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Original Research Article

Functional Outcomes Following Locking Compression Plate Surgery for Bilateral Forearm Fractures: A Prospective Study

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Abstract

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

Methods: This prospective study was conducted in the Department of Orthopaedics, Jawahar Lal Nehru Medical College and Hospital, Bhagalpur, Bihar, India. A total of 100 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 32.4 years. Majority of the patients belonged to 21-30 and 51-60 years age group (25%). There were 64% male and 36% females. About 55% of the participants (n = 55) had a fracture on the left side and 45% of the participants (n = 45) had a fracture on the right side. 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 142° 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 45° at four weeks to 68° at 24 weeks. The range of wrist dorsiflexion improved significantly over time from 47° at four weeks to 87° at 24 weeks. Complications were found among 7 (7%) patients.

Conclusion: Stable fixation is needed to establish fracture union and satisfactory function. Thus, ORIF with LCP may safely and effectively repair both bone forearms.

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

Introduction

The forearm has a complex anatomical architecture consisting of two parallel, mobile bones providing a stable link between the wrist and elbow. Diaphyseal fractures of the radius and ulna, commonly referred to as both bone forearm fracture, is one of the most common fractures among children, accounting for about 32% of all fractures. [1,2] As it serves as the origin of several muscles of the hand, restoration of forearm rotation, elbow and wrist movements, and grip strength following the fracture is facilitated by anatomic reduction and internal fixation. Historically, the majority of these fractures have been treated with nonoperative management relying on closed reduction and casting. [3-6]

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. [7] 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 [8] 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 [9,10] as it uses screw heads that are conically threaded on the under surface and create an angular stable plate screw device. This type of plate fixation relies on the threaded plate-screw interface to lock the bone fragments in position and does not require friction between the plate and bone as in conventional plating.

The Open reduction and internal fixation (ORIF) in adults with plating is the standard procedure for both bone forearm fractures and isolated radius/ulna fracture with or without bone grafting. As recommended by AO association internal fixation with dynamic or locking compression plate gives rigid fixation, impaction and compression at the fracture site. The advantage of using a locking plate construct gives us good amount of versatility in screw placement, the screw head locks securely to the plate thereby increasing the inherent stability of the fixation. Locking plates also for minimize the amount of soft tissue dissection required (periosteum left intact) thereby aiding in better fracture union. This new concept is more closely related to the concept of pure splinting. Plating gives rigid internal fixation and compression for diaphyseal forearm fractures to achieve union and restore functional movements in the forearm. [11]

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 Orthopaedics, Jawahar Lal Nehru Medical College and Hospital, Bhagalpur, Bihar, India from March 2018 to Feb 2019. A total of 100 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-aricular 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 immobilised with above elbow plaster slab with arm sling. All routine pre-operative investigations were done and pre-anaesthetic 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. [12]

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 [13] were used in grading the functional outcome, which is as follows.

Results	Union	Flexion Extension AtElbow	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

Data was analysed using Microsoft Excel (2010). Results were expressed as mean, frequency and range. Tables and figures were used as required. Subjective assessment was done using the Quick DASH score. 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	15 (15)
21-30	25 (25)
31-40	20 (20)
41-50	15 (15)
51-60	25 (25)
Gender	
Male	64 (64)
Female	36 (36)
Side of Injury	
Right	45 (45)
Left	55 (55)

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 32.4 years. Majority of the patients belonged to 21-30 and 51-60 years age group (25%). There were 64% male and 36% females. About 55% of the participants (n = 55) had a fracture on the left side and 45% of the participants (n = 45) 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* (%)	12 (12)
Middle one-third region, *n* (%)	28 (28)
Distal one-third region, *n* (%)	60 (60)
Fracture pattern	
Transverse fracture, n (%)	60 (60)
Short oblique fracture, n (%)	25 (25)
Comminuted fracture, n (%)	10 (10)
Segmental fracture, *n* (%)	5 (5)
Mechanism	
Self-fall, *n* (%)	23 (23)
Fall from height, *n* (%)	12 (12)
Fall while playing, *n* (%)	25 (25)
Road traffic accident, *n* (%)	40 (40)

About 28 participants (28%) had a mid-diaphysis fracture, 12 participants (12%) had a fracture at the upper one-third, and the remaining 60 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 60 (60%), 25 (25%) were short oblique type, 10 (10%) were comminuted type, and 5 (5%) was segmental fracture type. A road traffic accident was a common cause of injury in the study population constituting 40 (40%), followed by fall while playing in 25 (25%), self-falls in 23 (23%), and fall from height in 12 (12%).

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)	114 ± 36	125 ± 30	130 ± 32	142 ± 36
Extension at elbow (Active)	23 ± 6	18 ± 5	10 ± 5	1 ± 2
Flexion at elbow (Passive)	116 ± 34	127 ± 30	139 ± 32	148 ± 32
Extension at elbow (Passive)	18 ± 5	14 ± 4	7 ± 3	0 ± 1
Supination	68 ± 22	76 ± 24	77 ± 16	88 ± 12
Pronation	58 ± 22	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 142° 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 45° at four weeks to 68° 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	3 (3)
Skin irritation	4 (4)

Complications were found among 7 (7%) 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. [14] 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. [15] 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. [16-18]

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 32.4 years. Majority of the patients belonged to 21-30 and 51-60 years age group (25%). There were 64% male and 36% females. About 55% of the participants (n = 55) had a fracture on the left side and 45% of the participants (n = 45) had a fracture on the right side. About 28 participants (28%) had a mid-diaphysis fracture, 12 participants (12%) had a fracture at the upper one-third, and the remaining 60 patients (60%) had a lower one-third fracture of the radius and ulna. The majority of the fractures were transverse 60 (60%), 25 (25%) were short oblique type, 10 (10%) were comminuted type, and 5 (5%) was segmental fracture type. A road traffic accident was a common cause of injury in the study population constituting 40 (40%), followed by fall while playing in 25 (25%), self-falls in 23 (23%), and fall from height in 12 (12%). 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. [19]

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 142° 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 45° at four weeks to 68° at 24 weeks. The range of wrist dorsiflexion improved significantly over time from 47° at four weeks to 87° at 24 weeks. 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. [20] 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. [21]

Complications were found among 7 (7%) patients. 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 present study concluded that incidence of both bone fractures is more in this modern era when these fractures are managed conservatively, the outcomes tend to be unsatisfactory. Therefore, it is necessary to use stable fixation methods in order to promote fracture union and produce favourable functional results. Therefore, open reduction internal fixation (ORIF) with locking compression plate (LCP) is a secure and efficient alternative for stabilising fractures in the bones of the forearm.

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