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Optimizing fracture management: The role of the Ellis plate in distal radius fractures

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ABSTRACT

Background: Fractures at the distal end of the radius, a prevalent orthopedic concern, challenge clinicians due to their complex nature and the diverse patient demographics they affect. Primary stability is key, especially in cases involving osteoporotic bones or younger patients. The Ellis plate with a locking screw mechanism offers a promising solution to achieve this stability, potentially preventing secondary displacement regardless of bone quality. **Aims and Objectives:** This study aims to rigorously assess the effectiveness of the Ellis volar locking compression plate in treating distal end radius fractures. It focuses on evaluating functional outcomes post-treatment, providing insights into the efficacy of this approach. **Materials and Methods:** This study evaluated the efficacy of the Ellis plate in managing distal radius fractures, under ethical approval number KMC/IEC/Ortho/2021-5. Twenty adult patients with unstable fractures were included based on specific criteria and provided informed consent. Exclusion criteria included unwillingness for surgery, medical unsuitability, osteoporosis, minors, and compound fractures with vascular injury. Surgical outcomes were assessed using the Gartland and Werley scoring system, with follow-up appointments scheduled over 1 year to monitor progress and adherence to physiotherapy plans. **Results:** The study encompassed 20 patients, with a gender distribution of 12 males and eight females and an average age of 43.3 years. Utilizing the Gartland and Werley demerit grading system, the study reported 45% superb outcomes, another 45% good outcomes, 10% fair outcomes, and no poor outcomes. This distribution highlights the potential of the Ellis plate technique in achieving positive results in fracture treatment. **Conclusion:** The study concludes that the Ellis plate technique is a viable and effective option for stabilizing distal end radius fractures. However, achieving the best possible outcomes depends on several factors, including strict adherence to AO principles, maintaining high standards of aseptic practice, following appropriate post-operative rehabilitation protocols, and ensuring comprehensive patient education. This multifaceted approach is crucial for the successful treatment of these fractures.

Key words: Forearm; Fracture; Wrist; Internal fixation; Ellis plate; Transverse; Short oblique; Non-union; Delayed union

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INTRODUCTION

Fractures at the distal end of the radius, a common orthopedic injury, present significant rehabilitation challenges due to their potential to cause various complications, including carpal instability, restricted motion, decreased grip strength, and post-traumatic osteoarthritis.[1-3] Open reduction and internal fixation has emerged as the preferred treatment for these unstable fractures, especially when non-invasive methods fail to rectify articular incongruities. This approach hinges on the presence of adequate bone stock to enable early mobilization.[4,5]

The adoption of internal fixation, particularly for metaphyseal bending fractures, has gained traction due to

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its ability to directly address and maintain physiological palmar tilt, reduce the likelihood of collapse associated with external fixation, and eliminate the need to bridge the radio carpal joint.[5,6] A dorsal or volar approach can be utilized for the distal component, which generally provides a robust grasp.[6] Palmar plating, favored for its support against collapse and preservation of palmar tilt, uses screws strategically placed to optimize support. In contrast, dorsal plating increases the risk of extensor tendon injury, especially with smaller, more remote fragments.[7]

In managing distal radius fractures, two primary plate groups are commonly employed: Standard blades and fixed-angle locking compression plates. While conventional plates focus on securing cancellous bone fragments and avoiding comminution, their manipulation may result in settling and subsequent height loss.[3,6,8] Conversely, fixed-angle locking plates are designed to reinforce subchondral bone and withstand axial pressures, facilitating periosteal blood circulation without the need for compression between plate and bone.[2,9,10]

The implementation of fixed-angle constructs significantly enhances fixation stability, offering a supportive framework beneath the articular surface of the distal radius.[11,12] The Ellis volar fixed-angle locking plate has proven effective in treating unstable, extra-articular distal radius fractures, allowing for prompt initiation of post-operative rehabilitation.[13-15] Its angular stability is instrumental in maintaining long-term reduction, addressing concerns of secondary displacement effectively.[16-18]

This technique demonstrates a stability restoration level comparable to an intact radius under axial stress of <100 N, outperforming traditional palmar or dorsal T plates. Particularly in osteoporotic bones and unstable fractures, the fixed angular stable fixation method offers increased stability and sustained fracture reduction.

Aims and objectives

The present study aims to evaluate the functional outcomes of surgical interventions in patients with distal radius fractures, with a particular focus on those treated using the Ellis plate. In addition, it seeks to thoroughly assess the efficacy and potential complexities associated with the employment of the Ellis plate in the treatment of these specific fractures.

MATERIALS AND METHODS

This study, conducted under the ethical approval number KMC/IEC/Ortho/2021-5, investigated the outcomes of surgical treatment for distal radius fractures using the Ellis plate method. It involved 20 participants, selected based on specific inclusion criteria: Adults of any gender with unstable distal radius fractures and those who gave informed consent for surgery. Exclusion criteria encompassed unwillingness to undergo surgery, medical unsuitability for the procedure, a diagnosis of osteoporosis, minors under 18 years of age, and compound fractures with vascular injury. Ethical considerations were rigorously followed, and patient consent was obtained, ensuring adherence to the highest standards of clinical research.

Data recording (clinical and radiological)

A meticulous history was gathered from each patient or their caregivers to determine the exact nature and extent of the injury in cases of distal radial fractures. This was followed by an extensive clinical examination to assess overall health and the specific severity of the injury. Adhering to the acute trauma life support protocol, the surgery was meticulously planned, with vital parameters meticulously recorded. A detailed investigation ensured the exclusion of fractures in areas other than the distal radius. The examination of the affected forearm and hand involved assessing posture and alignment compared to the unaffected limb, along with careful observation for any abnormal swelling or deformity.

Each patient displayed a protective posture, typically holding the flexed elbow with the wrist supported by the opposite hand. An exhaustive evaluation was conducted, noting abnormalities, swelling, bruising, and signs of discomfort such as bone irregularity, crepitus, and the relative positioning of the radial and ulnar styloid processes. The range of motion in the wrist and forearm was assessed for limitations and associated pain. Vascular assessment included checking radial artery pulsations, capillary refill, and looking for pallor or paresthesia in the fingertips. The affected forearm was immobilized with a below-elbow plaster of Paris (POP) slab and elevated. Pain and inflammation were managed with diclofenac sodium, administered at 50 mg twice daily.

Pre-operative planning

A comprehensive laboratory analysis was conducted on blood samples to determine key health indicators. This included measuring hemoglobin levels, white blood cell count (both total and differential), fasting blood sugar, blood urea, serum creatinine, bleeding time, and clotting time. In addition, urinalysis was carried out to detect the presence of albumin and glucose in urine. All participants underwent blood pressure monitoring and electrocardiogram evaluations. On the day of the surgery, patients received thorough skin preparation, tetanus toxoid injections, and intravenous antibiotics. Patients were evaluated by a medical professional to ensure their fitness for surgery. Before the operation, a detailed pre-anesthetic checkup was conducted, and informed consent was obtained.

Radiographic examination

The diagnosis and classification of the fractures were confirmed using standard radiographs in posteroanterior and lateral views. Patients with complex comminuted fractures also underwent additional oblique imaging. Fracture fragments were analyzed and classified according to their involvement in the radiocarpal and distal radioulnar joints, following Frykman's and AO classification systems.

Surgical procedure

The surgery was performed within 1–6 days post-injury, averaging 2.35 days.

Anesthesia

General anesthesia was administered in 14 cases, while a brachial block was used in six cases. The patient was positioned supine on the operating table, with the affected limb elevated for 2–3 min for exsanguination, followed by the application of a pneumatic tourniquet. The limb was then thoroughly cleansed and draped.

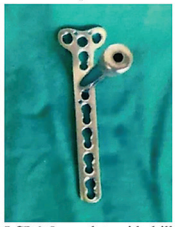
Procedure

The Ellis plate, applied using the Volar Henry approach, was used in all surgeries. Instruments and implants included various lengths of Ellis plates, a 3.5 mm drill bit and sleeve, a power drill, 3.5 mm cortical screws and a depth gauge, a hexagonal screwdriver for screw insertion and locking, and standard surgical tools such as retractors, periosteal elevators, reduction clamps, and bone levers. The pneumatic tourniquet was employed to temporarily obstruct blood flow during the procedure.

Instruments photographs with captions

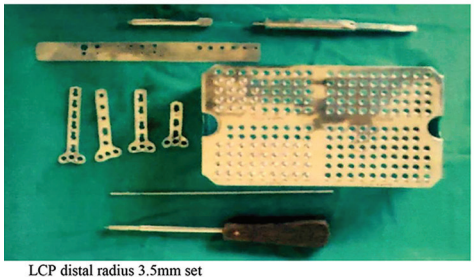
LCP 3.5mm plate

LCP 3.5mm screws



LCP 3.5mm plate with drill sleeve

LCP 3.5mm plate with locking screws



LCP distal radius 3.5mm set

Surgical technique

The surgical procedure for volar fixation of distal radius fractures is a meticulously crafted technique. It begins with a strategic incision using the Henry approach, situated between the flexor carpi radialis (FCR) tendon and the radial artery. This incision methodically exposes the flexor pollicis longus (FPL) muscle proximally, and distally, the pronator quadratus muscle. During the procedure, key structures such as the FCR and FPL tendons, as well as the radial artery, are carefully retracted to facilitate access. Precise dissection of the pronator quadratus muscle, while conserving surrounding muscle tissue for later reattachment, is a critical step. This exposes the fracture site, allowing for direct visual reduction.

The procedure involves meticulous realignment of the fracture using fluoroscopy-guided techniques, temporary stabilization, and selection of an appropriate plate for fixation. Initially, the plate is temporarily affixed to the proximal fragment, enabling adjustment of both proximal and distal plates. The placement of subchondral locking screws then stabilizes the distal fragment, restoring radial length as needed.

The positioning of distal screws is crucial, particularly below the lunate facet near the sigmoid notch at the radial styloid. Optimizing volar tilt during screw placement is achieved by wrist volar flexion, assisted by a second surgeon. The entire plating system is advanced distally for improved coverage and radial length, using the oval plate hole as a guide. Fluoroscopy confirms the final plate positioning.

Closure of the surgical site involves repositioning the pronator quadratus muscle over the implants on the anterior radius. Post-surgery, the wound is closed in layers, followed by a sterile compression dressing. Capillary refill in the fingers is assessed after tourniquet release. The operated limb is immobilized with a POP slab below the elbow, maintaining the wrist in a neutral position.

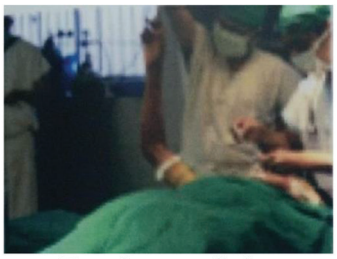
Post-operative protocol

The patient was accommodated in the post-operative ward for duration of 10 days. During this period, follow-up radiographic assessments were conducted. Sterile dressings were meticulously applied on the 2nd, 5th, and 8th days post-surgery. On the 10th day, post-procedure, the sutures were carefully removed, and the patient was discharged with a POP slab extending below the elbow. Instructions were given for the patient to schedule a follow-up appointment 4 weeks later.

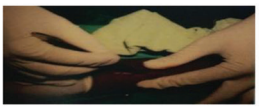
Follow-up protocol

Patients were advised to schedule follow-up appointments over the course of 1 year. During each visit, their progress

Technique

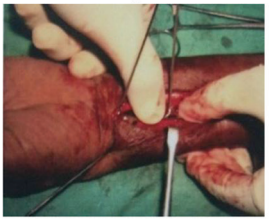

Tourniquet applied


Draping done



Volar Henry's incision


The Flexor Carpi Radialis muscle and the radial artery are retracted laterally to expose the Pronator Quadratus.


The Pronator Quadratus is divided and elevated medially, revealing the distal radius..


Ellis plate is placed, fixed with K- wires and the fracture is reduced.

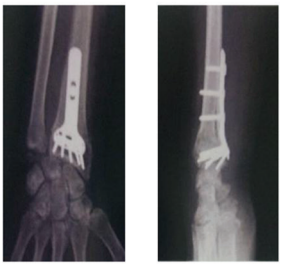

Drilling a shaft hole with drill sleeve


Inserting a locking screw of 3.5mm


Distal screw drilling


Plate safeguard with all screws


Wound closure with staples


POST OP Xray AP & lateral view

was meticulously evaluated using the Gartland and Werley scoring system, which included X-ray analysis and thorough assessment of both active and passive wrist movements. In addition, patients were encouraged to consistently follow their designated physiotherapy plans.

OBSERVATIONS AND RESULTS

This study involved 20 individuals treated for distal end radius fractures at Mahatma Gandhi Memorial Hospital, Warangal, affiliated with Kakatiya Medical College, from August 2021 to July 2023. Among these, 19 cases were classified as closed fractures, and one as an open fracture. Systematic follow-up was conducted for all cases within this timeframe. The analysis presented here is based on the collected data and observations made during the study period.

In a study comprising 20 patients, the age incidence showed a diverse distribution across different age groups. Specifically, 10% of the patients fell within the 21–30 years age range, 25% were between 31 and 40 years, 40% were aged 41–50 years, 20% were between 51 and 60 years, and

5% were in the 61–70 years age bracket. The ages of the participants ranged from 26 to 62 years, with an average age of 43.3 years. This distribution indicates a higher incidence of the condition under study in the middle-aged population, particularly in the 41–50 years age group (Figure 1).

Among the sample of 20 patients, it was observed that 12 individuals (60%) were identified as men, while 8 individuals (40%) were identified as females (Table 1). This distribution indicates a higher representation of males, with a male-to-female ratio of 3:2.

Among the sample of 20 patients, it was observed that the dominant wrist, namely, the right side, was affected in 14 individuals, accounting for 70% of the cases. Conversely, six patients, or 30% of the cases had the left side compromised (Table 2).

In the present study, a total of 20 patients were included, with 12 individuals (60%) having had road traffic accidents, while the remaining 8 patients (40%) reported falling on their outstretched hand (Table 3).

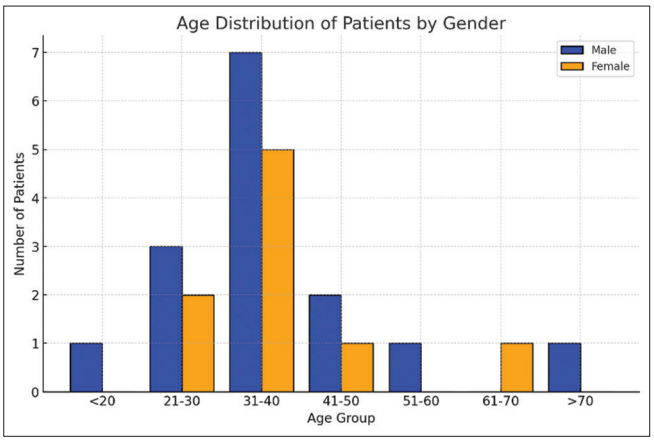


Figure 1: Age incidence: In this series, a total of 20 patients were included. Among them, 2 patients (10%) fell within the age range of 21–30 years, 5 patients (25%) were between 31 and 40 years, 8 patients (40%) were aged 41 and 50 years, 4 patients (20%) were aged 51–60 years, and 1 patient (5%) was between 61 and 70 years of age. The age range of the participants in the study spanned from 26 to 62 years, with a mean age of 43.3 years

Table 1: Sex incidence

Gender	Total number of patients n (%)
Female	8 (40)
Male	12 (60)

Table 2: Side affected

Affected side	Total number n (%)
Left	6 (30)
Right	14 (70)

In this group of 20 cases, the distribution of fractures according to Frykman's classification was as follows: Type I fractures were observed in 4 cases (20%), Type II in 2 cases (10%), Type III in 7 cases (35%), Type IV in 3 cases (15%), Type V in 1 case (5%), and Type VIII in 3 cases (15%). Notably, there were no occurrences of Type VI or Type VII fractures (Figure 2).

Among the sample of 20 cases, it was seen that 2 cases (10%) exhibited fractures classified as AO Type A2, 4 cases (20%) were classified as Type A3, 1 case (5%) fell under Type B1, 4 cases (20%) were categorized as Type B2, 4 cases (20%) were classified as Type B3, 4 cases (20%) were identified as Type CI and 1 case (5%) was classified as Type C2. There was an absence of AO type A1 and C3 fractures (Table 4 and Figure 3).

Nineteen out of the 20 cases (95%) exhibited closed fractures, whereas 1 case (5%) presented an open Type 1 fracture, as classified by Gustilo and Anderson (Table 5 and Figure 4).

Table 3: Mechanism of injury

Injury mechanism	Total number of patients n (%)
Fall on outstretched hand (FOOSB)	8 (40)
Road traffic accident (RTA)	12 (60)

Table 4: AO classification

Fracture Classification	Total number of patients (%)
Fracture type C	
C3	0 (0)
C2	1 (5)
C1	4 (20)
Fracture type B	
B3	4 (20)
B2	4 (20)
B1	1 (5)
Fracture type A	
A3	4 (20)
A2	2 (10)
A1	0 (0)

Table 5: Closed or open fracture (Gustilo and Anderson classification)

Fracture type	Total number of cases (%)
Open Type 1	1 (5)
Closed	19 (95)

Table 6: Prevalence of intra-articular fracture and extra-articular

Type	Total number of cases (%)
Intra-articular fractures	14 (70)
Extra-articular fractures	06 (30)

Among the 20 instances seen, 6 cases (30%) demonstrated fractures of the extra-articular type, whereas the remaining 14 cases (70%) presented intra-articular fractures (Table 6).

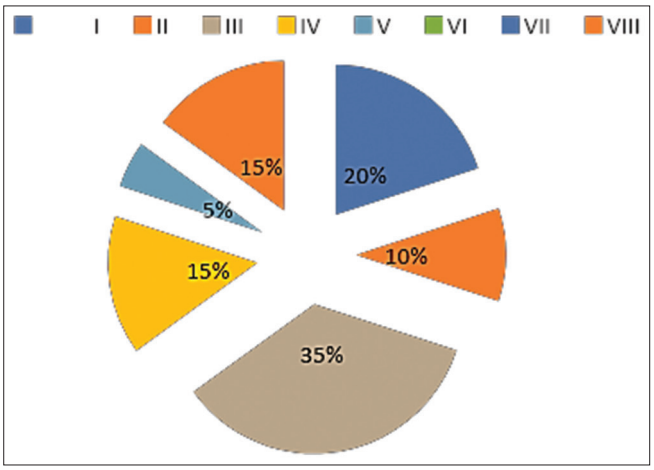


Figure 2: In this cohort of 20 cases, fractures were distributed as follows according to Frykman's classification: Type I fractures were present in 4 cases (20%), Type II in 2 cases (10%), Type III in 7 cases (35%), Type IV in 3 cases (15%), Type V in 1 case (5%), and Type VIII in 3 cases (15%). There were no instances of Type VI or Type VII fractures

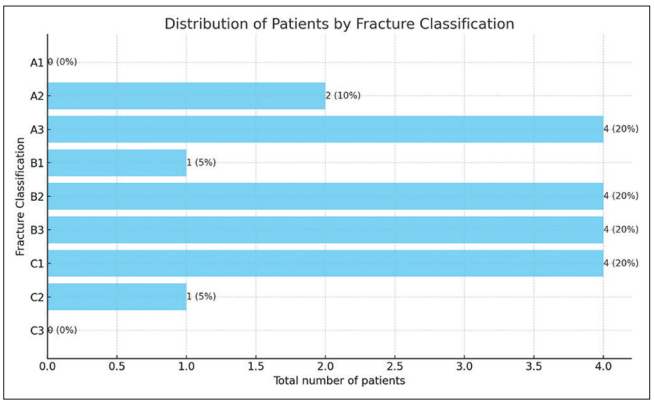


Figure 3: The plot visually represents the distribution of patients across various fracture classifications, with the horizontal bars indicating the fracture type from A1 to C3. The length of a bar reflects the total number of patients assigned to that fracture classification. Inside each bar, the absolute number of patients is displayed alongside the percentage, signifying the relative frequency of each fracture type in the patient population studied

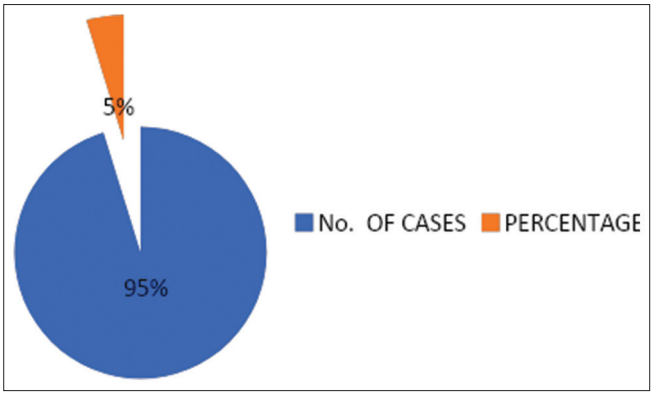


Figure 4: Distribution of fracture type

The elective surgical operation was performed within a time frame of 1–5 days in 18 patients, accounting for 90% of the total sample. The surgical procedures for two patients (10% of the total) were postponed until the 6th day due to their medical history of ischemic heart disease. The surgeries were performed only after receiving clearance from the cardiologist, ensuring the patients' physical readiness for the procedures (Table 7).

In the current investigation, it was observed that 16 patients, constituting 80% of the sample, achieved union within a period of 2–3 months. In addition, three patients, accounting for 15% of the sample, achieved union within a period of 3–4 months. There was one instance, accounting for a 5% occurrence rate, in which delayed union was observed (Table 8).

Throughout the course of this study, it was observed that the entire cohort of 20 patients (100%) displayed dorsiflexion within the appropriate functional range, achieving a minimal angle of 45°. Similarly, every patient in this group (100%) also exhibited palmar flexion below the standard average functional range, with the minimum angle recorded at 30°. In addition, each patient (100%) demonstrated pronation within the normal functional parameters, with the least angle being 50°. Equally, every individual in this sample of 20 (100%) showed supination within the acceptable functional range, defined operationally as a minimum of 50°. Moreover, a substantial majority, 17 participants (85%), manifested radial deviation within the normal functional range, operationally defined as at least 15°. Nineteen subjects, accounting for 95% of the sample, displayed ulnar deviation within the prescribed range for optimal functional mobility, with a minimal deviation of 15°. The same proportion of participants (95%) exhibited grip strength exceeding 60% in comparison to their opposite side. Conversely, a notable 5% of the sample exhibited a marked reduction in grip strength, falling below 60% when

Table 7: Duration of the operation from the date of injury

Time duration	Total number of cases (%)
6–10 days	2 (10)
1–5 days	18 (90)

Table 8: Duration required for the union of a fracture

Duration of union	No. of cases (%)
More than 4 months	1 (5)
3–4 months	3 (15)
2–3 months	16 (80)

Table 9: Range of motion

Movement (within the range of normal function)	Total number of cases (%)
Dorsi flexion (min 450)	20 (100)
Palmar flexion (300)	20 (100)
Pronation (500)	20 (100)
Supination (500)	20 (100)
Distal radioulnar joint pain	2 (10)
Redial deviation (150)	17 (85)
Ulnar deviation (150)	19 (95)
Grip power (at least 60% less than on the other side)	1 (5)

compared to the contralateral side. In addition, 10% of the patients reported experiencing localized pain; primarily in the distal radioulnar joint (Table 9). Notably, there were no instances of wrist stiffness observed in any of the cases.

One patient, representing 5% of the sample, encountered irritation in the extensor pollicis longus tendon, attributed to prolonged volar to dorsal screw placement. Another patient, also comprising 5% of the group, developed wrist arthritis due to inadequate reduction and the presence of an articular step. Remarkably, there were no median nerve complications observed in any of the patients, and no intraoperative issues were reported.

Evaluation of results

The evaluation of outcomes was conducted use the demerit rating system developed by Gartland and Werley,[19] which incorporates both objective and subjective evaluations, residual deformity, and complications.

Utilizing the demerit ranking system developed by Gartland and Werley, our study discerned nine instances, constituting 45% of the total sample, which were classified as favorable outcomes. Within the full scope of the sample, 45% demonstrated favorable results, 10% presented moderate outcomes, and notably, there were no occurrences of unfavorable outcomes (Table 10 and Figure 5).

DISCUSSION

The results of this study highlight the effectiveness of the Ellis plate in achieving positive outcomes for patients with distal radius fractures. A significant majority of patients exhibited satisfactory to excellent results, with a notable improvement in functional outcomes and a low incidence of complications. These findings are consistent with the study by Leung et al., which reported similar success rates in the use of volar locking plates for distal radius fractures.[8]

The high rate of good and excellent outcomes (90%) in our study underscores the potential of the Ellis plate in providing stable fixation and facilitating early mobilization.

Table 10: Response outcomes

Reward	Total number of responses (%)
Poor	0 (0)
Fair	2 (10)
Good	9 (45)
Excellent	9 (45)

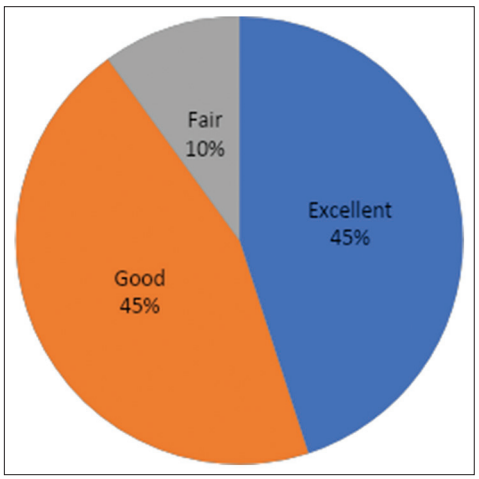


Figure 5: Response outcomes

This is in line with the findings of Fitoussi et al., who emphasized the importance of stable internal fixation in achieving optimal functional recovery.

Furthermore, our study observed a rapid union rate, with 80% of patients achieving fracture union within 2–3 months. This is comparable to the results reported by Gerostathopoulos et al., who also noted a quick union time with the use of fixed-angle locking plates.[2]

The low incidence of complications in our study, such as tendon irritation and wrist arthritis, further supports the safety profile of the Ellis plate. This is consistent with the findings of Ruch, who reported a low complication rate with the use of volar plates for distal radius fractures.[3]

Finally, our study reaffirms the efficacy of the Ellis plate in the management of distal radius fractures, aligning with the existing literature on the subject. The positive outcomes, rapid union rates, and low complication rates observed in this study contribute to the growing body of evidence supporting the use of volar locking plates in the treatment of these fractures.

Limitations of the study

In this study on the efficacy of the Ellis plate for distal radius fractures, several limitations should be considered. The sample size was relatively small and conducted in a single-center setting, potentially limiting the generalizability of the findings. The follow-up period was restricted to one year, which may not capture long-term outcomes

or late complications. The study lacked a control group for comparative analysis, and some outcome measures were subjective, potentially introducing bias. Additionally, important patient groups such as those with osteoporosis were excluded, and no cost-effectiveness analysis was conducted. These limitations highlight the need for further research with larger, more diverse populations and longer follow-up periods.

CONCLUSION

The utilization of Ellis plates in the management of distal end radius fractures has consistently yielded positive outcomes, ranging from satisfactory to truly exceptional. These plates have demonstrated their efficacy in not only rectifying but also preserving the anatomical integrity of the distal radial region.

Notably, the implementation of Ellis plates has proven instrumental in expediting the rehabilitation process, facilitating the restoration of joint mobility, and enhancing overall everyday functionality within a notably abbreviated timeframe. This underscores the profound impact of this approach, aligning with the most recent literature in the field.

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