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Original Research Article

Prospective Evaluation of Functional Outcomes in Both Bones Forearm Fractures Managed Surgically with Locking Compression Plates

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Abstract:

Background: Ulnar and radius bone forearm fractures account for a significant percentage of adult upper limb injuries and demand precise surgical treatment to ensure anatomical reduction and functional motion. Locking Compression Plates (LCPs) are now an improved method of fixation, particularly in osteoporotic or complicated fractures.

Objective: To prospectively evaluate the functional outcomes of both bones forearm fractures operated on by LCPs in adult patients.

Methodology: This was a prospective observational study conducted at Madhubani Medical College and Hospital, Bihar, on 30 cases of closed fractures of ulna and radius in adult patients. Fixation was done with 3.5 mm LCPs by standard methods, and standardized postoperative protocol was used. Functional outcome was measured with Anderson et al. criteria and Quick DASH score at follow-up.

Results: The maximum cases were in the age group of 51–60 years (26.7%). Transverse/short oblique fractures were most common (ulna: 70%, radius: 60%). Functional results were excellent in 83.3% of the patients, satisfactory in 10%, unsatisfactory in 3.3%, and failure in 3.3%, with an overall success rate of 93.

Conclusion: LCP fixation of both bones forearm fractures has the best functional results with few complications. The method provides stable fixation and early mobilization and is thus a method of choice in adult diaphyseal forearm fractures.

Keywords: Forearm fractures, radius and ulna, locking compression plate, functional outcome, internal fixation, orthopedic surgery, DASH score.

Introduction

Both radius and ulnar fractures of the forearm are two of the most frequent injuries seen in orthopedic clinics, particularly among adults. Isolated fractures of the two bones contribute to close to 31% of the total fractures of the upper limbs, and clinical significance is such that maximum recovery and restitution of function must be managed optimally [1]. The unique anatomical alignment of the forearm with the radius, ulna, interosseous membrane, and the proximal and distal radioulnar joints allow for sophisticated biomechanical movements like pronation and supination utilized in daily activities and also for occupation [2].

The congruence and parallelism of the radius and ulna and congruence of the radioulnar joints are essential factors determining the functioning of the forearm. Adequate treatment of the fractures of the two forearm bones is essential to prevent unacceptable sequelae like joint instability, malunion, nonunion, and ultimately significant impairment of rotational power and grip strength, severely diminishing the quality of the patient's life [3,4]. The conservative method of treatment using closed reduction with subsequent cast immobilization has traditionally been accompanied by unacceptably high complication rates up to 92% in some series mostly because of inappropriate anatomical reduction and unstable fixation of the fractures [5].

With the advent of orthopedic surgical techniques and biomaterials, Open Reduction and Internal Fixation (ORIF) by plate osteosynthesis has come to be the gold standard in the healing of adult forearm fractures [6]. Internal fixation using dynamic compression plates (DCPs) or locking compression plates (LCPs) is recommended by the Association for the Study of Internal Fixation (AO) for providing rigid stability, anatomical reduction, and enabling early mobilization. Of particular interest, the LCP system has been discovered to be of biomechanical as well as clinical advantage.

Locking Compression Plates are a significant innovation in fracture fixation systems. In contrast to conventional plates that achieve stability by friction between the plate and the bone, Locking Compression Plates achieve fixed-angle constructs where screw heads are embedded into the plate, thereby providing enhanced angular and axial stability [7]. This feature is particularly useful in cases of osteoporotic bones or complex comminuted fracture patterns for which conventional plating cannot maintain the reduction [9]. Locking Compression Plates also enable reduced periosteal disruption as they can perform effectively with less contact between the plate and the bone. This biological plating feature ensures that the blood supply is preserved, thereby enabling more rapid and uniform fracture healing [8].

A key benefit of the LCP system is screw placement flexibility, which allows surgeons to adjust the construct based on diverse fracture patterns without compromising optimal biomechanical properties. This flexibility has translated into increased rates of union, reduced hardware-related complications, and better postoperative outcomes in terms of range of motion and pain reduction [9]. The concepts upon which locking plate osteosynthesis is based are predicated upon the idea of an "internal external fixator," where the implant functions as a rigid splint that is independent of compression between the bone and the plate. This paradigm shift focuses on biological fixation rather than stiff anatomical reconstruction, which creates a more favorable condition for bone remodeling and regeneration [10].

There are various studies that have shown the superiority of LCP over DCP in adults' diaphyseal fractures of the forearm. Droll et al. have, in a systematic review, reported excellent to good functional outcomes in over 90% of patients with locking plates, with much fewer instances of reoperation on account of implant failure or nonunion [11]. Kloen et al. have also compared in a study and indicated enhanced rotational function and early return to activity with LCPs and suggested their widespread use in fractures of the forearm [12].

While these promising results are present, the literature remains to be filled with large-scale prospective studies that uniformly address the functional outcomes of both bone forearm fractures managed with LCPs in different patient populations. Heterogeneity remains present with regard to postoperative regimens, implant choice, and rehabilitation protocols. Hence, there is a pressing need for comprehensive prospective studies that quantify not just radiologic union but also functional recovery by employing validated scoring instruments like the Disabilities of the Arm, Shoulder, and Hand (DASH) score, Mayo Elbow Performance Score (MEPS), and grip strength measurements.

The present study aims to address this gap through conducting a prospective evaluation of the functional outcomes among adult patients having both bone forearm fractures treated through surgery with locking compression plates. The study addresses fracture union rate, recovery of forearm motion, complications, and patient satisfaction. This evidence shall be instrumental to enhance clinical practice guidelines and optimize surgical methods to these complex fractures.

Methodology

Study Design: This study was designed as a prospective observational study to evaluate the functional outcomes of patients with both bones forearm fractures treated surgically using Locking Compression Plates (LCPs).

Study Area: The study was conducted in the Department of Orthopedic, Madhubani Medical College and Hospital, Madhubani, Bihar, India.

Study Duration: The study was carried out over a period of 12 months

Sample Size: A total of 30 patients who fulfilled the inclusion and exclusion criteria during the study period were enrolled. The exact sample size may be mentioned based on data collected.

Sample Collection: Patients presenting to the emergency and orthopedic outpatient departments with forearm fractures were assessed. Eligible patients were enrolled consecutively after obtaining informed consent.

Inclusion Criteria

- Closed fractures of both radius and ulna
- Patients aged above 18 years
- Transverse, short oblique, or comminuted fracture patterns

Exclusion Criteria

- Fractures with intra-articular extension
- Open fractures
- Patients unfit for surgery
- Patients with multiple comorbidities that may affect functional outcomes
- Polytrauma cases
- Segmental fractures or grossly comminuted fractures

Procedure

- **Operative Details**

All patients were prepared for surgery on the basis of routine preoperative protocols such as imaging and anaesthetic fitness clearance. Sterile painting and draping were done under proper anaesthesia and after limb positioning. Tourniquet was used to obtain a bloodless field.

Henry's (volar) method was used to treat the radius, in which the ends of the fracture were located and freshened. Reduction was stabilized with a 3.5 mm Locking Compression Plate (LCP). At least six cortices were engaged by locking screws. The location of the LCP depended on the location of the fracture: dorsal aspect for the upper third, dorsolateral aspect for the middle third, and volar aspect for the distal third of the radius.

The ulna was accessed by direct subcutaneous exposure along its posterior border. The fracture was exposed, ends freshened with a periosteal elevator, and reduction achieved with bone-holding clamps. A 3.5 mm LCP was chosen, usually with six or more holes depending on complexity (e.g., comminuted or segmental fractures). Screws were drilled in with a 2.7 mm drill bit, and screw length was checked with a depth gauge prior to inserting 3.5 mm locking screws.

Fixation of the radius was performed first, followed by fixation of the ulna. Stable fixation was obtained, followed by the placement of a suction drain, and closure in layers of the wound. A sterile dressing and compression bandage were applied, and the limb was immobilized in an arm pouch. Patients were advised to elevate the limb and initiate active movements of the fingers postoperatively.

- **Post-operative Protocol**

The suction drain was removed on postoperative day 3. Patients were administered appropriate antibiotics and analgesics according to routine hospital protocol. Check X-rays (anteroposterior and lateral) were taken on postoperative day 5 to assess fracture alignment and hardware position. Patients were discharged and instructed to keep the limb in a short arm slab for a further two weeks.

Suture removal was done on the 14th postoperative day. Patients were instructed regarding home care and asked to do active movements of the elbow and wrist as tolerated. Follow-ups were planned at monthly intervals to monitor fracture healing and joint mobility clinically and radiologically.

- **Outcome Assessment**

Functional results were evaluated at each follow-up visit using a mixture of objective and subjective tests. Radiologic evaluation of union was marked by closure of the fracture gap and observation of periosteal bridging callus. Those that united in more than six months without additional treatment were referred to as delayed unions, while those that demonstrated no evidence of healing were referred to as non-unions.

Functional grading was performed according to parameters defined by Anderson et al. [13], i.e., the degree of union, decrease in elbow flexion-extension, and forearm rotation (supination-pronation). Subjective functional results were also assessed by using the Quick DASH (Injuries to the Hand, Shoulder, and Arm) Score. These findings were then statistically analyzed to evaluate the effectiveness of LCP fixation in the management of the fracture of the forearm.

Statistical Analysis: Data were entered and analysed using Microsoft Excel (2021) and SPSS version 25. Descriptive statistics were used to present the data in the form of mean, frequency, and range. The Quick DASH score was used for subjective functional assessment. A p-value of <0.05 was considered statistically significant.

Result

Table 1 presents the age distribution of the study population, comprising 30 individuals in total. The highest proportion of participants (26.7%) fell within the 51–60 age group (8 individuals), followed by 7 individuals (23.3%) aged 21–30. The 31–40 age group included 6 participants (20%), while 5 participants (16.7%) were aged between 41–50. The youngest group, aged 18–20, accounted for the smallest share, with 4 individuals (13.3%). This distribution shows a relatively even spread across age groups, with a slight predominance of older participants.

Table 1: The study population's age distribution

AGE	n (%)
51–60	8 (26.7%)
41–50	5 (16.7%)
31–40	6 (20%)
21–30	7 (23.3%)
18–20	4 (13.3%)
Total	**30 (100%)**

Table 2 illustrates the pattern of fractures observed in the ulna and radius among the 30 cases studied. In the ulna, the majority of fractures were transverse or short oblique, accounting for 21 cases (70%), while comminuted fractures were seen in 9 cases (30%). Similarly, for the radius, transverse or short oblique fractures were the most common, observed in 18 cases (60%), whereas comminuted fractures occurred in 12 cases (40%).

Table 2: Pattern of fractures

Type of fracture	**Ulna (%)**	**Radius (%)**
Transverse / short oblique	21 (70%)	18 (60%)
Comminuted	9 (30%)	12 (40%)
Total	**30 (100%)**	**30 (100%)**

Table 3 presents the functional outcomes of the study population. Out of 30 individuals, the majority—25 participants (83.3%)—achieved an excellent outcome. A satisfactory result was observed in 3 cases (10%), while unsatisfactory and failure outcomes were each reported in 1 case (3.3%). Overall, the data indicates a highly positive trend in functional recovery, with 93.3% of individuals achieving either satisfactory or excellent outcomes.

Table 3: Functional Outcome

Failure	**Unsatisfactory**	**Satisfactory**	**Excellent**
1 (3.3%)	1 (3.3%)	3 (10%)	25 83.3%)

Discussion

The age group of the study subjects indicated that patients in the age group of 51 to 60 years had the highest proportion (26.7%) of cases, followed by the 21- to 30-year-old patients (23.3%). Age groups of participants 31 to 40 years and 41 to 50 years had 20% and 16.7%, respectively, and the youngest age group between 18 to 20 years had 13.3%. The trend of age groups indicates that forearm fractures are prevalent in a wide age group of adults with a peak of the condition in middle-aged and young adult groups. The higher proportion in older age groups can be a reflection of skeletal changes with age or increased susceptibility to falling, while in young adults, it may be due to increased activity in physically demanding or risky occupations.

A retrospective review by Jerrhag et al. (2017) found a bimodal distribution of forearm fractures by age, with peaks in young adults due to high-energy trauma and in older adults due to osteoporotic fragility fractures [14]. This is confirmed in the work of Naser et al. (2014), who found that in younger patients, forearm fractures were most commonly related to sports and motor vehicle accidents, while in older patients, falls from standing height were more common [15]. Our results are consistent with those of Cheng et al. (1999), who found an increased incidence of such fractures in young adult males who engaged in physically demanding jobs or sports [16]. Lee et al. (2020) reported instead a dominance of cases in the 20–40-year age group, with fewer cases in the elderly, possibly due to variations in population demographics or access to care [17]. The high rate of middle-aged and older adults in our population may also be an effect of regional lifestyle conditions or differences in bone health, e.g., undiagnosed osteoporosis or reduced physical activity level.

By fracture pattern, the majority of radial and ulnar fractures were transverse or short oblique. Exactly 70% of ulnar and 60% of radial fractures were so classified. Committed fractures were less common, 30% of ulnar and 40% of radial fractures. This is an excess of simpler fractures, typical of lower-energy trauma or direct force trauma. The small excess of comminuted fractures in the radius might suggest heterogeneity in the biomechanical characteristics of the bones or in the forces applied in injury.

The same trend was noted by Leung & Chow (2003), who noted that the majority of adult both-bone forearm fractures were short oblique or transverse, especially when they resulted from low-energy trauma or domestic falls [18]. Similarly, Anderson and Sisk (1975) noted a high prevalence of simple fracture patterns in isolated forearm fractures, noting their association with direct trauma mechanisms and not high-energy impacts [2].

The results of the function achieved in this study are generally excellent. An overwhelming majority of patients (83.3%) showed excellent recovery, with optimal utilization of the injured limb regained. Another 10% were classified as good results. Few only had poorer results, of which one (3.3%) was unsatisfactory. and one was a failure. These findings are indicative of a high success rate of treatment, possibly because of good surgical or conservative management methods, early treatment, and correct rehabilitation. The few poorer results might be due to individual factors such as the difficulty of the fracture, healing response, or postoperative management compliance.

Similarly, Saikia et al. (2011), which 86% of patients operated with LCPs for fractures of the forearm had good or excellent results, attributing success to early mobilization and stable fixation [20]. Similarly, Droll et al. (2007) also showed excellent functional recovery in 82% of operatively treated patients by compression plating and emphasized that anatomical reduction and rigid fixation must be employed in maintaining forearm rotation and grip strength [21].

Conclusion

The prospective analysis of functional outcomes of both bones forearm fractures treated with locking compression plates showed very promising outcomes. Most patients had satisfactory functional recovery, with a minimal number of patients having unsatisfactory or failed outcomes. The analysis had a mixed age distribution, with the highest frequency in middle-aged patients, and dominance of transverse or short oblique types of fractures. The results validate the effectiveness of locking compression plates in the restoration of function in forearm fractures and confirm their status as a trustworthy surgical procedure in orthopedic practice.

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