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Original Research Article

Retrospective Study to Evaluate the Functional Outcome of Both Bone Forearm Fractures with Locking Compression Plate

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Conflict of interest: Nil

Abstract

Aim: The objective of the study was to evaluate the functional outcome of both bone forearm fractures with locking compression plate.

Methods: This retrospective study was conducted in the Department of Orthopedics, Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India for the period of 5 months. A total of 50 patients were included in our study. The study was conducted after obtaining written informed consent from the patient and patient attenders and patients who met the inclusion and exclusion criteria were studied.

Results: Our study population age ranged from 18 to 60 years, 18 years being the youngest patient and 60 years our oldest patient. Mean age of our study population was 31.3 years. Majority of the patients belonged to 21-30 and 51-60 years age group (24%). There were 60% male and 40% females. About 56% of the participants (n = 28) had a fracture on the left side and 44% of the participants (n = 22) had a fracture on the right side. About 15 participants (30%) had a mid-diaphysis fracture, 5 participants (10%) had a fracture at the upper one-third, and the remaining 30 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 30 (60%), 13 (26%) were short oblique type, 5 (10%) were comminuted type, and 2 (4%) was segmental fracture type. About 15 participants (30%) had a mid-diaphysis fracture, 5 participants (10%) had a fracture at the upper one-third, and the remaining 30 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 30 (60%), 13 (26%) were short oblique type, 5 (10%) were comminuted type, and 2 (4%) was segmental fracture type. A road traffic accident was a common cause of injury in the study population constituting 21 (42%), followed by fall while playing in 13 (26%), self-falls in 11 (22%), and fall from height in 5 (10%).

Conclusion: The incidence of both bone fractures is more in this modern era and if it is treated conservatively the results are poor and so require a stable fixation to achieve fracture union with good functional outcome. Hence ORIF with LCP is a safe and effective option in the fixation of both bone forearm.

Keywords: bone forearm, locking compression plate, open reduction, internal fixat

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Introduction

The use of bone-implant constructs through interfragmentary compression may result in devascularization of bone fragments and delayed fracture healing. Over the past 2 decades, new implants have been devised to minimize the bone-implant contact area. The point contact fixator (PC-Fix) was developed in which the epicortical locking head screws can be locked into the screw hole on the plate. [1] No compression of the plate on the bone is required. In a randomized controlled study, both the PC-Fix and the limited contact dynamic compression plate (LC-DCP) were found to be

effective in the treatment of forearm fractures, despite being different in fixation concept. [2] The locking compression plate (LCP) was devised by combining the features of an LC-DCP and a PC-Fix. [3] Each of the screw holes allows insertion of a conventional screw or a locking head screw, as it has features of both a smooth sliding compression hole and a threaded locking hole.

Higher prevalence of malunion and non-union associated with the fractures of the forearm makes the management challenging and complicated, but improvised surgical techniques have revolutionized the management and help in overcoming these challenges. [4] Lessons from the clinical applications and compression plating and internal fixation lead to the development of an implant system that combines different therapeutic modalities that help in regaining length, positioning, and alignment of the fractured bones. Locking compression plate (LCP) is a product of latest plating techniques, designed to have advantages of performing surgery with a minimal length of incision, preserving and retaining blood supply to the bone and adjacent soft tissues. In addition, providing stability at the fracture site is also an added advantage, a disappointing factor with other techniques. Reddy et al [5] reported that the use of LCP in forearm fractures is an ideal procedure as stable fixation along with early union is ensured. LCP has features of both LC-dynamic compression plate (DCP) and a point contact fixator [2,3] as it uses screw heads that are conically threaded on the undersurface and create an angular stable plate screw device.

Surgical treatment options include both rigid plate fixation and Titanium Elastic Nailing System (TENS). [6,7] Recently, there has been an increased interest in determining patient-reported functional outcomes. A few reports have shown that Disabilities of the Arm, Shoulder, and Hand (DASH) and Short Musculoskeletal Function Assessment (SMFA) questionnaires correlated well with reduced range of motion of wrist and forearm. In this context, we intend to assess functional outcomes in children with both bone fractures of the forearm undergoing open reduction and internal fixation using a validated functional outcome instrument. [8,9]

The objective of the study was to evaluate the functional outcome of both bone forearm fractures with locking compression plate.

Materials and Methods

This prospective study was conducted in the Department of Orthopedics, Government Medical College and Hospital, Bettiah, West Champaran, Bihar, India for the period of 5 months. A total of 50 patients were included in our study. The study was conducted after obtaining written informed consent from the patient and patient attenders and patients who met the inclusion and exclusion criteria were studied.

Inclusion Criteria

1. Age above 18 years of age
2. Closed fractures
3. Transverse/short oblique and comminuted fractures

Exclusion Criteria

1. Open fractures
2. Segmental fractures and grossly comminuted fractures
3. Intra-articular extension
4. surgically unfit patients
5. Polytrauma
6. Multiple co-morbidities affecting outcome

Patients examined clinically and assessed the mechanism of injury and severity of trauma and evaluated to rule out other associated injuries and examined locally to assess the extent of swelling, deformity, abnormal mobility, crepitus, limb length discrepancy and distal neurovascular examination. X- Ray of radius and ulna (shaft) AP and lateral view were taken and also both elbow and wrist joints were taken separately both the views. The affected limb was immobilized with above elbow plaster slab with arm sling. All routine pre- operative investigations were done and pre-anesthetic fitness obtained.

Operative Procedure

After patient positioning, painting and draping tourniquet was inflated. Radius was exposed with Henry's approach, fracture ends identified and edges freshened and after reducing the fracture a 3.5 mm LCP was used and minimum of 6 cortices were engaged with screws. Ulna was approached directly on the subcutaneous border of the shaft.

After the exposure fracture ends are identified and edges are freshened with periosteum elevator and reduction was done with bone holding clamp. After reduction 3.5 mm LCP plate was applied and plate was selected with at least 6 holes and in comminuted or segmental fractures plate of more than 6 in holes was selected. The plate fixation in the upper third of the radius is on dorsal side, middle third dorsolateral side and distal third on the volar aspect. In ulnar fractures plate applied over posterior surface of ulna. [10]

The drill sleeve was fixed in the locking screw slot near to the fracture site and drilled both cortices with 2.7mm drill bit, screw length was assessed with depth gauge after removing drill sleeve, 3.5 mm locking screws were inserted. The remaining screws were inserted in the same manner. The radius is fixed first followed by the ulna and drain placed and

wound closure done. Compression bandage applied with crepe bandage and arm pouch was used and patient advised limb elevation and active finger movements. Suction drain was removed on post-op day 3 and antibiotics and analgesics given and on day 5 post-op check x-ray in Antero-posterior and lateral views done.

Post-operative rehabilitation/protocol

Patient discharged on day 5 and was kept on above short arm slab for 2 weeks and suture removal done on 14th post-op day. All the patients followed up at monthly intervals and evaluated as per Anderson et al scoring system 8. The movements of elbow and wrist joint was assessed until fracture union.

The fracture is considered to be united when there is obliteration of fracture gap with presence of periosteal bridging callus seen on radiograph. Delayed union is considered when union ensues without any operative intervention but takes more than 6 months for union. Non-union: Fracture failed to unite without any intervention. Criteria for functional results The Criteria of Anderson et al[11] were used in grading the functional outcome, which is as follows

Results	**Union**	**Flexion Extension At Elbow**	**Supination And Pronation**
Excellent	Present	< 10 deg loss	<25 % loss
Satisfactory	Present	<20 deg loss	<50% loss
Unsatisfactory	Present	>20 deg loss	>50 % loss
Failure	Nonunion or unresolved chronic osteomyelitis.		

Statistical Analysis

Statistical analysis was made using the software SPSS 20. Difference was considered significant when the p value was < 0.05.

Results

Table 1: Patient details

Age	**N (%)**
18-20	8 (16)
21-30	12 (24)
31-40	10 (20)
41-50	8 (16)
51-60	12 (24)
Gender	
Male	30 (60)
Female	20 (40)
Side of Injury	
Right	22 (44)
Left	28 (56)

Our study population age ranged from 18 to 60 years, 18 years being the youngest patient and 60 years our oldest patient. Mean age of our study population was 31.3 years. Majority of the patients belonged to 21-30 and 51-60 years age group (24%). There were 60% male and 40% females. About 56% of the participants (n = 28) had a fracture on the left side and 44% of the participants (n = 22) had a fracture on the right side.

Table 2: Fracture site, fracture pattern and mechanism of injury in the study participants

Fracture site	**Frequency**
Proximal one-third region, *n* (%)	5 (10)
Middle one-third region, *n* (%)	15 (30)
Distal one-third region, *n* (%)	30 (60)
Fracture pattern	
Transverse fracture, n (%)	30 (60)
Short oblique fracture, n (%)	13 (26)
Comminuted fracture, n (%)	5 (10)
Segmental fracture, *n* (%)	2 (4)
Mechanism	

Self-fall, *n* (%)	11 (22)
Fall from height, *n* (%)	5 (10)
Fall while playing, *n* (%)	13 (26)
Road traffic accident, *n* (%)	21 (42)

About 15 participants (30%) had a mid-diaphysis fracture, 5 participants (10%) had a fracture at the upper one-third, and the remaining 30 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 30 (60%), 13 (26%) were short oblique type, 5 (10%) were comminuted type, and 2 (4%) was segmental fracture type. A road traffic accident was a common cause of injury in the study population constituting 21 (42%), followed by fall while playing in 13 (26%), self-falls in 11 (22%), and fall from height in 5 (10%).

Table 3: Description of the mean range of motion at elbow and radioulnar joints in the study participants

	4 weeks (mean ± SD)	8 weeks (mean ± SD)	12 weeks (mean ± SD)	24 weeks (mean ± SD)
In degrees				
Flexion at elbow (Active)	112 ± 34	124 ± 32	132 ± 34	144 ± 38
Extension at elbow (Active)	22 ± 6	19 ± 5	10 ± 5	1 ± 2
Flexion at elbow (Passive)	115 ± 34	126 ± 30	138 ± 32	149 ± 34
Extension at elbow (Passive)	17 ± 5	14 ± 4	7 ± 3	0 ± 1
Supination	69 ± 27	75 ± 25	78 ± 16	88 ± 12
Pronation	57 ± 23	65 ± 20	75 ± 20	87 ± 18
Palmar flexion	45 ± 17	56 ± 18	64 ± 16	69 ± 18
Wrist dorsiflexion	47 ± 20	66 ± 18	78 ±20	87 ± 18

There was a significant restriction in the movements at the elbow and radioulnar joints following the injury and fixation. The mean flexion (active) at the elbow improved from 112° at four weeks to 144° at 24 weeks. A restriction of about 22° in elbow extension at four weeks normalized to 0° at 24 weeks. The degree of pronation was more compromised than supination. However, both significantly improved over 24 weeks of the postoperative period. The range of palmar flexion improved from 44° at four weeks to 69° at 24 weeks. The range of wrist dorsiflexion improved significantly over time from 47° at four weeks to 87° at 24 weeks.

Table 4: Complications

Complications	Frequency, *n* (%)
Delayed union	2 (4)
Skin irritation	2 (4)

Complications were found among 4 (8%) patients out of 30 patients.

Discussion

Both bone forearm fractures in adults are most commonly encountered fractures in day to day practice accounting for almost 31% of all upper limb fractures. [12] The forearm consists of radius, ulna, interosseous membrane with proximal and distal radioulnar joint and helps in supination and pronation movements. Radius and ulna articulate with one another at proximal and distal radioulnar joints, the stability of which is an essential pre requisite for long term functional outcome after injury. [13] Both bone forearm fractures if not treated properly will result in severe loss of function, hence appropriate management of such injuries is necessary to achieve proper range of movements and a good functional outcome. Closed reduction and cast immobilization of forearm fractures have yielded poor results as reported up to 92 % of cases owing to malunion, nonunion or synostosis. [14-16]

Our study population age ranged from 18 to 60 years, 18 years being the youngest patient and 60 years our oldest patient. Mean age of our study population was 31.3 years. Majority of the patients belonged to 21-30 and 51-60 years age group (24%). There were 60% male and 40% females. About 56% of the participants (n = 28) had a fracture on the left side and 44% of the participants (n = 22) had a fracture on the right side. About 15 participants (30%) had a mid-diaphysis fracture, 5 participants (10%) had a fracture at the upper one-third, and the remaining 30 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 30 (60%), 13 (26%) were short oblique type, 5 (10%) were comminuted type, and 2 (4%) was segmental fracture type. About 15

participants (30%) had a mid-diaphysis fracture, 5 participants (10%) had a fracture at the upper one-third, and the remaining 30 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 30 (60%), 13 (26%) were short oblique type, 5 (10%) were comminuted type, and 2 (4%) was segmental fracture type. A road traffic accident was a common cause of injury in the study population constituting 21 (42%), followed by fall while playing in 13 (26%), self-falls in 11 (22%), and fall from height in 5 (10%). However, Kc et al., in a study done in 2013, reported that the incidence of fracture is higher on the left side because the left side is usually non-dominant and used as a protective function while the patients fall on the ground. [17]

The mean flexion (active) at the elbow improved from 112° at four weeks to 144° at 24 weeks. A restriction of about 22° in elbow extension at four weeks normalized to 0° at 24 weeks. The degree of pronation was more compromised than supination. However, both significantly improved over 24 weeks of the postoperative period. The range of palmar flexion improved from 44° at four weeks to 69° at 24 weeks. The range of wrist dorsiflexion improved significantly over time from 47° at four weeks to 87° at 24 weeks. There was a significant improvement in the range of motion in the elbow and radioulnar joints at 12 weeks and 24 weeks following TENS. This finding is similar to the systematic review done by Westacott et al., which compared the functional outcomes following intramedullary nailing or plate and screw fixation of pediatric diaphyseal forearm fractures. [18] The improvement in range of motion was significant over time in patients who underwent intramedullary nailing. The overall complication rate in our study was 6%, which is similar to the rates described by Kc et al.17 According to criteria by Price et al., 90% showed excellent outcomes, 7% showed good outcomes, and 3% showed fair outcomes. [19]

This procedure is not free from drawbacks; the surgeon has no tactile feedback as to the quality of screw purchase into the bone as he tightens the screw. As the screw locks in the plate, all screws abruptly stop advancing when the threads are completely seated in the plate regardless of bone quality. Current locking plate designs can be used to maintain fracture reduction but not to obtain it. The fracture must be reduced and limb alignment, and length and rotation must be set properly before placement off any locked screws. The inability of the surgeon to alter the angle of the screw within the hole and still achieve a locked screw is a problem that needs to be addressed. Any attempt to contour locked plates could potentially distort the screw holes and adversely affect screw purchase.

Conclusion

The incidence of both bone fractures is more in this modern era and if it is treated conservatively the results are poor and so require a stable fixation to achieve fracture union with good functional outcome. Hence ORIF with LCP is a safe and effective option in the fixation of both bone forearm.

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