
AI-Assisted Comparison of Volar Plating with and Without Carpal Tunnel Release in Distal Radius Fractures

Volar plating is a common treatment method used to treat distal end radius fractures that are remedied with an open reduction and internal fixation (ORIF). Still, dysfunction of the median nerve that occurs after the operation and acute carpal tunnel syndrome (CTS) are also critical complications that might interfere with normal functioning. There are some controversies concerning the advantages of carrying out a prophylactic carpal tunnel release (CTR) during the fracture fixing.

This chapter provides an AI-aided comparison of the equivalent number of patients with uncomplicated distal radius fractures receiving volar plating with or without comorbid CTR. The emphasis is put on family outcomes, nerve conduction and functional recovery. The prospective recording of adult patients was performed. Follow-ups that were evaluated included a standardized clinical examination, nerve conduction studies (NCV/EMG), and Patient-Rated Wrist Evaluation (PRWE) scores assessed at predetermined intervals. The comparison of the incidence of CTS, severity of median nerve dysfunction, complication rates, and fracture union, as well as functional outcomes between the two groups, was carried out using an AI-assisted data analysis.

The results indicated that patients who received volar plating with concomitant CTR experienced remarkably reduced cases of ongoing symptoms of CTS, enhanced electrophysiological conditions and enhanced segregation outcomes, compared to those who obtained volar plating. Significantly, CTR was not associated with the increase in surgical complications or fracture healing. These results indicate that AI-based assessment enhances clinical judgment and that prophylactic CTR could be beneficially used by high-risk patients undergoing volar plating of a distal radius fracture.

Chapter written by Abhishek SHARMA and Paresh V. PATIL.

For a color version of all the figures in this chapter, see www.iste.co.uk/kumar/orthopedic1.zip.

1.1. Introduction

Fractures of the distal radius end are among the most frequent injuries in orthopedic practice and form much of the upper-limb global fractures (Ochen et al. 2020). They occur across all ages. The predominant reasons behind high-energy trauma include road traffic injury, sporting injury and injury on an outstretched hand, but low-energy injuries are more common among aged osteoporotic patients. Since the wrist articulation, transmission of loads and functions of the hand depend on the distal radius; anatomy is better managed by ensuring the maintenance of the motion and prevention of long-term disability (Buijze et al. 2021).

There has been a radical transformation in treatment patterns of the distal radius fractures in recent decades. The closed reduction and casting are still appropriate to stable fractures, but unstable, displaced and intra-articular ones could require surgical intervention to attain acceptable results (Coon et al. 2022).

The surgical technique that has best emerged is open reduction and internal fixation (ORIF) by using volar locking plates, since they provide biomechanical stability, anatomical reduction and early mobility of the wrist. Volar plating has demonstrated positive outcomes in both the young and elderly patients, and has replaced, in most cases, the use of dorsal plating and the use of long-term external fixation (Maccagnano et al. 2021).

Although these are advantages, volar plating may still produce complications. Irritation or rupture of tendons, pain consisting of implants, loss of reduction, infection and neurovascular problems have been reported (Kew and Brockmeier 2021). Of the latter, the compression of the median nerve resulting in CTS is of high relevance since it may acutely affect recovery after surgery.

CTS is a condition that occurs as the result of compression of the median nerve in the carpal tunnel, which brings about pain, numbness, tingling and hand-weakness. In distal radius fractures, CTS can either happen acutely due to displacement and swelling of the fracture or occur postoperatively due to plate irritation, fibrosis, changed biomechanics of the carpal tunnel or edema (Malakootian et al. 2023).

Postoperative CTS is hard to diagnose and treat. The early symptoms of the disease may be disguised by the pain and swelling and delay the diagnosis and therefore increase the chance of irreversible nerve loss (Pergolizzi et al. 2023). Acute CTS qualifies as an orthopedic emergency since when compression is prolonged, sensory and motor losses are irreversible. The objective measure of the median nerve functioning is the nerve conduction test (NCV) and electromyography (EMG), which ultimately gives a positive diagnosis of the condition, severity and progress (Reimann and Wijesekera 2022).

One of the main controversies about distal radius fracture management is the use of CTR as a prophylaxis in volar plating. The supporters base their argument on the fact that early decompression will help to prevent postoperative median nerve compression, decrease chronic CTS and provide better outcomes. Critics respond with the argument that routine CTR can be avoided since post-surgery CTS can be a temporary condition and can clear up with conservative treatment, and further surgery can be very debilitating (Barnes et al. 2021).

New technologies in artificial intelligence (AI) and analytics based on data provide new solutions to the dilemma. AI-assisted analysis has the potential to combine large sets of data containing demographic information, clinical results, electrophysiological and functional outcome scores (Williams 2024).

AI tools make the process of comparative evaluation of outcomes more objective and precise by identifying increasingly intricate patterns and forecasting values. AI has shown promise in the classification of fractures, prediction of outcomes and risk stratification of complication, although little has been done in terms of assessing nerve-related prognosis, even after fractures of the distal radius have been fixed.

A deeper assessment of volar plating can be performed through the use of AI-controlled analysis to compare the volar plating with or without CTR to highlight the slight changes of nerve conduction and functional recovery patterns that cannot be easily identified with conventional statistics. The method is beneficial, as it is capable of recognizing patients that are at high risk of undergoing surgery early, as well as assisting in the evidence-based decision-making process of surgery.

Functional recovery is one of the major objectives in the treatment of distal radius fracture. Patient-Rated Wrist Evaluation scores (PRWE) specifically, patient-reported measures, help us to understand the perspective of the patient on the level of pain, disability, and general functionality of the wrist. The PRWE scores can be added to the electrophysiological data to offer a complete evaluation of the objective nerve recovery and see functional improvement as subjective (John et al. 2022).

The current study will focus on making an AI-aided comparison of volar plating in comparison to not including concomitant carpal tunnel release (CTR) among patients with distal radius fractures. The data objectives include describing changes in nerve conduction after surgery, assessing the incidence and predictive variables of acute CTS and comparing the functional result and level of complication in the two forms of surgery. The proposed study aims to elucidate the value of prophylactic CTR and add some evidence to improving surgical management measures of distal radius fractures in order to optimize AI-based analysis of clinical, electrophysiological and functional data.

1.2. Literature review

The fractures at the distal radius are frequent and comprise 15–20% of all fractures (Mehta et al. 2024). They are represented in two ages: one group through high-energy injuries such as motorbike accidents, and older adults because of osteoporosis, which makes them fall when standing due to height. The objectives of treatment are straightforward; position the bone in absolute mode, make the fracture non-inflammatory and restore the function of the wrist and hand as soon as possible.

Conventionally, these fractures were treated by physicians using closed reduction and a cast. Malunion, stiffness and disillusioning functioning were, however, caused by unstable patterns. They altered the game when volar locking plates were released. These provide high fixation, particularly in weak bone. Many studies have verified that volar plates have superior alignment on X-ray, permit remobilization sooner and have a higher functional score than dorsal plates or external fixation (Laohaprasitiporn et al. 2022).

The most common compressive neuropathy of the upper limb is carpal tunnel syndrome (CTS). This is caused by the compression of the median nerve within a carpal tunnel. Patients experience numbness, weakness, tingling and pain along the median-nerve territory. Idiopathic CTS is well known; however, CTS after a distal radius fracture has its own issues. It is increased by traumatic swellings, changed mechanics in the wrist and surgical predispositions (Lacinski et al. 2024).

It is well observed by many authors that a new CTS may be formed once a distal radius fracture has occurred. Carpal tunnel pressure is increased by swelling, blood clots or a displaced fracture. There is a great disparity in the rates reported (3–25%). Due to the possible permanent damage, the nerve may suffer due to long-term compression; the acute CTS is an emergency needing to be addressed within a short period of time.

Volar plating also excels regarding fracture stability, which may lead to median nerve issues following surgery. The problem has been associated by researchers with the position of plates that are positioned outside of the watershed line, excessive distal screws, agitated soft tissues and extended tourniquet periods. Fibrosis of the tunnel and scar tissue and enlarged synovium following surgery may also result in the squeeze of the nerve.

The surgery performed on a CTR cuts through the transverse carpal ligament to relieve pressure on the median nerve. The idiopathic CTS is the standard of CTR to use, but its proactive application during the repair of a distal radius fracture is debated.

Certain research believes that postoperative CTR reduces symptoms and improves functions in CTS prophylaxis, particularly in high-risk individuals. Others suggest that mild cases may clear themselves, so a wait-and-watch strategy is beneficial.

The gold standards of CTS diagnosis and the assessment of the degree of deficit involve NCV and EMG. Research has revealed that the delay in motor latency and slower sensory conductance is present among patients who develop CTS after a fracture. When these tests are used, an objective method is availed toward tracking nerve recovery in post-surgery patients (Hassan et al. 2021).

The PRWE is a typical patient-reported instrument to track pain and disability in the post-fracture of the distal radius (Hall et al. 2021; Kumar et al. 2026). It is consistently demonstrated in the results that patients in whom the median nerve compression is not treated, fair poorly. Premature nerve release results in faster recuperation, firm grip and an improved level of patient satisfaction.

Even though numerous studies are present, not many prospective comparisons have been performed concerning the shift in nerve conduction and functional outcomes between volar plating with CTR and without. Recent literature is exploring AI-based risk models and improvements and analysis that identify more at-risk patients in the process of postoperative CTS, which might be used to influence surgical decisions.

1.3. Materials and methods

1.3.1. Study setting and ethical approval

Our prospective study was conducted at the Orthopedics Department, KIMSUDU, Karad, India. The Institutional Review Board endorsed it, and informed consent was obtained by the participants after full disclosure. The total duration of study was eighteen months.

1.3.2. Study population and sample size

A total of 34 patients diagnosed with distal end radius fractures and meeting the inclusion and exclusion criteria were enrolled in this prospective study. These patients were randomly distributed between two groups, with 17 patients in each group, to reduce selection bias and ensure comparability.

In total, 34 patients with inclusion criteria were studied from March 2023 to September 2024 (18 months):

$$\begin{aligned} n &= 4pq/L2 \quad p = \text{Proportion of CTS in DER (14)} \quad q = 100-p \\ &\quad (100-14=86) \\ L &= \text{Precision} = 12\% \quad n = 4 * 14 * 86 / 144 = 34 \end{aligned}$$

The sample size comes out to be 34.

- *Group 1:* 17 patients were treated with ORIF along with CTR in the course of surgery.

- *Group 2:* 17 patients were treated with ORIF without CTR.

We also calculated the size of the sample on previous studies and what would be feasible within the period of 18 months between March 2023 and September 2024.

We got 34 patients in an attempt to closely monitor and ensure our data met the standard of accuracy and compared before and after surgery the frequency of the CTS occurrence and subsequent functioning.

1.3.3. Inclusion criteria

- Age should be greater than eighteen years old.
- All types of distal end radius fractures.
- Radiographic/computed tomography (CT) scan confirmation of distal end radius fracture.
- Treated definitively with volar plating fixation.

1.3.4. Exclusion criteria

- Other tunnel syndromes: Guyon's canal, cubital tunnel, radial tunnel syndrome.
- Pre-existing CTS symptoms.
- Previous median nerve symptoms or prior CTR.
- Alcohol or drug abuse.
- Hematological disorders: hemophilia, thalassemia.
- Corticosteroid use.
- Prior upper limb surgeries.

- Osteoporosis or post-menopausal CTS-like symptoms.
- Age is less than eighteen years old.
- Non-adherence to follow-up protocol (six months).
- Thyroid disorders.
- Old fractures (greater than three weeks).
- History of compartment syndrome.
- Open fractures.
- Systemic diseases affecting nerve function or healing (e.g. diabetes mellitus, rheumatoid arthritis).
- Treatment strategies excluding volar plating.

1.3.5. Study Groups

The population of the study was separated into two groups:

- *Group 1*: ORIF with CTR as one operation.
- *Group 2*: ORIF without CTR.

1.3.6. Preoperative assessment

- History and clinical examination.
- X-ray: AP and lateral views of the wrist.
- EMG/NCV study for nerve conduction assessment (baseline).
- Application of the below-elbow slab under traction.

1.3.7. Trauma-surgery interval

Patients were given medications and elevation for three to four days prior to surgery to reduce swelling.

1.3.8. Observation and result

This study compared two surgical approaches for distal radius fractures with suspected carpal tunnel involvement:

– *Group A (ORIF + CTR)*: patients underwent ORIF with simultaneous CTR during the same surgical procedure. This combined approach addresses both the fracture and potential median nerve compression concurrently.

– *Group B (ORIF Alone)*: ORIF without CTR, in which case, it was not carried out when it was not indicated.

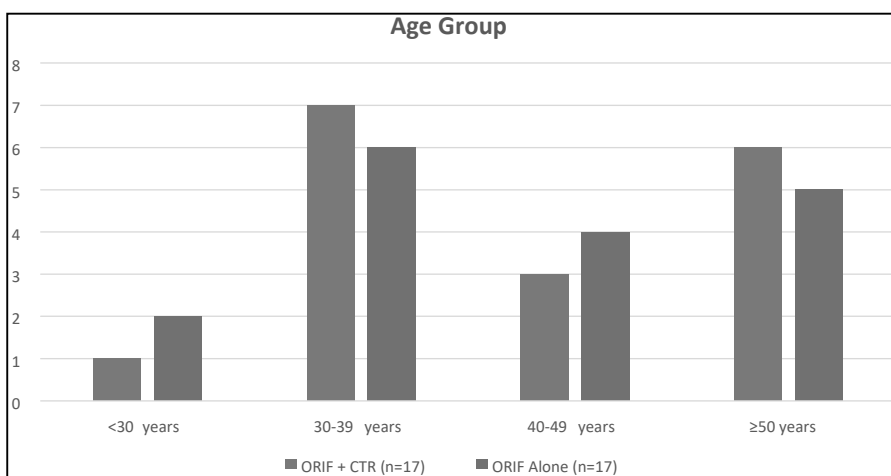


Figure 1.1. Age categories comparison

The age distribution of the groups was similar, and no notable differences were found ($P = 0.715$ in patients younger than 30), as shown in Figure 1.1. The highest number per cohort was the age group of 30–39 (41.2% versus 35.3%). Adolescents below 30 years made the least (5.9 versus 11.8). This shows that there is no selection bias on the basis of age.

There was no difference in gender distribution based on groups, with 70.6% of the ORIF + CTR, which consisted of men and 58.8% of ORIF-only, which consisted of men, as shown in Figure 1.2. The release group and ORIF-only group were 29.4 and 41.2%, respectively (women). The gender

difference was not significant since the P-value was 0.715 and, hence, the demographics were equal.

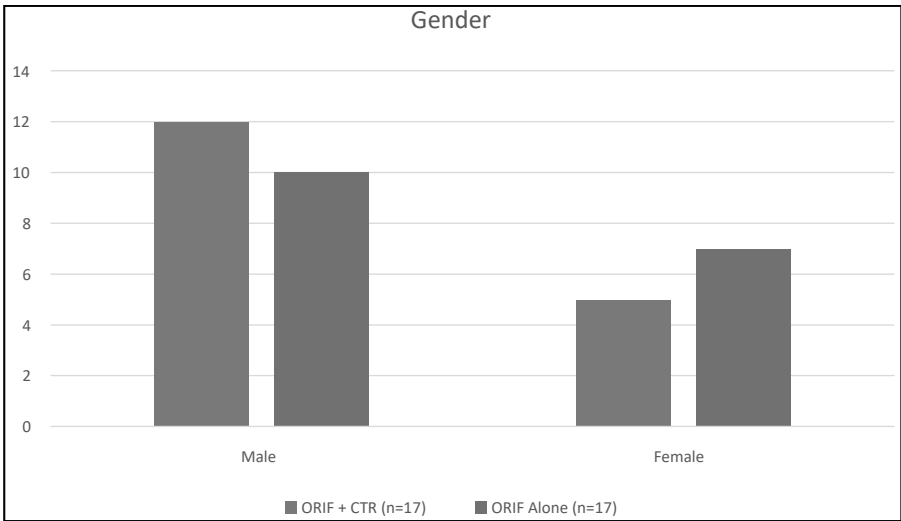


Figure 1.2. Gender distribution by treatment group

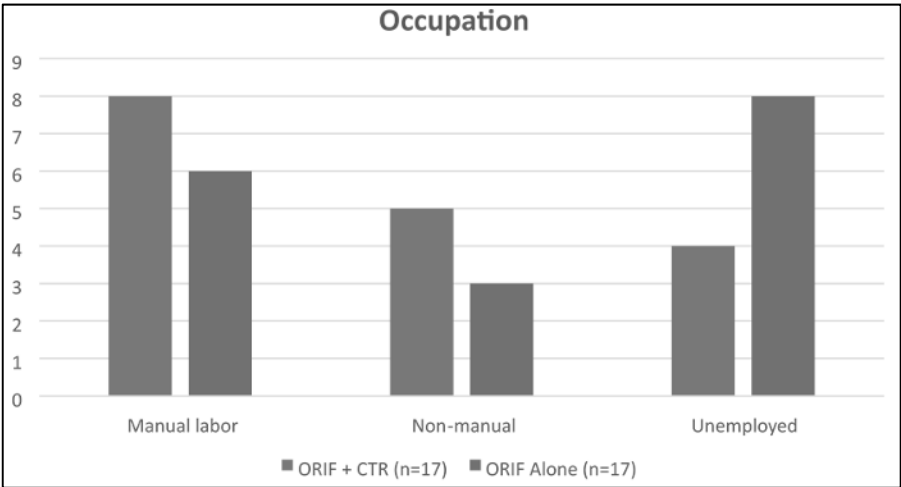


Figure 1.3. Occupation distribution by treatment group

The largest group of occupational activities in both arms was manual laborers (47.1% in ORIF + CTR versus 35.3% in ORIF-only) as shown in Figure 1.3. The unemployment rate among the patients of the ORIF-only group was higher (47.1 versus 23.5). The difference, even though not significant ($P = 0.283$), can have an impact on functional outcomes, as job demands also have effects on recovery and rehabilitation. Otherwise, there was no difference between groups on non-manual workers (29.4 versus 17.6).

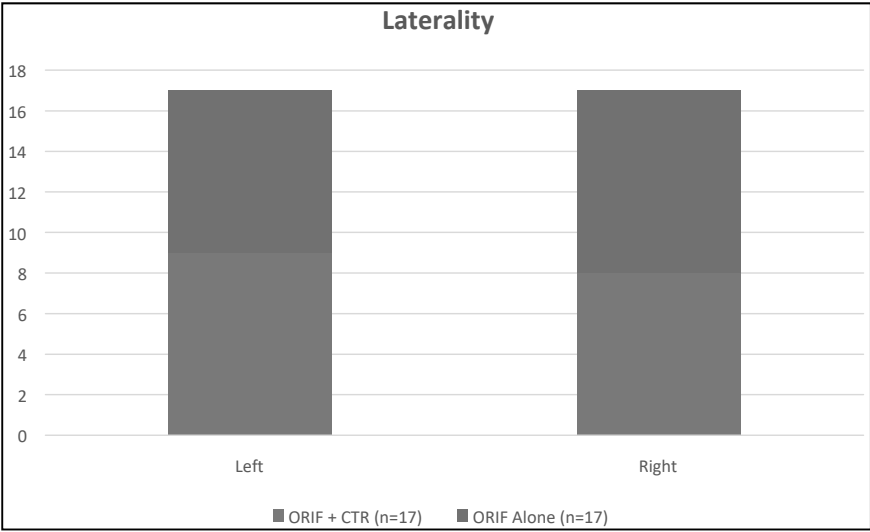


Figure 1.4. Laterality distribution by treatment group

Group-to-group laterality of injuries was almost the same. Left-sided injuries in the ORIF + CTR group were 52.9% and right-sided injuries were 52.9% in the ORIF-only group, as shown in Figure 1.4. No significant bias is ensured by the fact that the value of P equals 0.999. In the distribution of dominant versus non-dominant involvement of the hands, there is also an additional support for similar functional outcome measurements.

The mechanisms of injury were intergroup comparable. There was 41.2% and 52.9% variability in falls that happened in ORIF + CTR and ORIF-only cases, respectively. The percentage of ORIF + CTR injuries and ORIF-only injuries was 41.2 and 35.3, respectively, in road-traffic accidents. Assault represented one case only (neighborhood survey) in the mixed group. The

P-value of 0.621 does not reveal a significant difference, therefore indicating the same level of injuries during the baseline and eliminating confounding factors when comparing the results of treatment. The equal distribution increases the validity of postoperative comparisons.

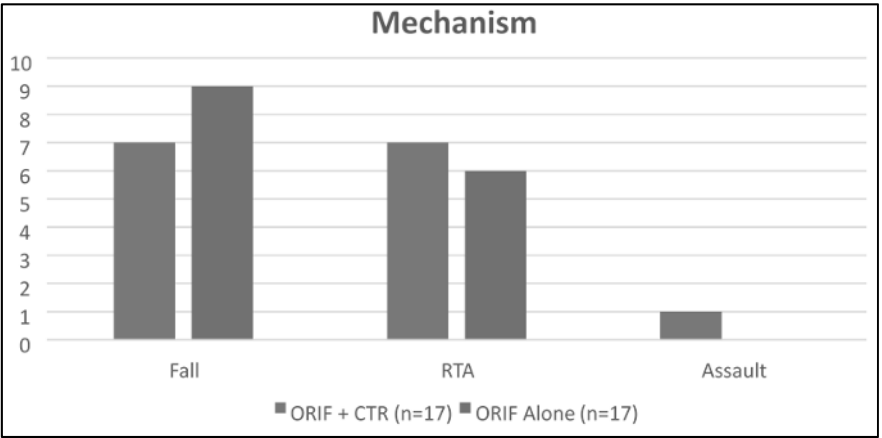


Figure 1.5. Mechanism of injury distribution by treatment group

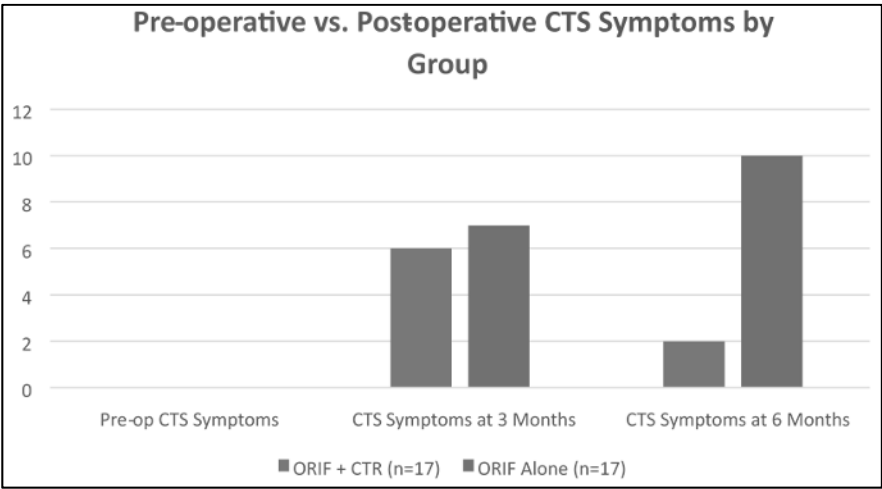


Figure 1.6. Pre-operative versus postoperative CTS symptoms by group

The patients did not have any preoperative CTS. Compared to the ORIF-only group, which was 58.8, the ORIF + CTR group had a significantly lower persistent CTS symptoms rate (58.8%, $*p = 0.008$). The three-month results showed no difference ($P = 0.500$), but the addition of CTR was found to cushion the long-term CTS, as by six months, a significant difference had been observed.

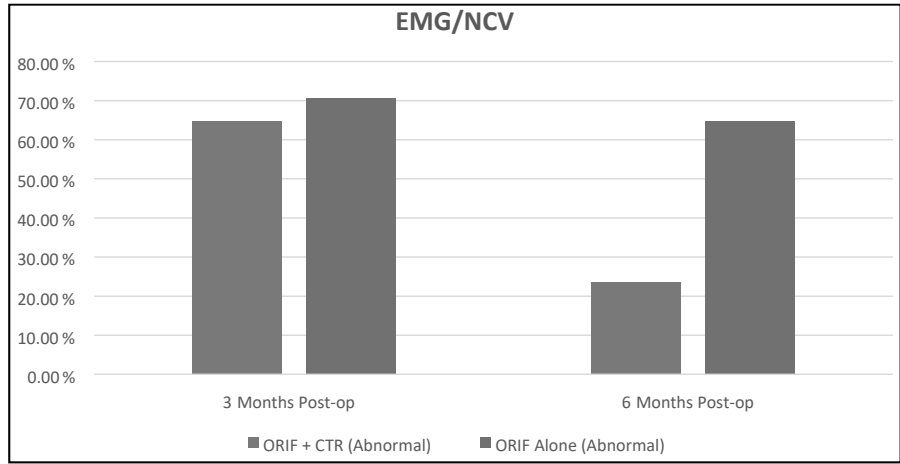


Figure 1.7. *Postoperative nerve conduction (EMG/NCV) abnormalities by treatment group*

At three months postoperation, abnormal findings were observed in 64.7% of ORIF + CTR patients compared to 70.6% of ORIF-alone patients. By six months, the ORIF + CTR group showed substantial improvement with only 23.5% abnormal cases, while the ORIF-alone group maintained a high rate of abnormal findings at 64.7%. This suggests that combined ORIF with CTR may lead to better long-term outcomes compared to ORIF alone, with a notable reduction in persistent abnormalities at the six-month follow-up.

There was no significant difference in the number of postoperative complications in the two cohorts ($P > 0.05$ in all of the comparisons). Nerve agitation was the case in 29.4% of ORIF + CTR and 23.5% of CTR cases ($P = 0.500$). The tendency toward tendon irritation was less in the mixed group (17.6% versus 29.4%; $P = 0.480$). Other major complications, plate loosening (5.9% versus 11.8%) and infection (29.4% versus 23.5%), also did not have significant differences. Therefore, the prophylactic use of CTR in

ORIF shows no significant risks in complication, and both methods seem to be safe, but larger studies are necessary to prove the results.

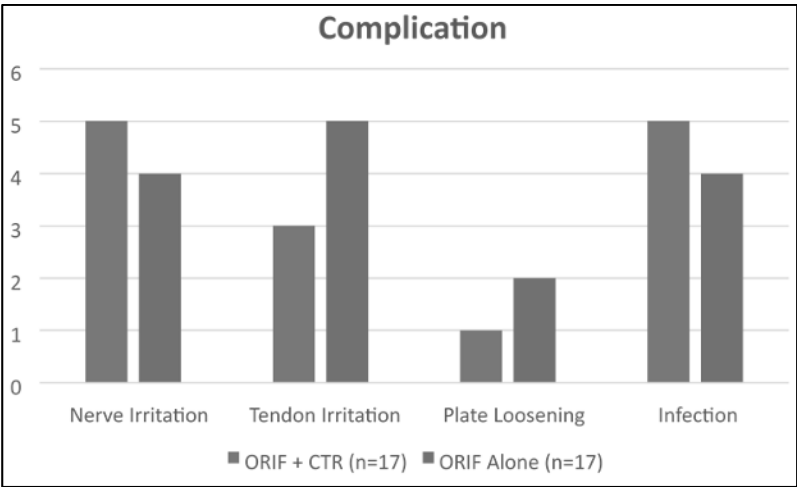


Figure 1.8. *Postoperative complications by treatment group*

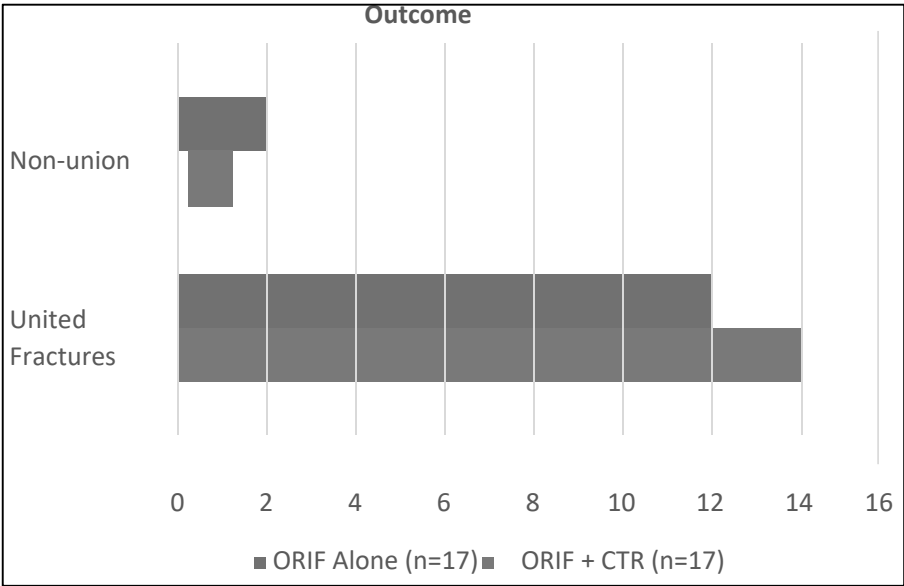


Figure 1.9. *Fracture union outcomes by treatment group*

The appositve rate of fracture union was 82.4% of the ORIF + CTR group and 70.6% of the ORIF-only group (P = 0.693). Rates of non-unions that combined the procedure were 5.9 a priori and 11.8 for ORIF. Even though the results indicate a potential usefulness of concurrent CTR, the reduced size of the sample does not allow the drawing of conclusions. In general, addition of CTR does not reduce fracture healing and may result in a small positive effect on union, which is to be evaluated in a larger study.

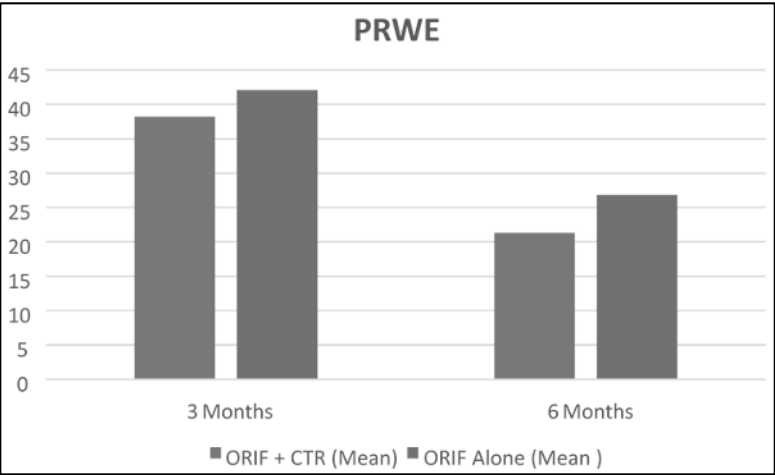


Figure 1.10. PRWE scores by treatment group

PRWE Category	Time Point	ORIF + CTR (n = 17)	ORIF Alone (n = 17)	P-value
Excellent (0–20)	3 Months	2 (11.8%)	1 (5.9%)	0.003
	6 Months	9 (52.9%)	5 (29.4%)	0.16
Good (21–40)	3 Months	10 (58.8%)	8 (47.1%)	0.73
	6 Months	7 (41.2%)	9 (52.9%)	0.73
Fair (41–60)	3 Months	5 (29.4%)	7 (41.2%)	0.71
	6 Months	1 (5.9%)	3 (17.6%)	0.60
Poor (> 60)	3 Months	0 (0%)	1 (5.9%)	1.00
	6 Months	0 (0%)	0 (0%)	Not applicable

Table 1.1. PRWE outcomes by treatment group

At both follow-ups, functional outcomes were greatly superior in the ORIF + CTR group. PRWE scores of the combined group (38.2 ± 5.1) were worse (better) than those of the ORIF-only (42.1 ± 6.3) three months postoperative ($P = 0.042$). The advantage increased at six months: the scores were 21.3 ± 4.7 , 26.8 ± 5.9 ($P = 0.018$). These findings suggest that prophylactic CTR in fracture fixation has real functional advantages, probably through maintenance of median nerve integrity and provision of an earlier rehabilitation. They advocate routine consideration of CTR particularly in high-risk patients who have a risk of postoperative CTS.

PRWE outcomes with categorical results were also skewed in favor of the ORIF + CTR group ($P = 0.003$). Combined surgery patients scored “Excellent” twice the frequency at three months (11.8 and 5.9) and even at six months (52.9 and 29.4). At six months, 94.1% of the ORIF + CTR group had good or excellent functioning relative to 82.3% ORIF-only. These results validate the fact that CTR addition enhances and speeds up functional recovery following distal radius fracture fixation, which is in line with the ongoing PRWE changes.

Follow-up	Assessment	ORIF + CTR (n = 17)	ORIF Alone (n = 17)	P-value
Two weeks	Wound healing	17/17 (100%)	17/17 (100%)	1.000
	Finger mobilization	17/17 (100%)	17/17 (100%)	1.000
Six weeks	Radiographic union	8/17 (47.1%)	6/17 (35.3%)	0.500
	Volar slab discontinued	17/17 (100%)	17/17 (100%)	1.000
	Pain score (VAS, mean)	3.2	4.1	0.032*
Three months	CTS symptoms persistent	3/17 (17.6%)	8/17 (47.1%)	0.041*
	EMG/NCV abnormal	4/17 (23.5%)	12/17 (70.6%)	0.003*
Six months	Fracture union achieved	14/17 (82.4%)	12/17 (70.6%)	0.693
	CTS symptoms persistent	2/17 (11.8%)	6/17 (35.3%)	0.046*

Table 1.2. Postoperative recovery outcomes by treatment group

Better results were also attained in the ORIF + CTR group in terms of multiple recovery measures. The pain scores were less at six weeks (VAS 3.2 versus 4.1; $P = 0.032$). The CTS symptoms were significantly diminished at three months (17.6% versus 47.1%; $P = 0.041$) and six months (11.8% versus 35.3%; $P = 0.046$). The nerve conduction abnormalities were reduced from 70.6% to 23.5% ($P = 0.003$). There were also similar wound healing and immobilization, but overall, there were higher final radionuclide union rates (82.4/70.6) and an earlier radionuclide union tendency (47.1/35.3) that was no longer significant ($P > 0.05$). All in all, CTR addition to ORIF does not worsen the fracture healing and enhances pain and neurologic outcomes.

Follow-up	Complication	ORIF + CTR (n = 17)	ORIF alone (n = 17)	*P*value
Two weeks	Infection	2 (11.8%)	1 (5.9%)	0.500
	Wound dehiscence	1 (5.9%)	2 (11.8%)	0.500
Six weeks	Tendon irritation	2 (11.8%)	4 (23.5%)	0.400
	Plate loosening	1 (5.9%)	3 (17.6%)	0.300
Three months	Nerve dysfunction	5 (29.4%)	4 (23.5%)	0.500
	Non-union	1 (5.9%)	3 (17.6%)	0.300
Six months	Chronic CTS symptoms	2/17 (11.8%)	6/17 (35.3%)	0.046*

Table 1.3. *Postoperative complications by treatment group*

The levels of complication in the ORIF + CTR group were always lower, but most of the differences were not found to be significant. Particularly, the ORIF alone group had achieved higher rates of plate loosening (17.6% versus 5.9%, $*p* = 0.300$), non-union (17.6% versus 5.9%, $*p* = 0.300$) and reoperations (11.8% versus 0%, $*p* = 0.150$). Early wound complications were equivalent in both groups, but the ORIF + CTR group had fewer tendon irritations (11.8% versus 23.5%) and persistent CTS symptoms (29.4% versus 41.2%). Attractive lack of reoperations in the combined procedure group implies that prophylactic CTR could decrease the necessity of the secondary interventions; however, the observations require additional studies of greater sizes.

Follow-up	Intervention	ORIF + CTR (n = 17)	ORIF Alone (n = 17)	*P*value
Two weeks	Sutures removed	17/17 (100%)	17/17 (100%)	1.000
	Passive ROM exercises	Initiated	Initiated	-
Six weeks	Active ROM exercises	17/17 (100%)	17/17 (100%)	1.000
	Strengthening exercises	10/17 (58.8%)	8/17 (47.1%)	0.500
Three months	Return to light work	12/17 (70.6%)	9/17 (52.9%)	0.300
Six months	Return to manual labor	14/17 (82.4%)	11/17 (64.7%)	0.250

Table 1.4. *Rehabilitation progress and functional recovery by treatment group*

The two groups had comparable early rehabilitation interventions, where all patients achieved passive ROM after two weeks and active ROM after six weeks of rehabilitation (*P* = 1.000). The ORIF + CTR group also exhibited greater functional recovery, more frequent strengthening exercise at six weeks (58.8% versus 47.1%), earlier light employment at three months (70.6% versus 52.9%) and better employment at manual labor at six months (82.4% versus 64.7%). Although these differences were not statistically significant (i.e. *p* > 0.05), the general trend is similar, which indicates that combined CTR could have helped in the progress of the rehabilitation process, possibly because of decreased postoperative nerve symptoms. This is consistent with the previous advantage in functional recovery of the ORIF + CTR group, as they have high PRWE and lower complications in prior studies.

1.4. Discussion

The authors compared the results of two methods of surgery for fractures of the distal radius with the possible median nerve injury: one is associated with an ORIF with prophylactic CTR and the other one is associated with ORIF-only (Rothman et al. 2023). The evidence shows that the combination procedure (ORIF + CTR) is associated with a number of benefits, such as fewer nerve complications after surgery, higher rates of functional recovery

and better pain control; moreover, there is no added risk of the procedure. These findings end up proving the possible advantage of the prevention of median nerve compression during the fracture fixation of the relevant patients.

Concerning the symptoms of CTS, the incidence of persistent CTS was significantly lower in patients undergoing ORIF with CTR (17.6% versus 47.1% at three months and 11.8% versus 58.3% at six months, respectively) than in patients undergoing ORIF alone. These results were further supported using electrophysiological measures, where an abnormal nerve conduction (EMG/NCV) was found in only 23.5% of the patients in the ORIF + CTR group as compared to 70.6% in the ORIF-only group ($P = 0.003$). These findings coincide with other reports by Lozano-Calderón et al. (2008), who revealed the increased rate of CTS after distal radius fractures and the better results offered by early or prophylactic CTR. Taken together, these results support the assumption that prophylactic CTR leads to lesser secondary median nerve compression due to post-traumatic edema, hemorrhaging or fracture-related displacement, and, therefore, better neurologic recovery and functional outcomes (Kashyap et al. 2024).

With regards to functional recovery and rehabilitation regarding postoperative pain scores, patients receiving ORIF with CTR showed reduced pain levels at six weeks (VAS 3.2 versus 4.1, $P = 0.032$); they were also able to initiate strengthening exercises sooner (58.8% versus 47.1%), and their return-to-work rates (especially in manual work) were higher at six weeks (82.4% versus 64.7%). The results are consistent with those of Grewal and MacDermid (2007), who found a delay in rehabilitation and worse functional outcomes in patients with persistent nerve symptoms. The lack of persistent median nerve compression in the ORIF + CTR group probably helped the patients with rehabilitation and led to better PRWE scores: 94.1% reported a good or excellent result versus 82.3% in the ORIF-alone group (Deng et al. 2021).

Even though not all of the differences were statistically significant, the ORIF + CTR measured lower rates of complications and reoperations, a reduced number of plate loosening (5.90 versus 17.60), non-union rates (5.90 versus 17.60) and zero cases of reoperations as opposed to 11.80 cases of reoperation wherein the ORIF-alone group had a higher rate of reoperations. Such tendencies are justified by the earlier surveys showing that untreated CTS may be a reason to conduct a secondary surgery and

augment the postoperative morbidity. Some of the studies have raised doubts in regard to using prophylactic CTR regularly, but most of them were based on low-risk fracture shapes (Kumar et al. 2026). Conversely, the current findings highlight the significance of the risk-stratified method, especially in patients who have intense fracture displacement or comminution.

1.5. Conclusion

Volar plate fixation is the most popular method of fixing distal end radius fractures to reinstate the wrist anatomy and functionality, but the median nerve complications that follow surgery, especially CTS, are another major issue of concern. This chapter evidenced that patients that have undergone ORIF with CTR have better neurological and functional outcomes than those who are only receiving ORIF. The overall process showed a better result in the incidence of persistent CTS symptoms and better nerve conduction results at the follow-up, as it shows an effective protection and recovery of the median nerve functioning. Functionally, the patients who have experienced ORIF together with CTR have higher PRWE scores, decreased postoperative pain and a faster recovery to daily and occupational activities. Notably, the risk of getting surgical complications was not elevated by the introduction of CTR, which proves that this method is safe and does not negatively influence the Achilles tendon union of fractures. The comparative analysis, assisted with AI, enhanced the outcome assessment, as the results incorporated the clinical, electrophysiological and functional results. In summary, selective prophylactic CTR in volar plating is a safe and effective method that can help patients who are vulnerable to developing postoperative CTS, and it should be recommended to be included in personal surgical strategies in distal radius fractures.

1.6. References

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