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Functional outcome of locking compression plating in diaphyseal fractures of radius and ulna

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Abstract

Background & Objectives: Forearm fractures are regarded as articular fractures as slight deviations in spatial orientation of the radius & ulna will significantly decrease the forearm's rotational range thus disturbing positioning & functioning of the hand. Conservatively done reduction of these fractures results in a poor functional outcome. Hence perfect reduction is essential in maintaining the rotation which is achieved by open reduction & internal fixation with plate & screws. The present study is undertaken to learn the techniques assess the advantages, functional outcome and complication of the new method of internal fixation of diaphyseal fractures of radius & ulna.

Materials & Methods: A prospective study involving 20 cases was carried out from September 2015 to September 2017 at Bapuji Hospital and Chigateri General Hospital attached to JJM Medical College, Davangere. These cases involving fracture both bone forearm was treated with open reduction & internal fixation using Locking Compression Plating. Functional outcome was assessed using Anderson *et al.* criteria scoring system (1975).

Results: In this study, majority of the patients were males, middle aged, with road traffic accidents being the commonest mode of injury, involving middle third of both bones of forearm. Majority of our cases had fracture union within 14 weeks with no cases of failure or non-union and most of the patients returned to their routine activities within 16 weeks of surgery. There was no major complication in our study. Excellent or full range of mobility of elbow and wrist joints was present in 15 patients (75%) and 5 (25%) patients had good range of movements.

Conclusion: The open reduction and internal fixation with LCP of forearm fractures produce 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 fractures are common due to Road Traffic Accidents (RTAs) & industrial accidents and 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 range thus disturbing the positioning and function of the hand. Imperfect treatment of fractures of the radius and ulna diaphysis leads to a loss of motion as well as muscle imbalance and poor hand function. Maintenance of parallel relation of radius and ulna with closed reduction is difficult due to constantly acting supinating & pronating muscles over these bones and thus results in a poor functional outcome with unsatisfactory results reported in up to 92% of cases, usually due to mal-union, nonunion, or synostosis.

Currently, Open Reduction and Internal Plate-Screw Fixation is generally accepted as the gold standard treatment of diaphyseal forearm fractures. In conventional plating, the actual stability results from the friction between the plate and the bone, which in turn may hamper periosteal perfusion. The limited contact dynamic compression plates (LC-DCP) was said to reduce the bone-plate contact by approximately 50% to minimize the disruption of periosteal blood vessels beneath the plate. However, it still relied on the plate-bone interface for stability and the problem of confluent contact areas was not completely resolved. Point Contact Fixator (PC-Fix), which did not have surface contact with the bone but only point contacts was developed later on.

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Locking compression plate (LCP) was devised by combining the features of a LC-DCP and a PC-Fix as it uses screw-heads that are conically threaded on the undersurface and create an angular stable plate screw device, the aim of which is to achieve the smallest surgical incision and to preserve blood supply to the bone and adjacent soft tissues and provide stability at the fracture site with minimal periosteal vasculature interference.

The LCP design allows for more rapid bone healing besides decreasing infection, bone resorption, delayed union/non-union and secondary loss of reduction. This type of plate fixation relies on the threaded plate-screw interface to lock the bone fragments in position and do not require friction between the plate and bone as in conventional plating.

The present study was undertaken to evaluate the use of LCPs in fractures of forearm bones at our institute. The functional outcome was evaluated using Anderson *et al.* scoring system in which the variables taken into consideration were union of the fracture and range of elbow and wrist movements.

Materials & Methods

As per Convenience Sampling Method, (N=19) so 20 patients having diaphyseal fractures of both bones forearm, admitted in Bapuji Hospital and Chigateri General Hospital attached to J.J.M. Medical college, Davangere were taken for study after obtaining their consent.

Inclusion criteria

- Patients above 18 years of age, with diaphyseal fractures of both bones forearm, fit for surgery, who have given their consent for the procedure and with no previous forearm injuries, surgeries or any other pathology.

Exclusion criteria

- Fractures in patients less than 18 years, fracture with compartment syndrome needing fasciotomy, fracture needing vascular repair, not willing to provide informed consent, not willing for surgery, medically unfit for surgery and with previous surgeries, tumors, infection, forearm muscle contractures.

On admission of the patient, they were assessed clinically to evaluate the general condition and the local injury. Neuro-vascular status assessment was done followed by x-rays in taken in both AP & Lateral views. Fractures were stabilized in above elbow plaster of paris slab and the medically fit patients were taken for surgery after obtaining informed and signed consent.

Operative procedure: Done under General anesthesia/ brachial block with patient in supine position.

For distal radius fractures, Henry's Volar approach ^[1] and for proximal radius and mid shaft fractures, Thompson's approach ^[1] was used. For upper third radial fractures, the plate was placed on dorsal aspect. For middle third, the plate was fixed dorso-lateral & for distal radial fractures the plate was fixed on the volar side. Ulna was approached directly over the subcutaneous border and plate was applied over the posterior surface of ulna.

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 stripped and fracture ends were cleaned. With the help of reduction clamps fracture was reduced and held in position. A 3.5mm LCP plate of at least 6 holes was chosen and longer

plates were used in spiral, segmental and comminuted fractures applied after contouring if required. 3.5 mm conventional cortical screw was inserted to secure the plate on no the bone temporarily. Based on fracture configuration second screw inserted was either cortical to achieve inter fragmentary compression or locking screw for bridging of fragments respectively. For second conventional screw to achieve compression the load guide is used with arrow pointing towards the fracture line to be compressed. A 3.5 mm locking screw is then inserted, as the locking screws are of self-tapping, tapping of the screw hole is not done. Once stable fixation is achieved and hemostasis achieved precisely, the wound is closed in layers over a suction drain and sterile dressing is applied.

Post-operative care: Posterior slab was continued or arm pouch was given depending upon the requirement. Limb is elevated and active movement of the fingers is encouraged. Check X ray AP and Lateral view was taken at that time. Antibiotics and analgesics were continued till the time of suture removal which was done on 10-12 postoperative day. On discharge patients were advised physiotherapy of shoulder, elbow, wrist and finger movements. Patients were cautioned against lifting heavy weight or exert the affected forearm till there is radiological evidence of fracture union. All the patients were followed up at monthly intervals for first 3 months then at 6 months. Union of fracture was considered when there were no subjective complaints, radiologically no fracture line could be seen. Functional outcome evaluation was done based on Anderson *et al.* scoring system (1975) ^[2].

Results

In this study 20 patients with displaced forearm fractures were treated by open reduction and internal fixation with 3.5 mm Locking compression plate (LCP).

Age distribution: The age of patients ranged from 18-65 years with the fracture being most common in 3rd & 4th decade with average age of 37.05 years.

Table 1: Age wise distribution

Age in Years	No. of patients	Percentage
18-20	1	5%
21-30	3	15%
31-40	6	30%
41-50	6	30%
51-60	3	15%
61-70	1	5%
Total	20	100%

Sex distribution: Out of 20 patients, 14 patients (70%) were males & 6 (30 %) were females showing male predisposition to fractures with 55% having Right sided fracture while 45% had Left sided fracture.

Table 2: Sex distribution

Sex	No. of patients	Percentage
Male	14	70%
Female	6	30%
Total	20	100%

Mode of injury: There were 10 (50%) patients sustaining fractures due to RTAs, 6 (30%) due to fall, 3 (15%) due to assault and 1 (5%) due to Trauma at work place.

Table 3: Mode of injury

Mode of injury	No. of patients	Percentage
Road Traffic Accidents	10	50
Fall	6	30
Assault	3	15
Trauma	1	5
Total	20	100

Level of fracture: Majority fractures in this study were middle 1/3, 14 (70%) of both bones of forearm, 4 (20%) fractures were proximal 1/3 and 2 (10%) were in distal 1/3 segment.

Table 4: Fracture level

Level of Fracture	No. of Patients	Percentage
Proximal third	4	20
Middle third	14	70
Distal third	2	10
Total	20	100

Table 5: Fracture pattern

Type of fracture	Radius	Ulna	Percentage
Transverse/Oblique	16	13	72.5
Wedge	3	5	20
Comminuted	1	2	7.5
Total	20	20	100

Table 6: Based on AO Classification

AO Type	22.A3.1	22.A3.2	22.B3.1	22.B3.2	22.B3.3	22.C1.2	22.C1.3	22.C2.2	22.C2.3	22.C3.1	22.C3.2	22.C3.3
Number	2	6	2	1	0	1	2	5	1	0	0	0

Table 7: Duration of Fracture Union

Time of union	No. of cases	Percentage
<4 months (16 wks.)	16	80
4-6 months (16-24 wks.)	4	20
Non-Union	0	0
Total	0	100

Functional evaluation was assessed using Anderson *et al.* Criteria Scoring System (1975) [2];

In this study we had - 15 (75%) Excellent and 5 (25%) Satisfactory results.

Table 8: Functional outcome

Results	No. of patients	Percentage
Excellent	15	75
Satisfactory	5	25
Unsatisfactory	0	0
Failure	0	0

Table 9: Complications

Complications	No. of patients	Percentage
Superficial infection	1	5
Radial Artery injury	1	5
Total	2	10

Table 10: Comparison of Age Distribution in previous studies and the present study

Series	Minimum Age (Yrs.)	Maximum Age (Yrs.)	Average Age (Yrs.)
H.N Burnwell [14]	16	57	44.8
Herbert Dodge [3]	13	59	24
Chapman <i>et al.</i> [17]	13	79	33
Moed B. R [4]	14	65	22
F. Leung [6]	11	90	36
Sharma <i>et al.</i> [7]	15	60	34
Saikia <i>et al.</i> [13]	16	60	30.5
Ibrahim Azboy <i>et al.</i> [11]	16	74	28
Meena <i>et al.</i> [8]	18	64	31.15
SPS Gill <i>et al.</i> [12]	18	60	32.4
KB Ravi [15]	18	56	38.6
Present Study	18	65	37.05

Sex distribution: The current study had male preponderance with 70% males & 30% females which was comparable to previous studies. Male preponderance could be due to

Intraoperative complication of Radial Artery injury was encountered in one case. Post operatively one patient developed superficial wound infection on Post-Operative day 5. No other complications encountered in the present study.

Discussion

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 range thus disturbing the positioning and function of the hand. Imperfect treatment of fractures of the radius and ulna diaphysis leads to a loss of motion as well as muscle imbalance and poor hand function. The present study was undertaken to evaluate the use of LCPs in 20 fractures of forearm bones at our institution and the outcome was analyzed and compared with the previously conducted studies as follows.

Age distribution: In the present study, diaphyseal fractures of radius & ulna were common in 3rd & 4th decade, with an average age of 37.05 years. (18-65 years) which was comparable to previously conducted studies.

involvement of males in outdoor activities, industrial labour and sports activities as compared to their female counterparts.

Table 11: Comparison of sex distribution in previous studies and the present study

Series	Males (%)	Females (%)
Dodge	89	11
Chapman <i>et al.</i>	78	22
William	67	33
F. Leung	82.6	17.4
Sharma <i>et al.</i>	86.6	13.3
Saikia <i>et al.</i>	70	30
Ibrahim Azboy <i>et al.</i>	77.27	22.7
KB Ravi <i>et al.</i>	87.5	12.5
SPS Gill <i>et al.</i>	73.07	28.92
Vijay Kumar Angadi <i>et al.</i>	90	10
Present Study	70	30

Mode of injury: In the present study, RTA (50%), fall (30%) and miscellaneous (assault + workplace trauma) = (20%).

Table 12: Comparison of Mode of Injury in previous studies and the present study

Series	Accident %	Fall %	Miscellaneous %
Moed <i>et al.</i>	70	14	16
Grace <i>et al.</i> [5]	45	22	33
Smith <i>et al.</i>	45	36	19
Sharma <i>et al.</i>	63.6	36.7	-
Meena <i>et al.</i>	50	30	20
Claudio Iacobellis <i>et al.</i> [10]	36.2	29.8	34
Present study	50	30	20

Extremity affected

In present study Right extremity was affected in 55% & 45 % was involving left extremity.

Table 13: Comparison of Side Affected due to fracture in previous studies and the present study

Series	Right (%)	Left (%)
H, N Burnwell [14]	50	50
M.W Chapman	55	45
Meena <i>et al.</i>	61	39
Claudio Iacobellis <i>et al.</i> [10]	38.2	61.7
SPS Gill <i>et al.</i> [12]	53.8	46.1
KB Ravi <i>et al.</i> [15]	55	45
Present Study	55	45

Fracture anatomy: a) Type of fracture

In present study, 72.5% were Transverse (Type AO/ASIF A),

20% were comminuted (Type AO/ASIF C) & 7.5% were wedge (Type AO/ASIF B).

Table 14: Comparison of Anatomy of fracture sustained in previous studies and the present study

Series	Transverse (AO/ASIF Type A)	Wedge (AO/ASIF Type B)	Comminuted (AO/ASIF Type C)
Chapman	53 %	-	47 %
Leung <i>et al.</i>	37.5%	46.8%	15.6%
Sharma <i>et al.</i>	76.7%	23.3%	-
SPS Gill <i>et al.</i> [12]	61.5%	34.6%	3.8%
Ibrahim Azboy <i>et al.</i>	61.5%	22.72%	13.63%
Present Study	72.5%	7.5%	20%

Large number of Transverse fractures and low number of comminuted fractures were attributed to low energy trauma in our country.

Level of fracture: Our series had 70 % in middle third, 20 % in proximal third and 10% in distal third.

Table 15: Comparison of Level of the fracture sustained in previous studies and the present study

Series	Proximal third	Middle third	Distal third
Present Study	20%	70%	10%
Sarmiento	-	84.6%	15.4%
Dodge	71.5%	21.5%	7.5%
Chapman	21 % (R); 13% (U)	59% (R);40%(U)	28%(R);12%(U)
Meena <i>et al.</i>	15%	55%	30%

Operative time: In the present study, we had average operative time of 77.75 minutes with average tourniquet time of 60.25 minutes.

Table 16: Comparison of time taken to operate in previous studies and the present study

Series	Operative Time (minutes)
Present Study	77.75
Ibrahim Azboy <i>et al.</i>	76
Meena <i>et al.</i>	70.25
Saikia <i>et al.</i>	93.05
SPS Gill <i>et al.</i> [12]	80.8 +/- 15.7

Time of union: Anderson's Criteria [2] for evaluation of radiological union were used in this study. We had 100% union rate in our study with union in average time of 12.6 weeks in range of 9 weeks-20 weeks.

Table 17: Comparison of time taken for fracture union in previous studies and the present study

Series	Time of union (weeks)	Union (%)
Present Study	12.6	100
Anderson <i>et al.</i>	7.4	97
Chapman <i>et al.</i>	12	98
Leung <i>et al.</i>	17	100
Saikia <i>et al.</i>	14.16	100
Meena <i>et al.</i>	12.80	100
Sharma <i>et al.</i>	12.6	93.3

Functional results: The criteria of Anderson *et al.* [33] were

Table 19: Comparison of Complications in previous studies and the present study

Complication	Present Study	Anderson <i>et al.</i>	Chapman <i>et al.</i>	Leung <i>et al.</i>	Sharma <i>et al.</i>
Infection	5%	2.9%	2.5%	3.1%	13.3%
Non union	-	2.9%	2.3%	-	-
Radial artery injury	5%	-	-	-	-
Neuropraxia	-	2%	1.5%	-	-
Radioulnar synostosis	-	1.2%	2.3%	-	-
Delayed union	-	-	-	6.25%	2%

Conclusion

Diaphyseal fractures of radius and ulna in adults have to be fixed at the earliest and it's so important to obtain anatomical reduction and stable internal fixation for excellent functional outcome. LCP is a stronger construct and by preventing primary and secondary loss of reduction it does not alter the natural course of healing of fracture. Being a rigid construct, it allows early rehabilitation and thereby preventing secondary complications like elbow and wrist stiffness. LCP does not involve stripping of periosteum and cause minimal damage to soft tissues around fracture and thus by minimal disturbance of local biology of fracture it allows fracture healing to proceed its natural course with decreased the incidence of infection. Because of locking screw heads in the holes of LCP, loosening of screws and failure of implant is markedly reduced. LCP shows slight advantage in terms of callus formation and early union. The limitation of our study was limited number of cases and absence of long-term follow-up. We are of opinion that open reduction and internal fixation with LCP provides good functional results in terms of union rate as well as functional outcome.

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used in evaluating the functional outcome. In the present study, excellent results were found in 15(75%), satisfactory in 5(25%). Anderson *et al.* [33] reported about 54(50.9%) cases as excellent, 37(34.9%) satisfactory, 12(11.3%) unsatisfactory and 2 (2.9 %) failure.

Table 18: Comparison of Functional outcome in previous studies and the present study

Series	Excellent	Satisfactory	Unsatisfactory	Failure
Present study	75	25	0	0
Anderson <i>et al.</i>	50.9	34.9	11.3	2.9
Chapman <i>et al.</i>	86	7	2	5
Leung <i>et al.</i>	98	2	-	-
Saikia <i>et al.</i>	89	8	3	-

Complications

In the present study, we had complications such as Superficial wound infection, Intraoperative radial artery injury. Intraoperative complication of radial artery injury was encountered in one case for which vascular repair was done immediately during surgery. Post operatively one patient developed superficial wound infection on post-operative day 5 for which culture sensitivity was done, Culture specific antibiotic was started. Wound healed completely by post-operative day 23.

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