Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v6i3.1620
*Biol. Clin. Sci. Res. J., Volume 6(3), **2025**: 1620*
Original Research Article

Functional outcomes of extra-articular distal radius fracture using T-buttress plate

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(Received, 24th November 2024, Accepted 8th March 2025, Published 31st March 2025)

Abstract: *Extra-articular distal radius fractures are common upper limb injuries, and optimal surgical intervention remains debated. While Kirschner's wire (K-wire) fixation is traditionally used, volar locking plates such as the T-butterfly (T-buttress) plate offer potentially superior outcomes.* ***Objective:*** *To assess the functional outcome of extra-articular distal radius fractures treated with T-buttress volar locking plate compared to closed reduction and K-wire fixation.* ***Methods:*** *This quasi-experimental study was conducted at SKBZ/CMH Muzaffarabad after obtaining ethical approval from January to July 2023. A total of 70 patients aged 20–40 years with extra-articular distal radius fractures were randomized into two equal groups: Group T (open reduction and internal fixation with T-buttress volar locking plate) and Group K (closed reduction and K-wire fixation followed by plaster immobilization). Functional outcomes were evaluated at 20 weeks postoperatively using a standardized scoring system.* ***Results:*** *In Group T, 12 patients (34.3%) had excellent outcomes, 20 (57.1%) had good outcomes, and 3 (8.6%) had fair outcomes, with no poor outcomes reported. In Group K, two patients (5.7%) had excellent outcomes, 18 (51.4%) had good outcomes, 12 (34.3%) had fair outcomes, and three patients (8.6%) had poor outcomes. Functional outcomes were significantly better in Group T compared to Group K ($p < 0.05$).* ***Conclusion:*** *The use of T-buttress volar locking plate for the fixation of extra-articular distal radius fractures provides superior functional outcomes with fewer complications compared to K-wire fixation. It should be considered a preferred method of surgical management for such fractures in young adults.*

Keywords: Closed Reduction Extra-Articular Fracture, Functional Outcome, Green and O'Brien Score, Kirschner's Wires, Radius and Open Reduction

[***How to Cite:*** Rasheed H, Mahmood K, Khan SH, Arra I, Summyia. Functional outcomes of extra-articular distal radius fracture using t-buttress plate. *Biol. Clin. Sci. Res. J.*, **2025;** 6(3): 69-72. doi: https://doi.org/10.54112/bcsrj.v6i3.1620

Introduction

Although surgical and non-operative methods can be used to treat distal radius fractures, there has been a notable shift in favor of operative management of distal radius fractures. For intra- and extra-articular fractures, closed reduction with plaster cast immobilization has historically been the favored treatment. (1) Over the past few decades, various other modalities has become part of operational management including Kirschner wires, plates, external fixators, volar locking plates and intramedullary implants. When used appropriately, these devices have produced good functional results. (2) Volar locking devices improve stability, allow early mobilization, and offer biomechanical benefits. They have contributed significantly to increased rates of operative treatment of extra-articular fractures. (3)However, tendon irritation is believed to result in greater complaints and complications, and the extensive dissection of soft tissue may lead to wound healing issues. (4) There is still disagreement regarding which of these approaches is better for treating extra-articular distal radius fractures.

Historically, thicker non-contoured implants were used in a region with minimal soft tissue coverage when dorsally applied plates, like the oblique T plate, were used to treat distal radius fractures. Although it made biomechanical sense to utilize a dorsal buttress plate, the concomitant problems with the extensor tendon limited its application. (5) The Pi-plate was the first generation of dorsal locking plates to be introduced. This plate construct offered the advantage of a fixed-angle device that would stabilize the articular and metaphyseal displacement and offer a stable internal fix for displaced distal radius fractures. (6) The plate immediately reduced the likelihood of a fracture, and patients returned to the dorsal angulation position. However, more than 20% of individuals had issues with their extensor tendons. (7) More recently, lower-profile pre-contoured locking titanium plates with a thickness of 1.5 mm have been created to treat
problems with the tendon related to dorsally applied locked plates. (8)

There is currently a shortage of literature describing the results of using these lower-profile titanium volar locking plates. This study will present functional outcomes of extra-articular distal radius fractures using a T-buttress plate, utilizing a titanium locking volar plate with a modest profile. Current guidelines recommend closed reduction and plaster cast immobilization as the main therapy for extra-articular distal radius fractures. We will compare minimally invasive techniques with operative management using a T-buttress volar locking plate and try to find which treatment translates into fewer consequences and has a better functional outcome.

Methodology

After getting permission from the hospital's ethical committee. The study was conducted in the orthopedic department from January to July 2023. The sample size was calculated with the help of the WHO sample size calculator, keeping the level of significance at 5%, the power of the test at 80%, the percentage of good functional outcomes after closed reduction to be 13%9 and with the t-plate to be 46% (9). The sample size came out to be 29. We collected a sample of 70 patients in total through non-probability consecutive sampling and randomized them into two groups: T and K. Inclusion criteria: The patients with age ranging from 20-40 years were included in the study that had no known co-morbids and who had extra-articular fracture of distal radius less than 5 days old. All the patients with distal radius fractures with dorsal angulation and

displacement within 2 cm of the articular surface were included. (10) Exclusion criteria: The patients with open fractures were excluded. The patients were booked from either the outpatient or the emergency department. The patients were subjected to detailed examination before preparing for surgery, and consent was taken from all patients. The patients were randomized into two groups through a sealed envelope. Half of the patients were subjected to closed reduction (Group K) and half to open reduction (Group T).

On the day of surgery, all patients were given general anesthesia. A single surgeon performed all surgeries to avoid the operator's bias. The closed reduction was performed in group K patients. The Kirschner's wires (K-wire BRAND) were passed percutaneously under imaging (C-arm, COMPANY), and a plaster cast was applied after the procedure. In group C patients, the T-buttress volar locking plate was applied (COMPANY). The plate was applied to the volar surface of radius with the help of screws that resulted in formation of fixed angle. The water shed line was marked, and it was aligned as the distal margin of the T-plate. (11) Splints were applied to all patients after surgery for four weeks. Stitches were removed in group T patients on the tenth post-operative day. Plaster casts were removed from group K patients after 4 weeks. K-wires were removed at 6 weeks. The patients were asked to perform assisted movements and exercises for three months. At 5 months (20 weeks) of post-operative follow-up, the patients were examined thoroughly, and their functional outcome was measured using the Green and O'Brien Score (Cooney modification) scoring system (12), with a total score of 100. The patients who had score between 90-100 were labeled to have excellent functional outcome, the patients with scores between 80-89 were labeled to have good functional outcome, the patients with score of 65-79 had fair outcome and the patients with score less than 65 were labeled to have poor functional outcome as presented in Table-1. Age, weight, gender, and operative time were recorded for all patients. The secondary outcomes were frequent complications, including Swelling of fingers, pin tract or T-plate infection, tendon irritation or rupture, non-planned hardware removal, pain, and paresthesia.

Table 1: Green and O'Brien Score (Cooney modification)

Excellent functional outcome	**90-100**
Good functional outcome	80-89
Fair functional outcome	65-79
Poor functional outcome	<65

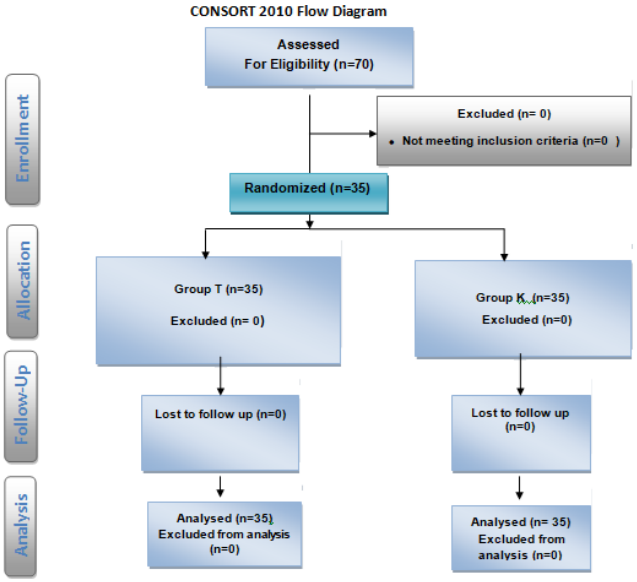

Figure-1

Results

A total of seventy relatively younger patients were included in the study to avoid confounding factors and possible bias. All the patients completed the study protocol. The primary outcome was functional outcome gauged through the T Green and O'Brien Score (Cooney modification) scoring system. The mean age of patients was similar in both groups. The mean age of group T patients was 34.34±8.38 years, and the mean age of group K patients was 31.94±5.97 years. The mean weight of group T patients was 68.00±4.41 Kg and the mean weight of group K patients was 70.03±5.28 Kg. There were 7(77.1%) males and 8(22.9%) females in group T. There were 29(82.9%) males and 6(17.1%) females in group K. The demographics were similar in both study groups. The mean operative time from incision to end of surgery was 67.77±5.39 in group T patients, and 36.0±6.36 in group K patients, with a p value of 0.001. The demographics are presented in Table 2.

The primary outcome variable was functional outcome, which was excellent in 12(34.3%) group T patients and 2(5.7%) group K patients. The functional outcome was good in 20(57.1%) group T and 18(51.4%) group K patients. The functional outcome was fair in 3(8.6%) group T and 12(34.3%) group K patients. No patient in group T had a poor functional outcome. In contrast, 3(8.6%) patients in group K had a poor functional outcome, as shown in Table 3. Overall, the complication rate was 4(11.4%) in group T and 19(54.3%) in group K, with a p-value <0.001. The frequencies of different complications are mentioned in Table 4.

Table 2: Demographic features of groups (n=70)

		Group T n=35	Group K n=35	p value
Mean Age (years)		34.34±8.38	31.94±5.97	0.786
Mean Weight (kilograms)		68.00±4.41	70.03±5.28	0.339
Mean operative time (minutes)		67.77±5.39	36.0±6.36	0.001
		Frequency (%)	Frequency (%)	
Gender	Male	2 7(77.1)	29(82.9)	0.383
	Female	8(22.9)	6(17.1)	

Table 3: The Frequencies of different categories of functional outcomes of study groups (n=70)

		Group T Frequency (%) n=35	Group K Frequency (%) n=35	p value
Functional outcome	Excellent	12(34.3)	2(5.7)	<0.001
	Good	20(57.1)	18(51.4)	
	Fair	3(8.6)	12(34.3)	
	Poor	0(0)	3(8.6)	

Table 4: Complications of both interventions in study groups (n=70)

		Group T Frequency (%) n=35	Group K Frequency (%) n=35	
Swelling	Yes	2(5.7)	9(25.7)	0.023
	No	33(94.3)	26(74.3)	
Infection	Yes	0(0)	3(8.6)	0.120
	No	35(100)	32(91.4)	
Tendon Rupture	Yes	0(0)	1(2.9)	0.500
	No	35(100)	34(97.1)	
Non-Planned Removal of K-Wire	Yes	0(0)	3(8.6)	0.120
	No	35(100)	32(91.4)	
Pain	Yes	1(2.9)	7(20.0)	0.027
	No	34(97.1)	28(80.0)	
Paresthesia	Yes	2(5.7)	8(22.9)	0.042
	No	33(94.3)	27(77.1)	

Discussion

Our study showed that the T-buttress plate had a better functional recovery than K-wiring and plaster cast. Our study included younger individuals who mostly sustained fractures as a result of high-energy trauma from sports and auto accidents. Distal radial fracture is an important problem in orthopedics, as almost eighty percent of the axial load is borne by the distal radius, and functional outcome is of prime importance. (13) Percutaneous K-wiring under imaging is extensively utilized along with additional plaster application for radial fractures, but there is a risk of residual functional limitation and pin tract infection. (14) In our study, pin tract infection was seen in 8.6% of patients who underwent K-wiring, and the functional outcome was inadequate in almost 17% of patients. There was no incidence of plate infection in patients in whom t-buttress plating was used as primary intervention. This evidence is supported by Markus Scharf (15) et al., who reported two cases of abscess formation with percutaneous K-wiring, and Tanner (16), who demonstrated that plating was less likely to be associated with bone infection.

A further issue with pin-in-plasters was that several of the patients in our study showed inadequate functional outcome by the end of 20 weeks post-operatively. According to Yu-Cheng Su (17), if the pin-in-plaster was removed too early, before the callus had established sufficiently to allow for early wrist range of motion, the fracture might lose reduction, and the functional outcome would be affected. In our patients, K-wires were removed in the sixth week in 91.4% of patients. Three (8.6%) patients had non-planned removal of K-wires due to infection. The functional outcome was poor in three patients in our study. The transient wrist stiffness was typical right after cast removal, for which exercises were required, and it settled by the end of 20 weeks in most of the patients in group K. Following 20 weeks, with the help of physical therapy and exercises, practically all the patients achieved a good range of motion in their wrists in both groups. However, many patients in group K had fair motion, which required further exercises.

Compared to open reduction and internal fixation with a locking plate, K-wiring seems faster, less expensive, and less invasive (18). K-wires' purchase cost is less than volar locking plates, but indirect costs may be higher (18). One of the limitations of T-plating is higher cost, especially in resource-limited countries where costs matter and affect patients' preferences. However, medical research aims to find better solutions and provide complete recovery, especially in young patients. The open reduction of a fracture by plating offers a more anatomically stable construct for early mobilization and can be helpful in extra-articular distal radial fractures. (19) In the past, plating of extra-articular fractures was associated with tendon rupture when the plates were of broader diameter and involved extensive soft tissue dissection. (20) The new generation T-buttress volar locking plate offers similar fracture stability with a lower risk of surrounding tendon irritation or rupture from the plate (21). A thicker and stronger implant resists load better. It offers a theoretical advantage in reducing the complication of tendon attrition due to an absence of flexor tendon–bone intimacy. (14) None of the patients in our T-plating group showed tendon injury, but paradoxically, the K-wiring

resulted in tendon rupture in one patient. The lack of tendon rupture can be partly attributable to the technique used by the surgeon. The surgeon positioned the plate on or close to the watershed line in all patients. The plate may occasionally need to be positioned quite far away. (22)
The overall complication rate was lower in group T. Hand swelling, post-operative pain, and paresthesia were significantly lower in the T-plating group compared to group K. (23) The operative time was higher with plating, but that was acceptable as long as recovery is adequate and complications are fewer. According to a systematic review by Todd H Alter et al, T-buttress plates have an overall lower complication rate despite complications like nerve compression and tendon irritation. (24)

Conclusion

We concluded that open reduction of extra-articular fractures of the distal radius with a T-buttress plate had better functional outcomes and fewer side effects.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-MMS-033-24)
Consent for publication
Approved
Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

HR (Postgraduate Trainee)
Drafting of work, design analysis, data acquisition, data interpretation, and approval of the final version to be published.
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Drafting of work, design analysis, data acquisition, data interpretation, and approval of the final version to be published.
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Drafting of work, critical review, and approval of the final version to be published.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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