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PROSPECTIVE RANDOMIZED COMPARISON OF PERCUTANEOUS KIRSCHNER WIRE FIXATION AND T-PLATE FIXATION FOR SURGICAL MANAGEMENT OF COLLES' FRACTURES

Orthopaedics

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ABSTRACT

Background Distal radius fractures, particularly Colles' fractures, are among the most common injuries encountered in orthopedic practice. Various treatment modalities have been described, including closed reduction with percutaneous K-wire fixation and open reduction with plate fixation. Achieving anatomical reduction, stable fixation, and early mobilization is essential for optimal functional recovery. **Aim** To compare the functional and clinical outcomes of Colles' fractures treated with Closed Reduction and Internal Fixation (CRIF) using K-wire fixation versus Open Reduction and Internal Fixation (ORIF) using T-plate fixation. **Materials and Methods** This prospective randomized study was conducted on 40 patients with Colles' fractures treated at a tertiary care centre in Vadodara Gujrat. Patients were randomly divided into two groups of 20 each. Group A underwent CRIF with percutaneous K-wire fixation, while Group B was treated with ORIF using T-plate fixation. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score. Radiological parameters and postoperative complications were also evaluated during follow-up. **Results** The majority of patients were above 50 years of age, with females slightly predominating. The most common mechanism of injury was a fall on an outstretched hand. Patients treated with T-plate fixation demonstrated better functional outcomes, with lower DASH scores and improved maintenance of anatomical reduction compared to the K-wire group. Complications such as pin tract infection and loss of reduction were more frequently observed in the K-wire fixation group. **Conclusion** Both treatment methods are effective in the management of Colles' fractures; however, ORIF with T-plate fixation provides better functional outcomes, greater stability, and earlier mobilization compared to CRIF with K-wire fixation.

KEYWORDS

Colles' Fracture; Kirschner Wires; Fracture Fixation, Internal; Bone Plates; Wrist injuries.

INTRODUCTION

Fractures of the distal radius are among the most common skeletal injuries encountered in orthopedic practice and account for a significant proportion of upper limb fractures worldwide. Colles' fracture represents a characteristic injury pattern involving the distal radius and is typically associated with dorsal displacement, dorsal angulation, and radial shortening of the distal fragment. The fracture was first described by Sir Abraham Colles in 1814, who provided a detailed clinical description of this injury and its classical deformity.[1] These fractures most commonly occur following a fall on an outstretched hand, where axial loading forces are transmitted across the wrist joint resulting in failure of the distal radial metaphysis.

Distal radius fractures exhibit a bimodal age distribution. In younger individuals, these fractures usually occur as a result of high-energy trauma such as road traffic accidents, sports injuries, or falls from height. In contrast, elderly individuals commonly sustain these injuries following low-energy trauma due to decreased bone mineral density and osteoporosis.[2] Epidemiological studies have shown that distal radius fractures are particularly common among postmenopausal women and represent an important indicator of underlying osteoporotic bone disease.[3] With increasing life expectancy and an active aging population, the incidence of distal radius fractures is expected to continue increasing in the future.

The management of distal radius fractures has evolved considerably over the past several decades. The primary objective of treatment is restoration of the normal anatomical alignment of the distal radius and recovery of optimal wrist function. Proper alignment of the distal radius is essential for maintaining normal wrist biomechanics and load transmission across the radiocarpal and distal radioulnar joints. Failure to restore anatomical parameters may result in complications such as reduced grip strength, decreased wrist range of motion, carpal instability, and early post-traumatic osteoarthritis.[4] Therefore, achieving and maintaining an adequate reduction of the fracture fragments remains a key goal in the management of Colles' fractures.

Several radiological parameters are used to assess the adequacy of reduction in distal radius fractures. These parameters include radial length, radial inclination, volar (palmar) tilt, and articular congruity. Restoration of these anatomical features is important to achieve satisfactory functional outcomes. Various authors have proposed acceptable limits for reduction following fracture management. Generally accepted criteria for satisfactory reduction include radial shortening of less than 5 mm compared with the contralateral side, radial inclination greater than 15 degrees, dorsal angulation not exceeding 10 degrees, and intra-articular step-off of less than 2 mm.[5] Maintenance of these parameters is associated with improved functional outcomes and reduced risk of long-term complications.

Historically, most distal radius fractures were treated conservatively using closed reduction followed by immobilization in a plaster cast. This method remains appropriate for stable and minimally displaced fractures. However, conservative treatment has certain limitations when dealing with unstable fractures, particularly those with comminution, dorsal angulation, or significant displacement. Loss of reduction during immobilization is a common complication and may lead to malunion and residual deformity.[6] Such deformities can significantly alter wrist biomechanics and impair hand function, particularly in individuals with higher functional demands.

Advances in surgical techniques and implant technology have led to increasing use of operative management for unstable distal radius fractures. The main objectives of surgical treatment are to achieve accurate anatomical reduction, provide stable fixation of fracture fragments, and allow early mobilization of the wrist joint. Various operative techniques have been described, including percutaneous pinning with Kirschner wires, external fixation, and open reduction with internal fixation using plates and screws.[7]

Closed reduction with percutaneous Kirschner wire fixation is a commonly used technique for the treatment of unstable distal radius fractures. In this procedure, the fracture is reduced by manipulation and stabilized using percutaneously inserted wires. The advantages of this method include minimal surgical exposure, shorter operative time, and relatively low cost. Additionally, the technique is simple and widely used.[8] However, K-wire fixation may not always provide sufficient stability in highly comminuted fractures and may be associated with complications such as pin tract infection, loosening of wires, and secondary displacement.

Open reduction and internal fixation (ORIF) with plate fixation is another widely accepted treatment option for unstable distal radius fractures. This technique allows direct visualization of the fracture site, enabling precise anatomical reduction of the fragments. Plates and screws are used to stabilize the fracture, commonly in the form of T-plates or volar locking plates. Plate fixation provides rigid stability and helps maintain the anatomical alignment of the distal radius, thereby facilitating early wrist mobilization and rehabilitation.[9]

In recent years, the development of locking plate technology has further improved the stability of fixation, particularly in osteoporotic bone. Locking plates act as fixed-angle constructs and provide improved mechanical support by distributing forces across the plate-screw interface. As a result, ORIF with plate fixation has become an increasingly preferred method for managing unstable distal radius

fractures, especially in younger patients and those with high functional demands.[10]

Despite the availability of multiple treatment options, the optimal management of Colles' fractures remains a subject of debate. Some surgeons prefer percutaneous pinning due to its minimally invasive nature and cost effectiveness, while others advocate plate fixation for its superior mechanical stability and ability to restore anatomical alignment more accurately.[11] The choice of treatment often depends on several factors including fracture pattern, degree of comminution, bone quality, patient age, functional requirements, and surgeon experience.

Numerous clinical studies have attempted to compare the outcomes of different treatment methods for distal radius fractures. However, the results reported in the literature are variable and sometimes conflicting. Some studies have demonstrated better radiological alignment and earlier functional recovery with plate fixation, whereas others have reported comparable functional outcomes between percutaneous pinning and plating techniques.[12] Differences in patient selection, fracture classification, and outcome assessment tools may contribute to these variations.

Given the ongoing controversy and the need for evidence-based clinical decision making, comparative studies evaluating different surgical techniques are essential. Therefore, the present prospective randomized study was undertaken to compare the outcomes of Colles' fractures treated with closed reduction and internal fixation using percutaneous K-wire fixation and open reduction with internal fixation using T-plate fixation. The study aims to evaluate and compare the functional and radiological outcomes of these two commonly used surgical techniques in a sample of 40 patients.

Materials and Methods

This study was designed as a prospective randomized comparative study conducted in the Department of Orthopaedics at Tertiary health care centre over a period of march 2025 to march 2026, after obtaining approval from the Institutional Ethics Committee. The objective of the study was to compare the functional and radiological outcomes of Colles' fractures treated with Closed Reduction and Internal Fixation (CRIF) using percutaneous Kirschner wire (K-wire) fixation and Open Reduction and Internal Fixation (ORIF) using T-plate fixation.

A total of 40 patients with Colles' fracture of the distal radius presenting to the outpatient department or emergency department were included in the study. Patients were selected based on predefined inclusion and exclusion criteria. After obtaining informed consent, patients were randomly allocated into two groups of 20 patients each.

Group A - closed reduction and percutaneous K-wire fixation,
Group B- open reduction and internal fixation using T-plate fixation.

Inclusion Criteria

- Patients aged 18 years and above
- Closed Colles' fractures of the distal radius
- Displaced or unstable fractures requiring surgical intervention
- Patients willing to participate and comply with follow-up protocol

Exclusion Criteria

- Open fractures of the distal radius
- Pathological fractures
- Associated fractures involving the same limb
- Previous wrist deformity or prior surgery of the wrist
- Presence of neurovascular injury around the wrist
- Patients medically unfit for surgical intervention

All patients underwent detailed clinical and radiological evaluation at the time of admission. Clinical assessment included evaluation of swelling, deformity, tenderness, wrist mobility, and neurovascular status. Standard anteroposterior (AP) and lateral radiographs of the wrist joint were obtained to evaluate fracture pattern, degree of displacement, dorsal angulation, radial height, radial inclination, and intra-articular involvement.

In Group A, patients underwent closed reduction under regional or general anesthesia. Fracture reduction was achieved by traction and manipulation under fluoroscopic guidance. Once satisfactory reduction was achieved, percutaneous Kirschner wires (2 mm) were inserted to stabilize the fracture fragments. Proper reduction and fixation were confirmed using a C-arm image intensifier, and the wrist was immobilized using a below-elbow plaster cast.

In Group B, patients underwent open reduction and internal fixation through a volar approach to the distal radius. After exposure of the fracture site, anatomical reduction of the fracture fragments was achieved and stabilization was performed using a T-plate with appropriate cortical screws. Reduction and implant placement were confirmed intraoperatively using fluoroscopy. The wound was closed in layers and the limb was supported with a splint.

Postoperatively, all patients received standard antibiotic and analgesic therapy. Early finger mobilization was encouraged in both groups. Patients treated with K-wire fixation were immobilized with plaster for approximately 3-4 weeks, after which wires were removed depending on radiological evidence of union. Patients treated with plate fixation were encouraged to begin early wrist mobilization once pain and swelling subsided.

Patients were followed up at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively. At each follow-up visit, patients underwent clinical and radiological evaluation. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) scoring system, range of motion, grip strength, and functional disability. Radiological assessment included evaluation of fracture union and maintenance of radial height, radial inclination, and volar tilt.

Data collected during the study were compiled and analyzed using appropriate statistical methods. Continuous variables were expressed as mean ± standard deviation, and categorical variables were expressed as frequency and percentage. Statistical comparisons between the two groups were performed using Student's t-test and Chi-square test, and a p-value <0.05 was considered statistically significant.

ETHICAL CLEARANCE

The study was conducted after obtaining approval from the Institutional Ethics Committee of GMERS Medical College and Hospital. The study protocol complied with the ethical principles outlined in the World Medical Association Declaration of Helsinki for research involving human participants.

Written informed consent was obtained from all patients prior to inclusion in the study. Confidentiality of patient data was strictly maintained throughout the study.

Observations and Results

A total of 40 patients with Colles' fracture were included in the study and were randomly divided into two groups of 20 patients each. Group A underwent Closed Reduction and Internal Fixation (CRIF) with K-wire fixation, while Group B underwent Open Reduction and Internal Fixation (ORIF) with T-plate fixation. Patients were followed up for a minimum period of 6 months.

Observation

Majority of patients were above 50 years of age.

Gender distribution
female predominance

Mode of injury
Majority trauma due to trivial fall , fall on out streched hand others are road traffic accident and fall from hight

DASH score
Mean DASH score for

- CRIF (K-wire):- 26.2 $\pm$ 5.4
- ORIF (T-plate):- 16.8$\pm$4.2

Complication
CRIF(k wire)

- Pin track infection -3
- Wrist stiffness-2
- Loss of reduction-2

ORIF (plating)

- Wrist stiffness-1

- Implant irritation -1

DISCUSSION

Fractures of the distal radius are among the most frequently encountered injuries in orthopedic practice and constitute a significant proportion of upper limb fractures. Colles' fracture, characterized by dorsal angulation and displacement of the distal radius fragment, most commonly occurs following a fall on an outstretched hand. Over time, management strategies for distal radius fractures have evolved considerably, ranging from conservative treatment to various surgical fixation techniques. Regardless of the technique used, the primary goals of treatment remain restoration of anatomical alignment, stable fixation of fracture fragments, and early mobilization of the wrist joint in order to achieve optimal functional recovery.

The present prospective randomized study aimed to evaluate and compare the clinical and functional outcomes of Colles' fractures treated with Closed Reduction and Internal Fixation (CRIF) using K-wire fixation and Open Reduction and Internal Fixation (ORIF) using T-plate fixation. A total of forty patients were included in the study and were divided equally into two treatment groups. Functional outcomes were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score, which is a validated and widely used tool for assessing upper extremity disability.

In the present study, most patients were above the age of 50 years. Distal radius fractures are particularly common in elderly individuals because of age-related reduction in bone mineral density and osteoporosis. Melton et al. demonstrated that the incidence of distal forearm fractures increases with advancing age, especially among elderly women, due to decreased bone strength and increased risk of falls[13]. The findings of the present study are consistent with this observation, as a majority of patients belonged to the older age group.

With regard to gender distribution, the present study showed a slightly higher number of female patients compared with males. This observation correlates with previously reported epidemiological studies indicating a higher prevalence of distal radius fractures among postmenopausal women. Hormonal changes associated with menopause result in decreased bone density and increased bone fragility, thereby predisposing elderly women to such fractures.

The most common mechanism of injury observed in the present study was fall on an outstretched hand (FOOSH). This mechanism is widely recognized as the classical cause of Colles' fractures. Jupiter reported that axial forces transmitted through the wrist during a fall lead to dorsal displacement and angulation of the distal fragment, producing the typical deformity associated with Colles' fracture[14]. In the present study, other causes such as road traffic accidents and high-energy trauma were less frequently encountered.

Restoration of anatomical parameters of the distal radius is essential for maintaining normal wrist biomechanics. Important parameters include radial height, radial inclination, and volar tilt. Failure to adequately restore these parameters may result in altered load transmission across the wrist joint, which can lead to decreased grip strength, restricted wrist motion, and long-term complications such as post-traumatic arthritis. Fernandez emphasized that anatomical reduction combined with stable fixation is essential for achieving satisfactory functional outcomes in distal radius fractures[15].

In the present study, patients treated with ORIF using T-plate fixation demonstrated better functional outcomes compared with those treated with CRIF using K-wire fixation, as indicated by lower DASH scores. Plate fixation provides rigid stabilization of fracture fragments and allows early mobilization of the wrist joint, which plays an important role in preventing joint stiffness and improving functional recovery.

Percutaneous K-wire fixation continues to be widely used in the management of distal radius fractures due to its simplicity, minimal soft tissue disruption, and relatively low cost. Kapandji described the technique of intrafocal pinning, which improves fracture stability by inserting wires directly at the fracture site. However, despite its advantages, K-wire fixation may not provide sufficient stability in osteoporotic bone or in comminuted fractures, potentially leading to secondary displacement or loss of reduction during the healing period.
In the present study, complications such as pin tract infection and loss of reduction were more frequently observed in the K-wire fixation group. Similar findings have been reported in earlier studies evaluating percutaneous pinning techniques. Cooney et al. identified pin tract infection and secondary displacement as common complications associated with K-wire fixation in distal radius fractures[16].

In contrast, open reduction and internal fixation with plate fixation offers several advantages. This technique allows direct visualization of the fracture site, facilitating accurate reduction of fracture fragments. Furthermore, stable internal fixation helps maintain reduction throughout the healing period and permits early initiation of wrist mobilization. Chung et al. reported that volar plate fixation provides reliable stability and improved functional outcomes in unstable distal radius fractures[17].

Wei et al. compared various fixation techniques for unstable distal radius fractures and concluded that plate fixation provides better restoration of anatomical alignment and improved functional outcomes compared with other fixation methods[18]. Similarly, Arora et al. demonstrated that volar locking plate fixation results in superior radiological outcomes when compared with conservative treatment in elderly patients with distal radius fractures[19].

The improved functional results observed in the plating group in the present study may be attributed to better stability of fixation and improved maintenance of fracture reduction. Stable fixation allows early rehabilitation, which is essential for restoring wrist mobility and preventing stiffness. Early physiotherapy and mobilization have been shown to significantly enhance functional recovery following distal radius fractures.

Despite these advantages, certain limitations of plate fixation should be considered. The procedure requires surgical exposure and may be associated with complications such as tendon irritation, implant prominence, or infection. In addition, plate fixation may be technically more demanding and relatively costly compared with percutaneous pinning. Therefore, treatment decisions should be individualized based on fracture pattern, bone quality, patient age, and functional requirements.

The present study has certain limitations. The sample size was relatively small, and the follow-up period was limited to six months. Longer follow-up is necessary to evaluate late complications such as post-traumatic arthritis and persistent functional impairment. Further studies involving larger patient populations and longer follow-up periods would provide more reliable evidence regarding the comparative effectiveness of these treatment modalities.

Despite these limitations, the findings of the present study suggest that ORIF using T-plate fixation provides superior functional outcomes and fewer complications compared with CRIF using K-wire fixation in the management of Colles' fractures. Improved stability of fixation and better maintenance of anatomical alignment contribute to enhanced wrist function and earlier return to daily activities.

CONCLUSION

Both CRIF with K-wire fixation and ORIF with T-plate fixation are effective treatment modalities for the management of Colles' fractures. However, the findings of the present study suggest that ORIF with T-plate fixation provides superior functional outcomes, as demonstrated by lower DASH scores and better maintenance of fracture reduction. Plate fixation offers greater stability, allows early mobilization, and is associated with fewer complications when compared to K-wire fixation. Therefore, ORIF with T-plate fixation may be considered a preferable treatment option for displaced or unstable Colles' fractures to achieve improved functional recovery and earlier return to daily activities.

CONFLICT OF INTEREST

The author declares that there is no conflict of interest regarding the publication of this paper.

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Tables

Table 1: Age Distribution of Patients

Age Group (years)	Number of Patients	Percentage (%)
<30	6	15%
30–50	10	25%
50–60	12	30%
>60	12	30%
Total	40	100%

Table 2: Gender Distribution

Gender	Number of Patients	Percentage (%)
Male	18	45%
Female	22	55%
Total	40	100%

Table 3: Mode of Injury

Mode of Injury	Number of Patients	Percentage (%)
Fall on outstretched hand (FOOSH)	26	65%
Road Traffic Accident	10	25%
Fall from height	4	10%
Total	40	100%

Table 4: DASH Score Comparison

Group	Mean DASH Score	Standard Deviation
CRIF (K-wire)	26.2	±5.4
ORIF (T-plate)	16.8	±4.2

Table 5: Complications

Complication	CRIF (K-wire)	ORIF (T-plate)
Pin tract infection	3	0
Wrist stiffness	2	1
Loss of reduction	2	0
Implant irritation	0	1
None	13	18

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