Original Article

Outcome of Locking Compression Plate (LCP) Fixation of Diaphyseal Radius-Ulna fracture in Patients of 50 Years and Above

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ABSTRACT

A prospective, observational study was conducted at National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from January 2018 to December 2019, to evaluate the effectiveness of locking compression plate (LCP) fixation in treating diaphyseal forearm fractures. A total of 34 adults aged 50 and above, a population with a high prevalence of osteoporosis, were selected for this study. With an average follow-up period of 25.27±1.39 weeks, the study found that older age and delayed surgery correlated with poorer outcomes, while motor vehicle accidents accounted for 52.94% of the injuries. The average time to radiological union was 12.18±1.53 weeks, with one case of nonunion and a complication rate of 11.76%. At the final follow-up, the mean range of motion for flexion-extension and supination-pronation was 133.53°±5.44° and 124.41°±11.19°, respectively, and the mean Quick DASH score was 14.6%±7.14%. According to the Anderson criteria, 50% of cases were rated as excellent, 47.06% as good, and 2.94% as poor. The study concludes that LCP fixation is an effective treatment for diaphyseal forearm fractures in this age group, demonstrating favorable outcomes regarding union rates, pain management, and functional recovery, with meticulous surgical technique being key to optimal results.

Keywords: Locking compression plate, fixation of diaphyseal radius-ulna *fracture,*

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INTRODUCTION

Diaphyseal fractures involving the radius and ulna, the so-called 'both bone' or double forearm bone fractures are common orthopedic injuries. These injuries can result in significant loss of function if inadequately treated[1]. As the upper extremity serves to position the hand in space, loss of forearm motion and/or muscle imbalance resulting from a poorly treated fracture can be particularly debilitating. Open reduction and internal fixation is the first line of treatment and is generally accepted as the best method of treatment in adults. Anatomical reduction allows restoration of normal radial and ulnar length to prevent subluxation of proximal or distal radio-ulnar joint and restoration of anatomical alignment essential for normal pronation supination function of the forearm[2]. The average yearly incidence in adults has been reported to be 1.35 per 10,000 populations,

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ranging from 0 to 4 per 10,000 populations depending on age and gender. Four-fifths (75%) of forearm shaft fractures occur in children. Above the age of 20, the yearly incidence of forearm shaft fractures remains below 2 per 10,000 people, predominating in males throughout all age groups[3]. Injuries most frequently occur in the setting of high-energy trauma such as motor vehicle accidents or sports injuries[4]. The force applied by trauma can be applied either directly or indirectly onto the diaphysis of the radius and/or ulna. Direct injury frequently results from gunshot injuries or from blunt injury to the forearm. Indirect trauma on the other hand occurs either as bending or torsional forces. Bending forces can result in both-bone forearm fractures that are located at similar segments along the diaphysis of the ulna and radius[3]. Since the radius and ulna articulate with each other at both the distal and proximal end, the integrity of these joints is a further essential ingredient in achieving excellent long-term results after injury. Treatment by closed reduction and cast immobilization results in a poor functional outcome with unsatisfactory results reported in up to 92% of cases, usually caused by malunion, nonunion, or synostosis[5]. Fractures involving both bones of the forearm have been acknowledged as articular fractures as even minor aberration in the spatial orientation of the radius and ulna can appreciably debilitate the performance of the hand[6]. To acquire an adequate range of pronation and supination, reclamation of length, apposition, and axial and rotational alignment are paramount. Limited contact dynamic compression plate (LCDCP) was popularized in 1991, an amelioration over the dynamic compression plate (DCP), which claimed to reduce the bone plate area by 50%, thereby decreasing the plate interference with the cortical perfusion and thus diminishing cortical porous[7].

However, the LC-DCP still relied on the plate–bone interface for stability[8] and the problem of confluent contact areas was not completely resolved[9]. Point contact fixator (PC Fix), was the first implant that did not confide on the plate bone interface for stability as it further diminished the contact area to mere point contacts of the plate with the bone[10]. The locking compression plate (LCP) was devised by combining the features of an LC-DCP and a PC-Fix. 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[2]. Locking compression plates has been shown to provide a stronger fixation compared with DCPs in biomechanical studies. In addition, LCPs can be placed using a bridging plate technique, allowing biological fixation for the treatment of comminuted fractures. These advantages of the LCP have been considered to accelerate fracture healing and reduce the problems of delayed union and nonunion[11]. However, LCPs have some disadvantages, including difficulties during removal and a higher cost[12]. Studies have suggested that the LCP performs better than the DCP in older or osteoporotic bone. Locked plating has been reported to have increased fatigue strength and ultimate failure loads. On the other hand, studies have shown that the pull-out strength of compression screws increases with bone density, and they perform better than locked plating in healthy bone[13]. Although LCPs have some theoretical advantages, the superiority of the LCP remains to be proven. The goal of the current study was to evaluate the outcome of LCP fixation in the treatment of diaphyseal forearm bone fractures in adults of 50 years and above considering this age group has weaker bones.

METHODS

This prospective, observational study was conducted at National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh, from January 2018 to December 2019. Participants included individuals aged 50 years and above, of both genders, with closed fractures, who consented to surgery. The sample size was initially calculated to be 24, but 34 cases were included due to sample availability. Exclusion criteria encompassed patients below 50 years, medically unfit cases (e.g., uncontrolled diabetes mellitus, chronic renal failure), open fractures, and cases of infection. Patients underwent pre-operative evaluation and X-rays upon selecting eligible cases. Surgical procedures were performed using stainless steel LCP, with post-operative administration of Ceftriaxone followed by oral Cefixime and Flucloxacillin for 14 days. Patients were discharged on the 4th post-operative day after drain removal. Follow-ups occurred at the 4th, 6th, 12th, and 24th weeks post-operation, during which various assessments were conducted, including range of motion, X-rays, VAS score for pain, quick DASH score, and functional outcome according to Anderson criteria. Late complications were also assessed.

Operational Definitions: A displaced fracture was defined as having an angulation greater than 30 degrees or a translation exceeding 2 millimeters[14]. Bone union was determined by the presence of periosteal callus bridging in three or four cortices or the closure of the fracture line on anteroposterior and lateral radiographs[15]. A fracture was classified as united if healing occurred within six months[14], while delayed union indicated healing lasting beyond six months without necessitating further surgical intervention[16]. The absence of visible callus formation characterized Nonunion and required additional surgical intervention for management[14].

Data was collected using a pre-tested structured questionnaire encompassing history, clinical examination, pre-operative, perioperative, postoperative complications, and follow-up findings. An assessment sheet based on Anderson's criteria was utilized to evaluate outcomes.Top of Form Data was processed and analyzed using SPSS version 25.0. The data presented on a categorical scale was expressed as frequency and corresponding percentage, while the quantitative data was presented as mean and standard deviation (SD).

The study was approved by the Ethical Review Committee of the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh.

RESULTS

In this study, 34 eligible cases were included, meeting the specified criteria. The average age of the patients was 58.27 years, with a standard deviation of 5.68 years, ranging from 51 to 75 years. The highest incidence of age was observed in the 51-55 years group, accounting for 41.18% of cases (n=14). The distribution among other age groups was as follows: 10 cases (29.41%) in the 56-60 age group, 7 cases (20.59%) in the 61-65 age group, 2 cases (5.88%) in the 66-70 age group, and 1 case (2.94%) in the 71-75 age group. Of the total patients, 27 (79.41%) were male and 7 (20.59%) were female, resulting in a male-to-female ratio of 3.86:1 (Table-I). Occupations of the patients varied, with 20.59% being businessmen and farmers each, 17.65% being housewives and service holders each, 14.71% being retired personnel, and 8.82% having other occupations. Fractures were observed predominantly on the left side in 52.94% of cases (n=18) compared to 47.06% (n=16) on the right side. Motor vehicle accidents were the leading cause of injury, accounting for 52.94% of cases, followed by falls from height (38.24%) and physical assaults (8.82%) (Table-I).

Table-I: *Demographic characteristics of the patients (N=34)*

Variables	Frequency	Percentage
Age group (in years)		
51-55	14	41.18
56-60	10	29.41
61-65	7	20.59
66-70	2	5.88
71-75	1	2.94
Mean± SD	58.27±5.68	
Sex		
Male	7	20.59
Female	27	79.41
Affected side		
Right	16	47.05
Left	18	52.94
Occupation		
Business	7	20.59
Farmer	7	20.59
Housewife	6	17.64
Service	6	17.64
Retired service holder	5	14.07
Others	3	8.82
Cause of Injury		
Motor vehicle accident	18	52.94
Fall from height	13	38.24
Physical assault	3	8.82

Fractures were classified according to the AO classification, with the most common type being 2R2A 2U2A (38.24%), followed by 2R2A 2U2B (23.53%), and other less frequent types (Table -II). The average duration of hospital stay was 9.44 days, ranging from 6 to 15 days (Table-III). Complications were observed in 11.76% of cases, including tourniquet palsy in 5.88% of cases, deep surgical site infection (SSI) in 2.94% of cases, and superficial SSI in 2.94% of cases (Table-IV).

Table-II: *Distribution of patients according to type of fracture (N=34)*

Fracture Sub-type	Frequency	Percentage
2R2A2U2A	13	38.24
2R2A2U2C	1	2.94
2R2B2U2A	6	17.65
2R2B2U2B	3	8.82
2R2B2U2C	1	2.94
2R2C2U2B	1	2.94
2R2C2U2C	1	2.94
Total	34	100

Table-III: *Distribution of patients according to hospital stay (N = 34)*

Hospital stay(in days)	Frequency	Percentage
6-10	25	73.53
11-15	9	26.47
Total	34	100.00
Mean±SD	9.44±2.31 days	

Table-IV: *Distribution of patients according to complications (N=34)*

Complication	Frequency	Percentage
No Complications	30	88.24
Tourniquet palsy	2	5.88
Deep SSI	1	2.94
Superficial SSI	1	2.94
Total	34	100

The average follow-up period was 25.27 weeks, with most cases (88.24%) being followed up for 24 to 26 weeks (Table-V). Patient pre-operative and last x-ray are shown in Fig. 1 & 2. Fig. 3 & 4 have shown supination-pronation and flexion-extension after follow-up (30 weeks). The outcomes were categorized as excellent in 50% of cases, good in 47.06% of cases, and poor in 2.94% of cases; however, no cases having a fair outcome was observed (Fig.-5).

Table-V: *Follow-up period of patients (N=34)*

Follow-up period (in weeks)	Frequency	Percentage
24-26	30	88.24
27-30	4	11.76
Total	34	100.00
Mean ±SD	25.27 ±1.39	

Fig.-1: *Pre-operative x-ray.*

Fig.-2: *X-ray at final follow-up (30 weeks).*

Fig. 3: *Flexion –Extension at final follow-up (30 weeks).*

Fig. 4: *Supination-Pronation at final follow-up (30 weeks).*

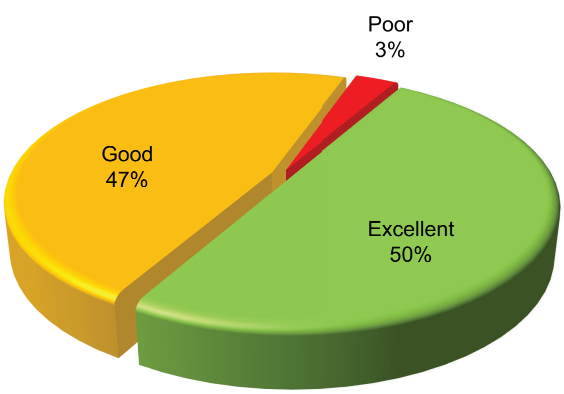

Fig. 5: ***Outcome according to Anderson criteria (n=34)***

DISCUSSION

Diaphyseal fractures of the forearm are a common occurrence in orthopedic practice, often presenting a challenge for effective treatment. The advent of locking compression plates (LCPs) has revolutionized fracture management, offering a blend of advantages over conventional plates. This study aims to explore whether LCPs are superior to conventional plates in treating forearm fractures.

LCPs, amalgamating features of both locking plates and dynamic compression plates (DCPs), present distinct biomechanical advantages. They offer robust fixation, especially beneficial in comminuted fractures, and facilitate biological fixation through a bridging plate technique. Previous biomechanical studies have demonstrated their superiority over DCPs, attributing to stronger fixation and potential acceleration of fracture healing, reducing instances of delayed union and nonunion[18].

The study population comprised individuals with a mean age of 58.27±5.68 years, with the majority falling in the 51-55 age group (41.18%). This age distribution is notably higher compared to previous studies, where the mean age ranged from 30 to 38 years[9-10,19]. The higher age in this series reflects the targeted population of individuals aged 50 years and above.

Gender distribution skewed towards males (79.41%), with a male-to-female ratio of 3.86:1, contrasting with previous studies showing a higher male predominance[20]. The increased female representation in this series may be attributed to osteoporotic fractures more prevalent in females.

Fractures predominantly affected the left side (52.94%), consistent with similar studies[19]. Motor vehicle accidents emerged as the leading cause of injury (52.94%), followed by falls from height (38.24%) and physical assault (8.82%), mirroring findings from previous research highlighting high-energy trauma as a significant contributor[12,20].

Fractures were classified according to the AO classification system[7], with the majority falling under 2R2A 2U2A type (38.24%). This study's classification aligns with previous studies[9], though the use of the latest AO classification system distinguishes it from earlier research.

Surgical intervention occurred at a mean duration of 16.29±3.35 days post-injury, with earlier intervention associated with better outcomes. The mean radiological union time was 12.18±1.53 weeks, notably shorter compared to previous studies due to the application of compression to locking plates, a factor consistently shown to expedite union[18,21].

Complications occurred in 11.76% of cases, including tourniquet palsy, superficial, and deep surgical site infections (SSIs). Tourniquet palsy cases experienced transient neurapraxia, resolving with time. In the series of Saikia et al.[9] where they found pt develop a transient radial nerve palsy postoperatively,which improved with conservative treatment by the 6th postoperative week. SSIs were managed with appropriate antibiotics and regular dressings, resulting in satisfactory outcomes.

The average follow-up period was 25.27±1.39 weeks, allowing for short-term outcome evaluation. Pain assessment utilizing the Visual Analog Scale (VAS) demonstrated significant improvement post-operatively, indicating enhanced patient comfort. Union rates were high (97.06%), with only one case of nonunion attributed to deep infection necessitating implant removal and revision surgery. Nonunion rates align with previous studies, highlighting the detrimental impact of deep infections on fracture healing. Functional outcomes were predominantly excellent (50%) or good (47.06%), with only one case of poor outcome due to nonunion. Comparatively, previous studies reported higher rates of excellent outcomes, likely influenced by factors such as younger patient age and shorter follow-up durations[9,19].

Locking compression plates offer favorable outcomes in diaphyseal forearm fractures in patients aged 50 years and above. Their biomechanical advantages, including enhanced fixation and compression capabilities, contribute to expedited healing and improved functional outcomes. However, careful consideration of factors such as timing of surgery and management of complications is essential for optimizing treatment efficacy. However, this was a single-centered study that was conducted with a small sample. A short follow-up period precludes assessing long-term outcomes, and its single-centered design, which may limit the generalizability of conclusions.

CONCLUSION

The present study underscores the efficacy of locking compression plates (LCPS) in treating forearm diaphyseal fractures, highlighting their versatility and favorable outcomes in terms of union rate, pain management, and functional recovery. internal plating with lcps proves to be a promising approach, contingent upon meticulous surgical technique. It can be recommended that locking compression plates (LCPs) yield satisfactory outcomes for diaphyseal bone fractures of the forearm in individuals aged 50 years and older. however, further long-term multicentric investigations are necessary to fully understand the behavior of LCP implants and to identify specific fracture types that would benefit most from their use. such studies will aid in refining treatment protocols and optimizing outcomes for forearm fractures, especially in older patient demographics.

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