

Original Research Article

Comparative study of the role of pronator quadratus repair versus no pronator quadratus repair in volar plate fixation of distal radius fractures

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Received: 15 November 2024

Revised: 19 December 2024

Accepted: 06 January 2025

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ABSTRACT

Background: There is a controversy regarding the merits of repairing pronator quadratus (PQ) following volar plate fixation of distal radius fracture via Henry's approach. The aim of this study was to evaluate and compare the post-operative functional outcome between those with PQ repair vs those without PQ repair.

Methods: The 41 patients (33 males and 8 females) were included in this randomized controlled trial as per our inclusion and exclusion criteria. Of these 21 patients were in group A in which PQ repair was done and 20 patients were in group B in which PQ repair was not done. Both groups were compared with DASH score, wrist range of motion, post-operative pain and grip strength.

Results: The patients were followed up for minimum 1 year. Patients in both the groups shared similar baseline and demographic characteristics. There was no significant difference in the mean DASH score and mean grip strength at any point of time in follow up. However, wrist flexion at 6 weeks was better in group A ($p=0.03$) along with post-operative pain at 2nd and 6th week ($p=0.035$, 0.039).

Conclusions: PQ repair during volar plating of distal radius fractures does not provide any significant better functional outcome, range of motion and grip strength, especially in long run. But it reduced early post-operative pain significantly.

Keywords: Distal radius fracture, Volar plating, Pronator quadratus, Grip strength

INTRODUCTION

Distal radius fractures account for about 2.55 of all emergency room visits.¹ It appear to have a bimodal distribution with respect to age.

The intricacy of the intra-articular disruption, the range of anatomical patterns, and the resulting soft tissue and bone damage make distal radius fractures a very difficult treatment case. Although the majority of distal radius fractures, particularly those that are dorsally displaced and dorsally angulated extra-articular fractures in the elderly, can be effectively managed without surgery. Thirty percent or more are more complicated and need to be

managed surgically.¹ Closed reduction and casting, percutaneous pinning, external fixation, internal fixation, and combinations of these techniques have all been recommended as treatment modalities over the years.²

Open reduction and internal fixation (ORIF) for distal radius fractures has increased within the last 25 years.² Due to known issues with external fixation and dorsal plating, volar plating in particular has become more and more common.^{3,4} Furthermore, due to its low profile design, capacity to neutralize load across the fracture site, and lack of requirement for high-quality bone, advancements in locked plating have enlarged the indications of volar plating.⁵ The benefits of volar plate fixation include early recovery of mobility, functional

strength, articular fragment stability, and a comparatively low risk of tendon ruptures.⁶

By elevating the PQ off its radial insertion, one may reach the fracture site, reduce it, and make plate fixation easier when using the modified Henry's technique to position the volar plate on the fracture site.

Regaining pronation strength, safeguarding the volar flexor tendons and stabilizing the distal radio-ulnar joint are some of the alleged advantages of PQ repair.⁷⁻⁹ Some surgeons contend that the tissue quality frequently makes a long-lasting repair impossible and that there is a chance of ischemic contracture of the PQ following tight closure, which would limit the range of motion (ROM) in the wrist.¹⁰ We want to assess the effects of PQ healing on the results of volar plate fixation for distal radius fractures.

METHODS

Study population

This study was conducted after obtaining ethical clearance from institute ethical committee. It was a prospective, institution based randomized controlled study. From July 2022 to July 2024, patients admitted for ORIF of distal radius fracture via volar approach were selected in the study.

Inclusion criteria were all patients in the age group 18-75 years, acute closed distal radius fractures, according to OTA fracture classification system fractures=2 R 3 A-2 to 2 R 3 C-2, fractures that got displaced after initial reduction and immobilization and who consent to be a part of this study.

Exclusion criteria were open fractures, stable distal radius fractures that can be treated by closed reduction and immobilization and fracture 2R3A1 and 2R3 C3.

Study design

Below flow chart shows the study design (Figure 1).

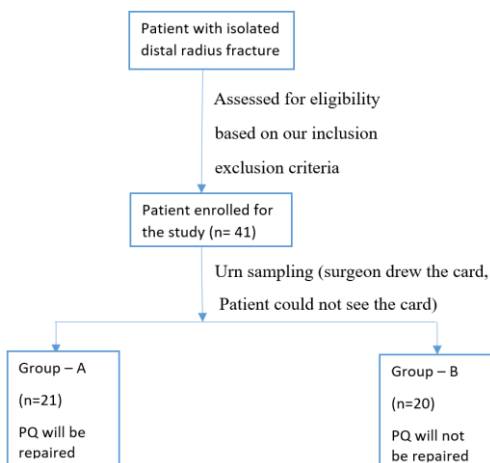


Figure 1: Study design.

Intervention

The surgery was performed under either regional or general anaesthesia and the arm pneumatic tourniquet was used for all the patients. A modified volar Henry approach was used to expose the distal radius. PQ was incised on the radial insertion side leaving a 2 mm muscle strip on the radial insertion to re-establish correct muscle alignment if repair had to be performed (Figure 2).

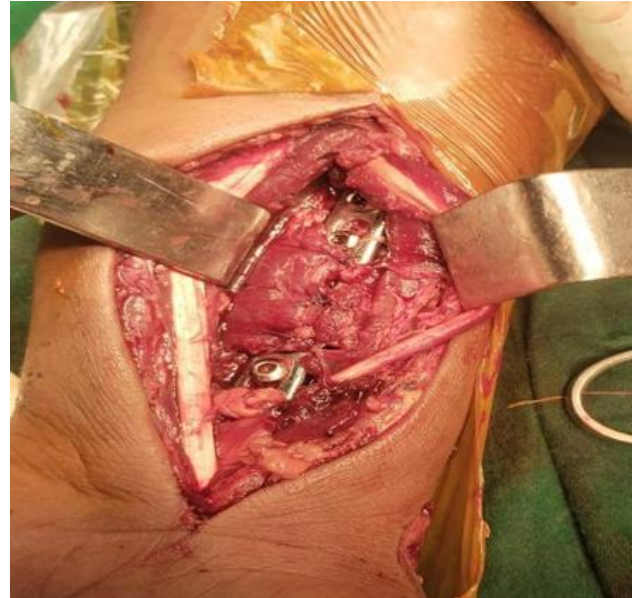


Figure 2: PQ repaired.

In the repair group (Group A) repair of the PQ was performed over the plate with 4 to 5 interrupted, 2-0 absorbable, synthetic, braided sutures. In the control group (Group B) PQ was placed back to its anatomic position but was not repaired with sutures.

Post-operative management and assessment

All the patients were followed in a similar post-operative protocol that consists of a below-elbow orthosis with wrist in neutral position for 1-2 weeks, followed by range of motion exercises involving the wrist and fingers upon orthosis removal. Weight bearing was permitted 6 weeks after surgery until signs of union was noted on radiograph. The patients were scheduled to follow up at regular intervals of 6 weeks, 3 months, 6 months and one year after surgery and clinical outcomes were recorded.

Primary outcome measure was DASH score via disability of arm, shoulder and hand questionnaire. Secondary outcome assessments include (1) Range of motion-with elbow in 90° flexion, Wrist palmar flexion, dorsiflexion, radial deviation, ulnar deviation, pronation and supination measured with a Goniometer. (2) Postoperative pain-Through visual analogue scale (0-10). (3) grip strength-measured with a Dynamometer with the elbow at 90° and the wrist in neutral rotation.

Statistical analysis

Statistical analysis was done for all data and suitable statistical tests of comparison were used. Mean±standard deviation (SD) was used to present the continuous variables. Continuous variables were analysed with the Unpaired test while chi-square test was used for categorical variables. Statistical significance was taken as $p < 0.05$. The data was analysed using Microsoft excel 2010.

RESULTS

A total of 41 patients were included in our study. Table 1 lists the basic demographics.

Table 1: Basic Demographic information.

Demographics		Group A, (PQ repair)	Group B, (no PQ repair)
Patients		21	20
Sex (M:F)		17:4	16:4
Age (in years) Mean±SD		38.5±13.47	40±15.88
Mode of injury	Motor vehicle accident	17	13
	Fall on an outstretched hand	4	5
	Physical assault	0	2
Side of injury	Left side	9	8
	Right side	12	12
A.O. type	2R3A2	3	4
	2R3A3	2	4
	2R3B1	1	2
	2R3B2	7	13
	2R3B3	4	8
	2R3C1	3	7
	2R3C2	1	3

Comparison of functional outcome (DASH score)

In our study, we found slightly better functional outcome in group A i.e., PQ repair group (lower DASH score) consistently during our follow up at 6 weeks, 3 months, 6 months and at 1 year though not significant at any point of time ($p = 0.282, 0.079, 0.139$ and 0.629 respectively).

Range of motion

At 6 weeks of follow up-the independent t test result shows that there is a significant difference in flexion value between the groups ($p = 0.035$) with better flexion range in PQ repair group (Group A). Group A performed slightly better in extension and pronation whereas group B was slightly better in supination, Radial deviation and ulnar deviation in comparison with each other, however these were not significant ($p > 0.05$) (Table 2).

Table 2: Range of motion at 6 weeks.

Variables	Group A, (Mean±SD)	Group B, (Mean±SD)	P value
Flexion	37.19±3.86	34.45±4.17	0.035*
Extension	32.56±6.21	31.68±5.36	0.71
Pronation	72.9±3.83	70.1±5.39	0.064
Supination	45.23±5.44	46.14±4.32	0.51
Radial deviation	7.63±3.85	8.25±4.12	0.76
Ulnar deviation	19.64±6.4	19.85±5.65	0.83

*P value significant

At 3 months: The independent t test for wrist range of motion at 3 months after the procedure demonstrated no any significant difference between both the groups ($p > 0.05$ for all variables).

At 6 months: The independent t test result shows that there is no significant difference between group A and group B.

At 1 year: similar to 6 months follow-up, at 1 year postoperatively no significant differences were detected in wrist ROM.

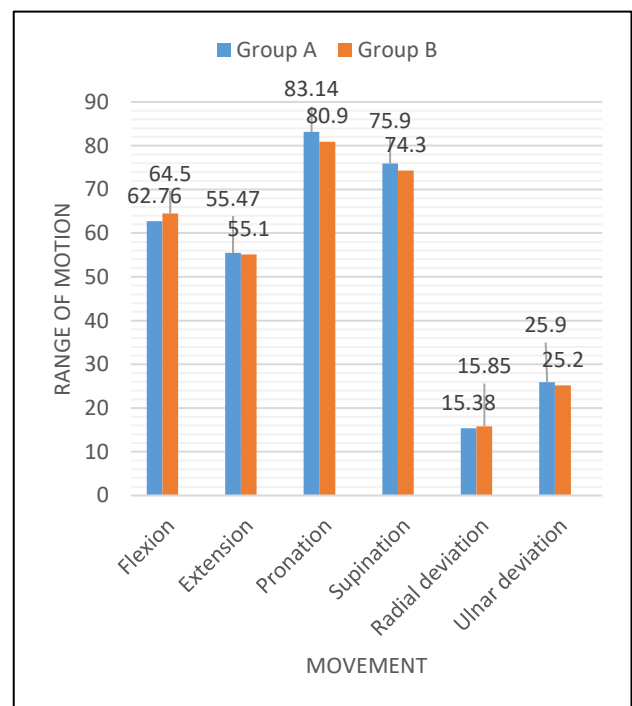


Figure 3: ROM at 1 year of follow-up graph.

Post-operative wrist pain (Visual analog scale, 0-10)

At 2nd and 6th week of follow up, the independent t test results show a significant reduction in postoperative pain (lower VAS score) in group A in comparison to group B ($p = 0.035$ and $0.039 < 0.05$ at 2 and 6 weeks respectively). However later in the follow up difference was insignificant.

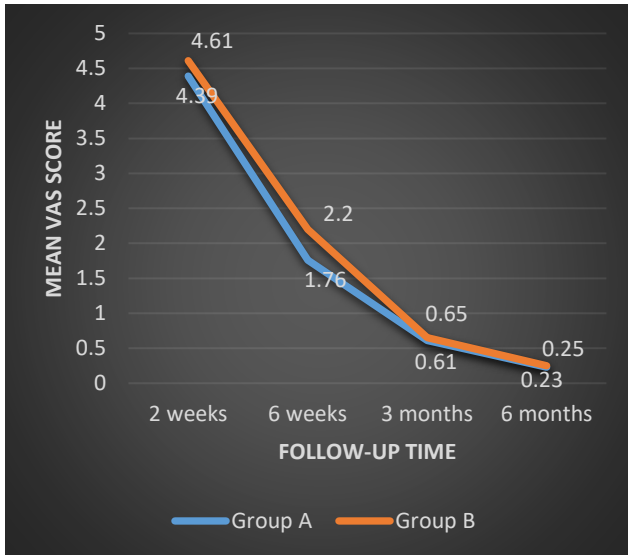


Figure 4: Post-operative pain (mean VAS score 0-10) graph.

Mean grip strength (in kg)

In our study, the independent t test results show no significant difference in mean grip strength between both groups at all follow up intervals.

Complications

one patient developed surgical site infection in group A which was superficial in nature at around 2 weeks of surgery which resolved after early debridement and antibiotics. One patient in group B had malunion, for which he didn't want any 2nd surgery as it was in non-dominant hand and patient had no significant functional limitation. 2 patients, one in each group, in our study had wrist stiffness at around 6 weeks to 3 months follow up and patients had to undergo physiotherapy after which their wrist range of motion improved significantly. Rest of the patient (90%) didn't have any significant complication.



Figure 5: Pre op radiograph.



Figure 6 (A and B): Immediate post op radiograph.



Figure 7: Pronation at 3 months.



Figure 8: Supination at 3 months.

DISCUSSION

Distal radius fractures are amongst the most common injuries orthopaedic surgeons treat. An increasing amount of evidence suggests that anatomical reduction and surgical fixation is required, with intra-articular fractures requiring special attention in order to restore anatomy and joint congruency and return to optimal function.

In this randomized clinical trial, we investigated the role of PQ repair in distal radius fractures treated with volar plate fixation. For this, 41 patients were placed into two groups: 21 in group A (PQ repair) and 20 in group B (no repair).

The majority of patients (68%) belonged to the 20-50 age range. Motor vehicle accidents caused the most injuries (73%) and fall on outstretched hands were the most common cause of injury for the elderly (22%) leading to insufficiency fractures.

We observed a progressive improvement in DASH score (functional outcome) over time in both groups, with group A patients performing somewhat better, however this was not significant at any time.

With the exception of the six weeks following surgery, when group A patients exhibited a significantly greater flexion range of motion than group B, there was no discernible difference in the wrist range of motion of the two groups.

The mean grip strength evaluation between the two groups revealed no significant difference over the follow-up period.

This is supported by the majority of comparative research. In their randomized controlled experiment, Tosti and Ilyas et al observed no statistically significant variation in DASH score at the 1-year follow-up, involving 57 patients. Grip strength and flexion showed a statistically significant difference at 6 weeks, with the PQ repair group showing the greatest advantage. Later follow-ups, however, did not reveal these differences, and no other secondary outcome revealed a statistically significant difference.¹¹

Pathak et al showed better pain alleviation and range of motion at 4 weeks and increased grip strength at 3 months in the repair group in a retrospective study of 63 patients.¹²

In his retrospective analysis with 112 patients at a 1-year follow-up, Herschman et al could not find any differences in DASH score or range of motion.¹³

Fan et al discovered that while there were no significant changes at 3 and 12 months of follow-up, there were significant differences at 1st, 2nd, and 6th week post-operatively in terms of wrist pain, range of motion, and grip strength between the two groups.¹⁴

In his study, Häberle et al discovered that patients with PQ repair had stronger isometric pronation at 6 and 12 weeks following surgery, although this difference was not statistically significant when compared to the group that did not get PQ repaired.¹⁵

This is explained by the fact that wrist strength and distal radioulnar joint stability are not significantly increased by PQ repair, as PQ plays a modest role in both of these tasks.^{16,17} According to earlier anatomical research, PQ has a deep head that functions as a dynamic stabilizer of the distal radioulnar joint and a superficial head that is primarily responsible for forearm pronation.¹⁸ The pronation strength of the deep head should be preserved, regardless of whether the superficial head is restored or not.^{17,19}

In our investigation, PQ repair considerably reduced post-operative pain (measured on a VAS scale of 0-10) in the first 6 weeks ($p=0.035$ and 0.039 at 2 and 6 weeks, respectively) when compared to the no-repair group, although this benefit faded later. This is consistent with the findings of the Häberle et al study.¹⁵

This may be explained by improved hardware coverage leading to less irritation of overlying flexor tendons, but it is doubtful, because uncomplicated plating of distal radius fractures seldom induces considerable post-operative pain, regardless of whether the PQ is repaired or not.

On the other hand, critics of PQ repair bring up a number of concerns regarding its anticipated benefits. Sonntag et al advised against PQ muscle restoration because there was no discernible functional benefit.²⁰

Volar prominence of the plate was proposed as the causal reason for flexor tendon rupture in investigations by White et al and Arora et al, even when PQ was regularly repaired.^{21,22}

Following a distal radius fracture, the function of the pronator quadratus muscle may be affected by a number of variables, such as the severity of the initial trauma, the position and type of volar plate, the rate at which the muscle heals, the ability of the repaired muscle to retract, and the longevity of the repair in the restored muscle.

Limitations

Our study has some limitations. Larger sample size as well as longer follow-up was required for assessing flexor tendinopathy and rupture, arm dominance was not taken into consideration.

CONCLUSION

Clinical and functional benefit of PQ repair, except better wrist flexion and reduced pain at 6th weeks and 3 months, were not proven in this study. Based on the results we obtained in our study, we conclude that PQ repair

during volar plating in distal radius fractures does not provide any significant better functional outcome, range of motion and grip strength, especially later in the follow-up period. PQ repair reduced the early post-operative pain significantly. Though in some cases, after trauma or plate placement quality of the PQ often precludes a durable repair.

Nonetheless, we recommend that surgeons should make an effort to repair the PQ wherever possible for better hardware coverage and early post-operative pain relief.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Kumar S, Choudhary R, Rahman S. Comparative study of the role of pronator quadratus repair versus no pronator quadratus repair in volar plate fixation of distal radius fractures. *Int J Res Orthop* 2025;11:269-74.