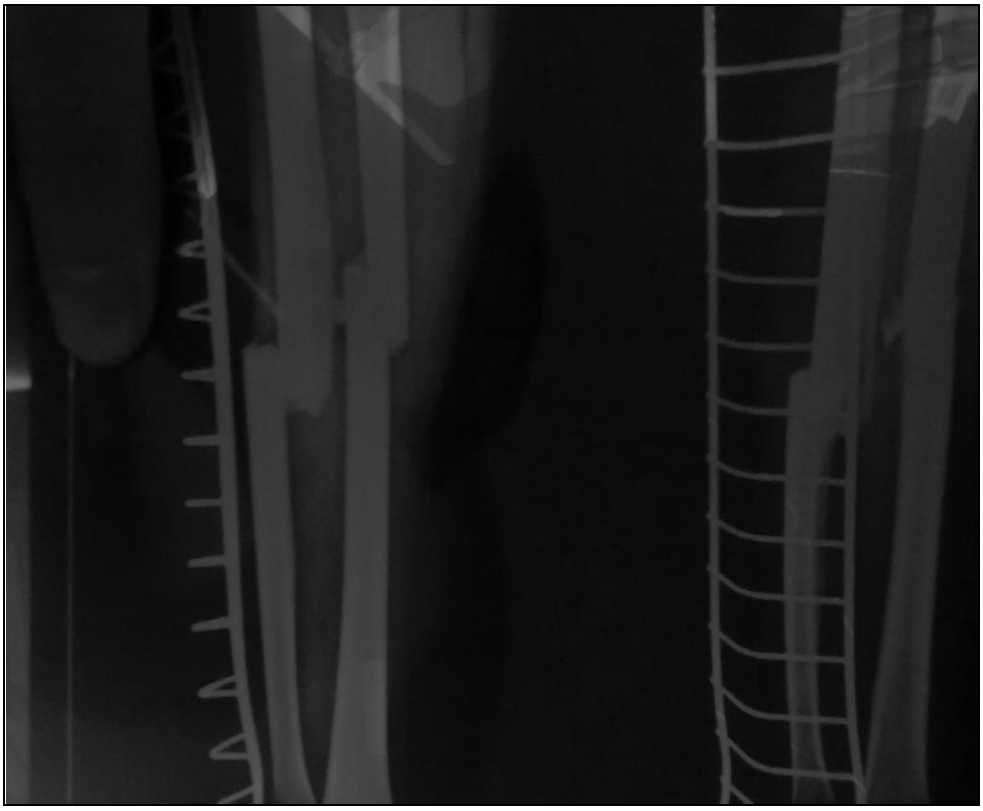

Fig 1: Anteroposterior and lateral radiographs of a both bone bone forearm fracture.

Fig 2: Anteroposterior and lateral view radiographs of another both bone forearm fracture.

Fig 3: Post-operative anteroposterior and lateral radiographs of a both bone forearm fracture, radial fracture with a butterfly fragment fixed with a lag screw and dynamic compression plate, while the segmental fracture of the ulna fixed with two dynamic compression plates.

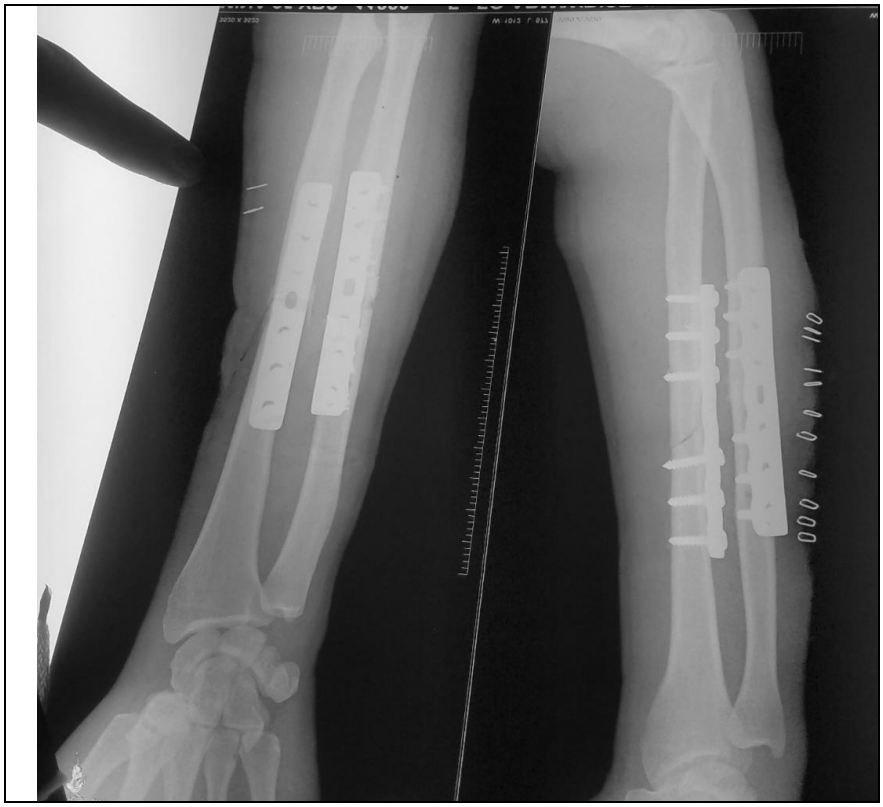

Fig 4: Postoperative anteroposterior and lateral radiographs of a both bone forearm fracture fixed with dynamic compression plates.

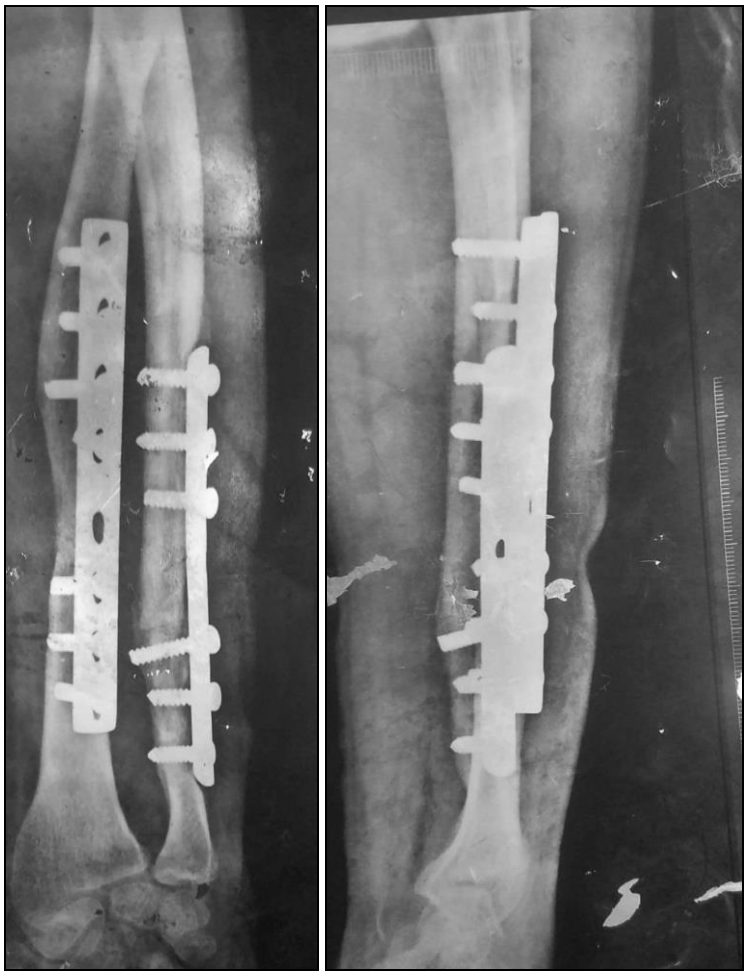

Fig 5: Follow up anteroposterior and lateral radiographs of a both bone forearm fracture fixed with dynamic compression plates, depicting union at the fracture sites.

Discussion

Open reduction and internal fixation with plates is now the gold standard in the management of most of the both bone diaphyseal forearm fractures in the adults. Dynamic compression plating (DCP) is used most commonly for these fractures, unless the bone is severely osteoporotic in which case fixation with locking plates[9] is preferred. The use of dynamic compression plating in the forearm fractures enables attainment of anatomical reduction, compression at the fracture site, excellent rates of union and early attainment of functional range of motion at the wrist, elbow and radioulnar joints [10, 11, 12].

In our present study we evaluated the effectiveness of open reduction and internal fixation with dynamic compression plates in the management of both bone forearm fractures, through the assessment of attainment of union and functional results. Anderson et al scoring system (Table 1.) was used for assessment of results. This was a prospective observational study conducted on 36 patients of either sex (Table 3.) with an average age of 36.38 years (Tables 2,4), with the diagnosis of fracture both bone forearm (Fig 1,2). All the patients underwent open reduction and internal fixation with dynamic compression plating (Fig 3,4). The fractures of most of the patients in this study united (Fig 5.) with an average duration of 9.46 weeks (Table 4.). According to Anderson et al. scoring system, the results (Table 4.) were excellent in 30(83.33%), satisfactory in 4(11.11%) unsatisfactory in 1(2.78%) and failure in 1(2.78%) patients respectively. Two patients developed superficial skin infections which resolved with antibiotics and local drainage. One patient had residual stiffness and more than 50% loss of supination and pronation, which improved with physiotherapy. One patient, who was a heavy smoker developed nonunion, and required revision plating and bone grafting for attainment of union.

The results of our study are quite comparable to other studies [13, 14, 15] done about this procedure. In the study by Saikia et al[13], the average taken for union in the LC-DCP group was 16.27 weeks, while the Anderson's criteria were excellent in 16(88%), satisfactory in 1(6%) and unsatisfactory in 1(6%) of the patients respectively, which compares quite favourably to our study. In the study by Ram mohan et al[14], the average time taken for union was 12 weeks, while the Anderson's criteria were excellent in 24 (80%), satisfactory in 4(13.32%), unsatisfactory in 1(3.33%) and failure in 1(3.33%) of the patients respectively, which is fairly comparable to our study. In the study by Pushkarna[15] the average time taken for union was 8.46 weeks, while the Anderson's criteria were excellent in 80%, satisfactory in 17% and failure in 3%) of the patients respectively which is quite comparable to our study.

Conclusion

From the above analysis, we can infer that open reduction and internal fixation with dynamic compression plating is a safe and effective surgical procedure for the management of both bone forearm diaphyseal fractures in adults with a high rate of union and excellent functional results.

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