International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2018; 4(1): 467-471

www.orthopaper.com
Received: 19-11-2017
Accepted: 20-12-2017

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Management of diaphyseal fractures of both bones of forearm by internal fixation using locking compression plate and screws

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DOI: https://doi.org/10.22271/ortho.2018.v4.i1g.69

Abstract
Background and objective: The fractures of both bones forearm are one of the commonest fractures found and can be treated by different methods. The accepted management for fractures of both bones forearm is open reduction and internal fixation using compression plating. The present study is undertaken to verify the claims made by the authors of the new design of the plate (LCP) and to learn the techniques, advantages and complication of the new method of internal fixation of forearm fractures.
Materials and methods: It is a prospective study which was carried out from November 2012 to October 2014 in Karnataka Institute of Medical Sciences, Hubli. In this study period 20 cases of fractures of both bones of forearm were treated by open reduction and internal fixation using Locking Compression Plate.
Results: In our series, majority of the patients were males, middle aged with road traffic accidents being the commonest mode of injury, involving middle third of forearm. Transverse or short oblique fractures were most common. All twenty ulna fractures and nineteen radius fractures united. Excellent results or full range of mobility of elbow and wrist joints were present in 15 patients(75%), 4(20%) patients having good range of movements and 1(5%) patient with failure.
Conclusion: The fixation with LCP for forearm fractures produces excellent results, the advantage being early mobilization, early union but the complication, duration of surgery and surgical techniques remains unchanged.

Keywords: Shaft of both bones of forearm fractures, LCP, Open reduction and internal fixation

Introduction
Forearm bone fractures are commonly encountered in adults in today's modern industrial era. While closed methods of reduction and immobilization by conservative methods may be successful in diaphyseal fractures of radius and ulna in children [1] same is not true in case of diaphyseal fractures of radius and ulna in adults. Fractures of the forearm bones may result in severe loss of function unless adequately treated. Mal-union and nonunion occur more frequently because of the difficulty in reducing and maintaining the reduction of two parallel bones in the presence of the pronating and supinating muscles that have angulating and rotational influences [2]. Because of these factors open reduction and internal fixation with plating is generally accepted as the best method of treatment for displaced diaphyseal fractures of the forearm in the adult [3].
In conventional plating, the actual stability results from the friction between the plate and the bone, which in turn may prevent periosteal perfusion [4, 5]. LCP allows for more rapid bone healing besides decreasing infection, bone resorption, delayed union/non-union and secondary loss of reduction [7]. But reports on the results of clinical application of LCP are few, especially on its efficacy, or superiority over other plates in the treatment of diaphyseal fractures of forearm bones [3]. Although LCPs have theoretical advantages, there is need for evaluating their efficacy through well-planned trials and accurate documentation. We aim to evaluate the use of LCPs in diaphyseal forearm fractures, as plate.

Objectives of study
1) To evaluate the results of treatment of displaced fractures of both bones of forearm treated by internal fixation with "locking compression plate and screws"

2) To note intraoperative and postoperative complications of management.
   To assess the efficacy and advantage of this treatment modality.

Methodology

The present study includes treatment of 20 cases of fractures of both bones of forearm by open reduction and internal fixation with 3.5 mm LCP between November 2012 to October 2014 at Karnataka Institute of Medical Sciences, Hubli.

Inclusion criteria

1. Age group adults (>18years)
2. Male and female patients.
3. Radiologically diagnosed closed fractures of both bones of forearm (Diaphyseal fractures of radius and ulna).
4. Consent to participate in the study.

Exclusion criteria

1. Open fractures of both bones of forearm.
2. Fractures of both bones of forearm with compartment syndrome needing fasciotomy.
3. Fractures of both bones of forearm needing vascular repair.
4. Fractures of both bones of forearm associated with distal radius/ulna.
5. Refusal to provide informed consent.

The general condition of the patient and the vital signs were recorded. Head to toe examination was done to rule out fractures at other sites. Local examination of injured forearm revealed swelling, deformity and loss of function. Any nerve injury was looked for and noted. Palpation revealed abnormal mobility, crepitus and shortening of the forearm. Distal vascularity was assessed by radial artery pulsations, capillary filling, pallor and paraesthesia at finger tips. Radiographs of the radius and ulna i. e., anteroposterior and lateral views, were obtained. The elbow and wrist joints were included in each view. The limb was then immobilized in above elbow Plaster of Paris slab with sling.

The patient was taken for surgery after routine investigations and after obtaining fitness for surgery. The investigations done are as follows: Hb%, Blood group, RBS, Blood urea, Serum creatinine, HIV, HBSAg, ECG and chest radiograph. Proximal radius was approached by dorsal Thompson incision and volar Henry approach was used for middle and distal radius. A narrow 3.5mm LCP was used and a minimum of 6 cortices were engaged with screw fixation in each fragment.

Operative procedure

- Type of anaesthesia: General anaesthesia was used in 12 cases and brachial block in 8 cases.
- Pneumatic tourniquet was applied and time noted.
- Painting and draping of the part done.
- The Radius was approached using either dorsal Thompson/volar Henry's approach. For proximal radius shaft fractures, dorsal Thompson approach was preferred and for mid and distal radius fractures, volar Henry's approach was preferred. Ulna was approached directly over the subcutaneous border.
- The internervous plane in volar Henry's approach is proximally between brachioradialis muscle (radial nerve) and pronator teres (median nerve) and distally between brachioradialis muscle (radial nerve) and flexor carpi radialis muscle (median nerve).
- The internervous plane in dorsal Thompson approach is proximally between extensor carpi radialis brevis (radial nerve) and extensor digitorum communis (posterior interosseous nerve) and distally between extensor carpi radialis brevis (radial nerve) and extensor pollicis longus muscle (posterior interosseous nerve)
- The internervous plane for subcutaneous approach to ulna is between extensor carpi ulnaris (posterior interosseous nerve) and flexor carpi ulnaris (ulnar nerve).
- The bone which was less comminuted and more stable was fixed first and later the other bone was fixed.
- After identifying the fracture ends, periosteum was not elevated and fracture ends were cleaned.
- With the help of reduction clamps fracture was reduced and held in position. The plate was then applied after contouring if required.
- For upper third radial fractures, the plate was fixed dorsally. For middle third, the plate was fixed dorsolateral and for distal radial fractures the plate was fixed on the volar aspect. In ulnar fractures, plate was applied over the posteriolateral surface of ulna.
- A drill sleeve for locking screw is fixed in the hole, near the fracture site, and 2.7 mm drill bit is use to drill both the cortex of the bone, the sleeve is removed and the screw length is measured with depth gauge.
- A 3.5 mm locking screws are then inserted, as the locking screws are of self tapping, tapping of the screw hole is not done.
- After adaptation of the fragments, a screw hole for axial compression is drilled in the fragment which forms an acute angle near the plate. Here the load guide is used with the arrow pointing towards the fracture line to be compressed. At this position, a lag screw will be inserted for axial compression in case of short oblique fractures.
- The lag screw is applied by subsequently over drilling (3.5mm) the near cortex to create a gliding hole. The lag screw and remaining screws are inserted.
- Once stable fixation is achieved and hemostasis secured meticulously, the wound is closed in layers over a suction drain and sterile dressing is applied.

Follow-up

All the patients were followed up at monthly intervals for first 3 months and evaluation was done based on "Anderson *et al*" scoring system. Elbow movements and wrist movements were noted and the union was assessed radiologically.

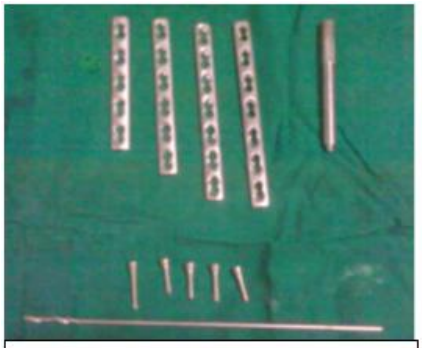
The fracture was designated as united when there was presence of periosteal callus bridging the fracture site and trabeculation extending across the fracture line.

"Anderson *et al*" scoring system (1975) is as follows:

Table 1: Anderson Scoring System

Results	Union	Flexion/Extension At Elbow Joint	Supination And Pronation
Excellent	Present	$<10^0$ Loss	$<25^0$ Loss
Satisfactory	Present	$<20^0$ Loss	$<50^0$ Loss
Unsatisfactory	Present	$>20^0$ Loss	$>50^0$loss
Failure	Non union with or without loss of motion		

Operative photographs



3.5mm LCP, drill sleeve, locking screws and drill bit

Position of patient

Fracture fragments exposed and reduced

Final plate and screw placement

PREOPERATIVE X-RAY

POSTOPERATIVE X-RAY

Results

The present study consists of 20 cases of fracture both bones of the forearm. All the cases were openly reduced and internally fixed with 3.5mm LCP. The study period was from November 2012 to October 2014.

Age distribution

The age of these patients ranged from 18-75years with fracture being most common in 3rd and 4th decade and an average age of 42.1years.

Sex distribution

Out of 20 patients, 16 patients (80%) were males and 4 patients (20%) were females.

Side affected

There were 12(60%) patients with right forearm fracture and 8(40%) patients with left forearm fracture.

Mode of injury

There were 11(55%) patients with history of road traffic accidents, 7(35%) patients with history of fall and 2(10%) patients with history of assault.

Fracture characteristics

1) Clinical: All the fractures were closed injuries.
2) Level of fracture:

Majority of the fractures were seen in the mid diaphysis of both bones of forearm. 10(50%) patients had mid diaphysial fractures, 4(20%) patients had proximal third fractures and 6(30%) patients had lower third fracture of both bones of forearm

Duration of fracture union

The fracture was considered united when there were no subjective complaints, radiologically when the fracture line was not visible. Those fractures which healed after 6 months without an additional operative procedure was considered as delayed union. Fractures which did not unite after six months or that needed an additional operative procedure to unite was considered as non-union. 19 patients (95%) had sound union in less than 6 months, one (5%) of the patients had non union.

Table 2: Criteria for Evaluation of Results

Results	Union	Flexion/Extension At Elbow Joint	Supination And Pronation
Excellent	Present	$<10^0$ Loss	$<25^0$ Loss
Satisfactory	Present	$<20^0$ Loss	$<50^0$ Loss
Unsatisfactory	Present	$>20^0$ Loss	$>50^0$loss
Failure	Non Union With Or Without Loss Of Motion		

Table 3: Functional Results

Results	No. Of Patients	Percentage
Excellent	15	75
Satisfactory	4	20
Unsatisfactory	-	-
Failure	01	05

Postoperative complications

1. Superficial infection
2. Neuropraxia
3. Non union

Discussion

Fracture both bones of forearm presents a formidable challenge to the orthopaedicians as the various muscle forces acting upon the fracture tend to displace it. Hence to provide the functional rehabilitation of the upper limb, anatomic reduction and rigid fixation is mandatory. This is achieved by open reduction and internal fixation with dynamic compression plate and screws [8].

The present study was undertaken to determine the efficacy of LCP in the treatment of fractures of both bones of the forearm. A total of 20 patients of fractures of both bones of forearm were treated with open reduction and internal fixation using 3.5mm LCP.

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment. Our analysis is as follows.

Age distribution

- In our study, diaphyseal fractures of radius and ulna was commoner in the third and fourth decade, with average age of 42.1 years (18-75years).
- H. Nevile Burwell and A.D. Charnley in 1964 witnessed 50% of the patients between second and third decade and an average of 44.8 years [26].

Sex distribution

Our series had male preponderance with 80% male patients and 20% female patients which was comparable to previous studies.

H. Dodge in his study noted about 89% males and 11% females [18].

Mode of injury

- In our series 55% of cases had road traffic accidents, 35% had fall and 10% had direct blow (assault). Our series is comparable to Grace *et al*., and Smith series as mode of injury.
- Smith noted about 45% of his cases were due to RTA, 36% were due to fall and 19% were due to industrial accidents [51].

Extremity affected

- We accounted about 60% incidence of fracture both bones in right extremity
- M. W. Chapman reported about 55% incidence of fractures of both bones in right extremity [21].

Time of union

- Anderson's criteria for evaluation of union were taken into account. In our series we had an average union time of 12.95 weeks with range of 10 to 18weeks. We had 100% union of ulna and 95% union of radius.

Complications

- In our series we had 2 cases of superficial infection which resolved with appropriate antibiotics.
- 2 cases of neuropraxia immediately following surgery. Patient was treated conservatively and there was spontaneous resolution of the nerve injury.
- One patient developed non union of radius fracture due to plate loosening which was treated with implant removal and intramedullary nailing with bone graft.

Conclusion

The present study was conducted to assess the outcome of LCP plating in fractures of both bones forearm.

We conclude as follows:-

- Fractures of both bones of forearm in adults are commoner in third and fourth decade of life. Male predominance in the high incidence of fractures may be due to manual working and outdoor activities.
- Majority of the fractures were transverse/short oblique in the middle shafts of both bones forearm and were due to vehicle accidents/fall.
- The 3.5mm LCP, properly applied, is an excellent method for internal fixation of fractures of the forearm bones.
- Use of tourniquet, separate incisions for radius and ulna and preservation of the natural curves of radius will lessen the rate of complications.
- These fractures have to be fixed as early as possible and it is important to achieve anatomical reduction and stable internal fixation for excellent functional outcome.
- A minimum of 6 cortices have to be fixed on each fracture fragment.
- After LCP fixation, postoperative support, given in the form of arm pouch in most instances, can be discontinued after the soft tissues have healed and rapid return to full, painless motion can be anticipated.
- Most of the fractures united within 4 months.
- LCP plating of both bones forearm produces excellent results when applied properly.

To obtain excellent results: proper preoperative planning, minimal soft tissue dissection, adherence to AO principles, strict asepsis, proper postoperative rehabilitation and patient education are mandatory.

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