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Surgical management of fracture both bone forearm in adult using limited contact dynamic compression plate

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Abstract
Background and objectives: The forearm represents a critical anatomic unit of the upper limb, permitting the effector organ of the upper limb, the hand, to perform multi axial daily activities of living. Historically, the closed management of forearm fractures has been met with poor functional outcome in adults, hence perfect fracture reduction and rigid fixation is mandatory and achieved by plating.
Conservative treatment has resulted in malunion, nonunion, synostosis and ultimately poor functional outcome [1]. Hence the present study was undertaken to provide satisfactory functional outcome and to know the advantage and complications of the newer plate design, the LC-DCP.
Materials and methods: The present study was conducted in Department of Orthopaedics at Sri Siddhartha medical college, hospital and Research Center Tumkur during the period from August 2014 and July 2016. A total of 32 patients attending the hospital during the study period with closed diaphyseal fracture of both bones forearm aged more than 18 years who were medically fit for surgery were included in the study.
Results: In this study, Males were predominant with left forearm affection more than right. Most of the fractures were due to road traffic accidents and fall. The average age was 33.5 years with fracture being most common in second and third decade. Most of fractures both bones forearm were located in the middle third and the fracture pattern, transverse/short oblique was commonest. 32(100%) Radius and 32(100%) ulna united within 6 months. The results were based on Anderson *et al*, scoring system and in our study there were 26 (81%) patients with excellent results, 6 (19%) patients with satisfactory results.
Conclusion: Our study shows that LC-DCP 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

Keywords: Both bone forearm fractures, LC-DCP

Introduction
The forearm represents a critical anatomic unit of the upper limb, permitting the effector organ of the upper limb, the hand, to perform multi axial daily activities of living. Historically, the closed management of forearm fractures has been met with poor functional outcome in adults, hence perfect fracture reduction and rigid fixation is mandatory and achieved by plating [2].
The number of forearm fractures is increasing faster than the predicted rate due to rapid industrialization, increased incidence of violence, road traffic accidents and various sports activities.
With conventional plating, the screw acts as an anchor, with its axial" force being exploited to press the plate against the bone, this produces large frictional force at the bone plate interface when the construct is loaded, and this force has been shown to cause vascular disturbances, especially in the periosteum. This observation has prompted the development of the limited contact dynamic compression plate (LC-DCP), which decreases the bone contact area to approximately 50% of the total area of the under surface of the plate [3].
Conservative treatment has resulted in malunion, nonunion, synostosis and ultimately poor functional outcome [1]. Hence the present study was undertaken to provide satisfactory functional outcome and to know the advantage and complications of the newer plate design, the LC-DCP.

Methods

The present study was conducted in Department of Orthopaedics at Sri Siddhartha medical college, hospital and Research Center Tumkur during the period from August 2014 and July 2016. A total of 32 patients attending the hospital during the study period with closed diaphyseal fracture of both bones forearm aged more than 18 years who were medically fit for surgery were included in the study.

Methodical examination was done to rule out fractures at other sites. Local examination of injured forearm revealed swelling, deformity, abnormal mobility, crepitus, shortening, and loss of function. Any neuro vascular injury was looked for and noted.

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 up for surgery after the thorough pre operative work up including routine investigation.

Proximal radius was approached by dorsal Thompson incision and volar Henry approach was used for middle and distal radius. Subcutaneous approach was used for the ulna. A narrow 3.5mm LC DCP was used and a minimum of 6 cortices were engaged with screw fixation in each fragment.

Post operatively a crepe bandage was applied over affected forearm and limb elevation given with the instruction of active finger movement. Drain removed after 24-48 hours and arm pouch given. Wound inspected on 3-4 days. Antibiotics and analgesics used for initial five days. check X-rays in anterioposterior and lateral were obtained. Sutures removed on 10 day and discharged with the advice not to lift any weight or exert the operated forearm.

All the patient followed up at monthly interval for first 3 months and later every six months and evaluation was done based on "Anderson *et al*" scoring system. Movements of elbow, wrist and forearm were noted clinically and union assessed radilogically.

Aims and objectives

Aim of the study

To provide early and complete functional activity of the upper extremity.

Objectives

- To provide early and complete functional activity of the upper extremity.
- To study advantage and complication of the newer plate design, LC-DCP.
- To verify the hypothesis that use of the LC-DCP device for the treatment of diaphyseal fractures of the forearm results in better bone healing and decreased complications.

Inclusion Criteria

- Patients with diaphyseal fractures of both bones of forearm
- Patients above the age of 18 years
- Patients fit for surgery.

Exclusion Criteria

- Compound fractures of forearm bones
- Patients not willing for surgery
- Patients medically unfit for surgery

Incision

- **Ulnar shaft:** Parallel and slightly volar to the subcutaneous crest of the ulna.
- **Radial shaft:** Dorsal Thompson approach and Volar Henry's approach.

Operative procedure

- Type of anaesthesia: General anaesthesia was used in 14 cases and brachial block in 6 cases.
- Pneumatic tourniquet was applied: Time noted.
- Painting and draping of the part done.
- The Radius was approached using either dorsal Thompson/Volar Henrys approach. For proximal radius and mid shaft fractures, dorsal Thompson approach was preferred and for distal radius fractures Volar Henry's approach was preferred. Ulna was approached directly over the subcutaneous border.
- The bone which was less comminuted and more stable was fixed first and later the other bone was fixed,[4]
- 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.
- A plate of at least 6 holes was chosen and longer plates were used in spiral, segmental and comminuted fractures
- 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 posterior surface of ulna[5].
- Using the neutral drill guide, the first screw is applied to the fragment, which forms an obtuse angle with the fracture near the plate. The resulting space between the fracture plane and plate under surface guides the opposite fragment towards the plate. The arrow of the neutral drill guide points towards the fracture. 2.5mm drill bit is used for drilling a hole through both cortices and with depth gauge, appropriate 3.5mm screw length is determined, 3.5mm drill tap used before screw insertion[5].
- 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.
- 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.
- The contour between the plate and the screw head of the eccentrically placed screw moves the screw head towards the center of the plate and thus moves the fragment into the same direction. In case of porotic, comminuted and/or small bones, long screws and/or a longer plate were used.
- Once stable fixation is achieved and hemostasis secured meticulously, the wound is closed in layers over a suction drain and sterile dressing is applied.

After treatment

Postoperatively a crepe bandage was applied over the affected forearm and arm pouch was given. The patient was instructed to keep the limb elevated and move their fingers and elbow joint. Suction drain was removed after 24-48 hours. Wound was inspected after 3-4 days postoperatively. Antibiotics and

analgesics were given to the patient till the time of suture removal. Suture/staples removed on 10th postoperative day and check X-ray in anteroposterior and lateral views were obtained.

Later patient were discharged after suture/staple removal with the forearm in arm pouch and advised to perform shoulder, elbow, wrist and finger movements. Patients were advised not to lift heavy weight or exert the affected forearm.

Follow-up

All the patients were followed up at monthly intervals for first 3 months and evaluation was done based on "Anderson *et al*[6]" 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.

Results

Age distribution

The age of these patients ranged from 18-55 years with fracture being most common in 2nd and 3rd decade and an average age of 33.5 years.

Sex distribution

Out of 32 patients, 24 patients (75%) were males and 8 patients (25%) were females showing male preponderance because of working in factories, fields, traveling and sports.

Side affected

There were 22(69%) patients with left forearm fracture and 10(31%) patients with right forearm fracture.

Mode of injury

In our study, there were 25(78%) patients with road traffic accidents, 5(16%) patients with fall and only 2(6%) patients with assault.

Type of the fracture

Majority 81.25% of the fractures were transverse/short oblique. About 18.75% of fractures were comminuted.

Duration of fracture union

The fracture was considered as 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.

all patients(100%) had sound union in less than 6 months, non of the patients had delayed union or nonunion.

Final results according to Anderson *et al* criteria Using the Anderson *et al* scoring system we had 26(81%) patients with excellent results, 6(19%) patients with satisfactory results.

There were no cases of intraoperative complications.

Postoperative complications

1. **Superficial Infection:** Three patient developed superficial infection. Infection was controlled with appropriate antibiotics after culture and sensitivity report.
2. **Posterior interosseous nerve injury:** Immediate postoperative (Proximal radius fracture fixation), one patient developed transient posterior interosseous nerve injury. Patient was treated with static cock up splint which recovered in a span of about 1 1/2 months.

In our study we noted the duration of surgery for fixation of both bones forearm ranged from 60-90 min, with average time of 77 min. The tourniquet time ranged from 40-60 min, with average time of 54 min.

Discussion

- A study (56 cases) by A S Rao *et al*, showed excellent results were obtained (75 %, 42 cases), good(12.5%,7), fair(12.5%,7) with one infection and delayed union each when fixed with DCP [7].
- G Sahni *et al*, concluded that Open Reduction and Internal Fixation with Dynamic Compression Plate (ORIF with DCP) still has a prospect in repair of forearm fractures considering its low complication rate, cost and acceptable results in developing country like India where financial matter and non availability of C-arm image intensifier are to be considered [8].
- R K Meena *et al*, concluded that the newly developed Locking compression plate (LCP) consists of self compression plate and screw system where the screw are locked in the plate. This locking minimizes the compressive forces exerted on the bone by the plate. This means that the plate need not touch bone surface at all [9].
- KB Ravi *et al*, finalized in their study that the locking compression plating of diaphyseal bones produced excellent results, the advantages being early mobilization, early union and hence prevention of fractures disease. The only disadvantage is that it is more expensive than the Dynamic compression plate [10].
- A Ali *et al*, stated at the end of their study that open reduction and internal fixation of adult forearm shaft fractures using small Dynamic Compression Plate was associated with a high rate of success. Conclusion being results with this type of plate are comparable with the newer and more expensive implants [11].
- Overall there have been many studies with either results between LCP and LC-DCP
- Our study convinces that 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

Conclusion

We conclude

Fractures of both bones of forearm in adults are commoner in second and third decade of life. Males predominant in the high incidence of fractures 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 LC-DCP, properly applied, is an excellent method for internal fixation of fractures of the forearm bone.
- Use of tourniquet, separate incisions for radius and ulna and preservation of the natural curves of radius will lesser 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 has to be fixed on each fracture fragment.

- After LC-DCP 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 fracture united within 4 months.
- LC-DCP 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

Table 1: Age distribution

Age	No. of. Patients	Percentage
18-20	1	3
21-30	3	10
31-40	12	37
41-50	13	40
51-60	3	10
Total	32	100

Table 2: Sex Incidence

Sex	No. of patients	Percentage
Male	24	75
Female	8	25
Total	32	100

Table 3: Side of Fracture

Side affected	No. of patients	Percentage
Right forearm	22	69
Left forearm	10	31

Table 4: Mechanism of Injury

Mode of injury	No. of patients	Percentage
RTA	25	78
Fall	5	16
Assault	2	6
Total	32	100

Table 5: type of fracture

Type of fracture	Radius	Ulna	Percentage
Transverse/short oblique	26	26	72.5
Comminuted	6	6	25
Segmental	---	--	2.5
Total	20	20	100

Table 6

Level of fracture	No. of patients	Percentage
Proximal third	2	6.25
Middle third	25	78
Distal third	5	15.75
Total	32	100

Table 7: duration of fracture union

Time of union	No. of patients	Percentage
< 4 months	26	81
4-6 months	6	19
6 months- 1 year	——	——
Non union	—	——
Total	20	100

Table 8: results

Results	No. of patients	Percentage
Excellent	26	81
Satisfactory	6	19
Unsatisfactory	-----	—
Failures	——	——

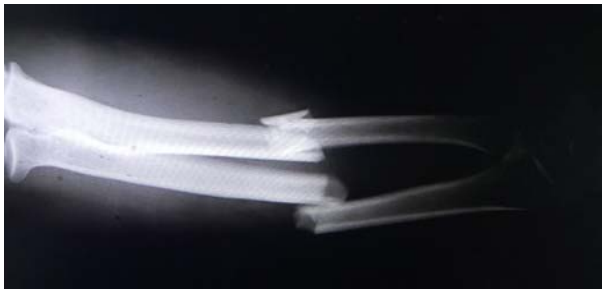
Complications

Table 9: Complications

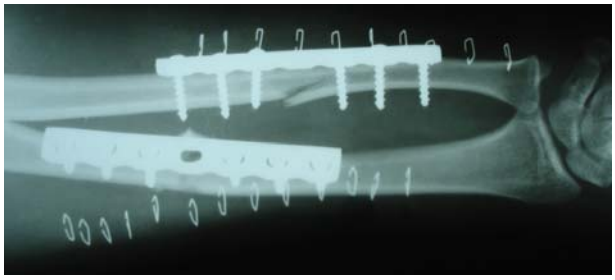
Complications	No. of cases	Percentage
Superficial infection	3	9
Posterior interosseous nerve injury	1	3
Total	4	12

Photos

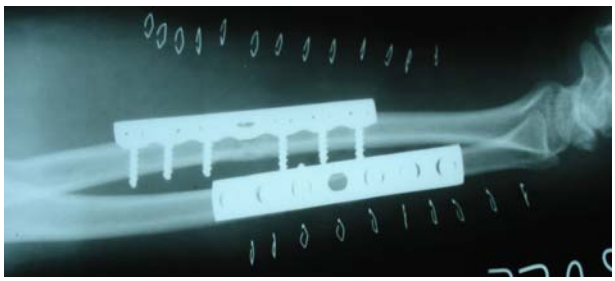
Case 6 (Pre op)



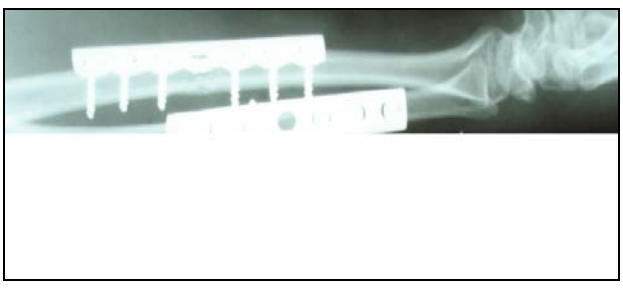
Case 6 (1st Follow up)



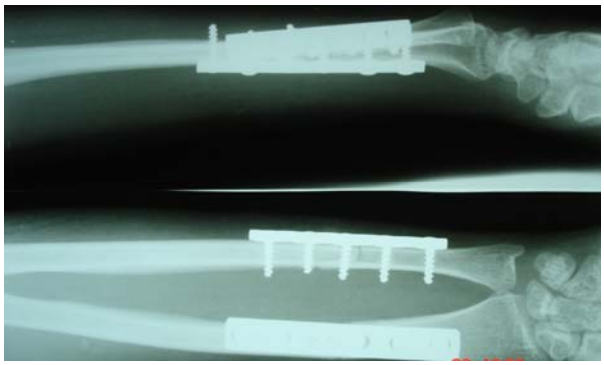
Case 6 (2nd Follow up)



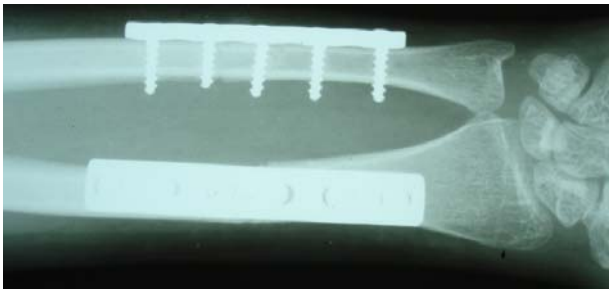
Case 6 (Final Follow up)



Case 8 (Immediate post op)



Case 8 (Final follow up)



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Declarations
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Conflict of interest: none
Ethical approval: Approved by ethical committee

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