

A randomized controlled trial on management of distal radius fractures with plating followed by pronator quadratus repair versus no repair in a tertiary care hospital in Andhra Pradesh, India

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Abstract

Background: Among all the fractures of upper limbs, distal radial fractures are one of the most common in adults in India and also one of the commonest fractures encountered in orthopaedic clinical practice. Several methods of treatment have been suggested for these fractures. However, controversies about the best treatment approach still exist. This study is an attempt to evaluate the functional outcome of surgical treatment of distal radius fractures by volar plating followed by complete repair of PQ versus no repair. It was a RCT conducted among 72 patients (36 with PQ repair and 36 with no PQ repair). **Results:** The age in years ranged from 24 to 60 years. The mean age was 47.4 years. There were 50 (69.44%) females and 22 (30.56%) males. Group A (Subjected to Pronator Quadratus repair) had 36 patients with mean age of 45.23 years and included 24(66.7%) females and 12 (33.3%) males, whereas Group B (Not subjected to pronator quadratus repair) had 36 patients with a mean age of 47.64 years and included 26 (72.2%) females and 10 (27.8%) males. With regard to ROM, at 6 weeks post-operatively, PS arc showed significant improvement in Group A compared to Group B ($t = 2.022$, $P = 0.047$) while at 12 weeks post-operatively, EF arc showed significant improvement in Group B compared to Group A ($t = 2.551$, $P = 0.013$). About Quick DASH scores, a statistically significant difference was seen between group A and group B at 6 weeks ($t = 3.375$, $p = 0.001$) and 12 weeks ($t = 3.008$, $p = 0.004$). About the Mayo-Wrist-Score, both groups showed satisfying results after 6 weeks and values improved in both groups at 12 weeks. But, no significant differences found between groups ($t = 0.240$, $p = 0.811$ at 6 weeks; $t = 0.641$, $p = 0.524$ at 12 weeks). Though, a significant reduction of pain was found in group A (Chi square = 4.645, $p = 0.031$ at 6 weeks postoperatively, no significant difference could be seen (Chi square = 0.061, $p = 0.806$) between groups at 12-weeks post operatively. **Conclusions:** Repair of PQ muscle could be considered as an attempt for improved outcome following volar plating in distal radius fractures. More studies in large samples and different settings are to be conducted to provide further evidence for confirmation of the results.

Key Word: Distal radius fractures, PQ repair and no repair, functional outcome, A.P.

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INTRODUCTION

Among all the fractures of upper limbs, distal radial fractures are one of the most common in adults in India and also one of the commonest fractures we come across in orthopaedic clinical practice.^{1,2} Distal radius fractures comprise 8–17% of all extremity fractures and almost 72% of all forearm fractures,^{3,6} the incidence being about 26 per 10,000 person-years.^{7,8} Various treatment methods have been suggested for these fractures. However, the best treatment approach is still controversial. In the surgical management of displaced and/or unstable distal

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radius fractures, Internal fixation with volar plates is one of the methods of treatment which has become increasingly popular and is being commonly practiced.^{7,9,11} By any method of treatment, the ultimate outcome is to achieve full recovery without the least functional compromise. Following volar plating of distal radius fractures, some complications such as flexor tendon irritation, partial or complete rupture, flexor tenosynovitis etc have been reported.^{12,17} The surgical treatment with Internal fixation using Volar plates has been advantageous enough in reducing tendon irritation, a common complication associated with dorsal plate fixation.⁷ Despite this, tendon rupture as high as 17% has been reported following volar plate fixation for distal radius fractures.¹⁰ After volar plate fixation, though Flexor pollicis longus (FPL) is the most commonly involved flexor tendon, even other tendon ruptures or irritation have also been reported,^{18,19} tendon wear over the edge of a prominent plate being the most likely reason.¹⁰ Placing the plate in improper position, prominence of the screws, design of the plate, use of steroids, reduction being lost, collapse of the fracture and drill guides being retained inadvertently may all act individually or synergistically.^{10,12,19} Such complications and factors may lead to functional compromise. As a result of restoration of the pronator quadratus (PQ) to its earlier position after volar plating of the radius, the muscle protects the flexor tendons from friction and irritation by providing a layer of vascularized tissue between the plate and the flexor tendons, thus preventing or reducing the risk of rupture. This is the importance of PQ repair after volar plating as also cited by Orbay.^{20,21} Some of the other benefits that could be expected may be recovery of the pronation strength, protection of the flexor tendons and maintaining stability of the distal radioulnar joint.²²⁻²⁴ The durability of PQ repairs, after fracture fixation using volar plate, is also high. The failure rate being as low as 4%, they withstand forces which are generated at the distal radius throughout the healing process.²¹ This study is an attempt to evaluate the functional outcome of surgical treatment of distal radius fractures by volar plating followed by complete repair of PQ versus no repair.

AIMS AND OBJECTIVES

To compare the functional outcome of pronator quadratus repair versus no repair following volar plating in distal radius fractures.

MATERIAL AND METHODS

It is a randomized controlled trial conducted in the orthopaedic department of a tertiary care hospital for a period of one year. All the patients presenting to the OPD

with unstable distal radius fractures from October 2017 to September 2018, aged between 18 – 60 years were included in the study. A total of 79 patients with unstable distal radius fractures reported to the OPD. Preoperative radiographs [anterioposterior (AP), lateral and oblique] were evaluated to determine unstable fractures. The criteria proposed by Lafontaine *et al.*²⁵ and Altissimi *et al.*²⁶ were used to determine unstable distal radius fractures. Besides this, fractures were considered unstable if associated with the presence of three or more of the following parameters:

- a) Patient's age more than 60 years
- b) Radial dorsal angle more than 20°,
- c) Dorsal fracture comminution,
- d) Intraarticular fracture line,
- e) Presence of ulnar fracture, and
- f) Radial shortening of more than 4 mm.

Exclusion criteria included patients with open fractures, previous surgery or fracture in the distal radius, patients with other associated fractures and patients with a history of traumatic brain injury. Our final study group comprised 72 patients, since 7 patients did not consent for the study. These 72 patients were randomized into group A (36 patients) and group B (36 patients). Group A patients were treated with volar plating and repair of the PQ muscle while Group B patients were treated with volar plating and no PQ repair. Randomization was done using systematic random sampling technique, such that every alternate patient entering the study was included into group A (Odd numbered patient) and group B (Even numbered patient).

Data was collected using a predesigned and pretested clinical proforma containing socio – demographic, clinical and follow up details of the patients.

Functional outcome was assessed at 6 weeks and 12 weeks postoperatively using the following parameters:²⁷⁻²⁹

1. Range of motion (ROM) of both wrists,
2. The shortened Disabilities of the Arm, Shoulder and Hand questionnaire (*Quick DASH*), with Cronbach's alpha = 0.94
3. The Mayo-Wrist-Score, and
4. A visual analog scale (VAS) (range 0 points = no pain to 10 points = maximum pain)

Statistical analysis: The collected data was entered in Microsoft excel, double checked for errors and analyzed using epi info and SPSS trial version 21. Categorical variables were expressed as percentages and proportions, while continuous variable as mean and standard deviation. The association between two categorical variables was analyzed using Chi– square test and association between two continuous variables using Independent samples ‘t’ test. Ethical clearance was

obtained from the institutional ethical committee. A prior informed consent was taken from the patients and their relatives. The purpose of the study was explained in vernacular language in an understandable manner and confidentiality of the information assured. The patients participated in the study with their voluntary will and could withdraw from the study anytime they suspected breach in the ethics.

Quick dash-score³⁰: The Quick DASH is scored in components of the disability/symptom (11 items, scored 1-5). The assigned values for all completed responses are simply summed and averaged, producing a score out of five. This value is then transformed to a score out of 100 by subtracting one and multiplying by 25. This transformation is done to make the score easier to compare to other measures scaled on a 0-100 scale. A higher score indicates greater disability. The Modified Mayo Wrist Score (MMWS)³¹ is a modification of the Geen and O'Brien score. A total of 100 points are divided among the evaluator's assessment of pain (25 points), active flexion/extension arc as a percentage of the opposite side (25 points), grip strength as a percentage of the opposite side (25 points), and the ability to return to regular employment or activities (25 points). Based on the patient's subjective description the evaluator rates Pain as

none (25 points), mild (20 points), moderate (10 points), or severe (0 points). The total score ranges from 0 to 100 points with higher scores indicating a better result. An excellent result is defined as 90–100 points, good is 80–89, fair is 65–79 points, and poor is less than 65 points.

RESULTS

There were a total of 72 patients in the study and their age in years ranged from 24 to 60 years. The mean age was 47.4 years. Sex distribution showed that there were 50 (69.44%) females and 22 (30.56%) males. Group A (Subjected to Pronatus Quadratus repair) and Group B had 36 patients each. The mean age of Group A patients was 45.23 years and included 24 (66.7%) females and 12 (33.3%) males, while the mean age of Group B patients was 47.64 years and included 26 (72.2%) females and 10 (27.8%) males. Fractures were classified using the AO classification. In both group A and group B, all fractures were A-type distal radius fractures. There were seven A2-type and 29 A3-type fractures in group A, and nine A2-type and 27 A3-type fractures in group B, respectively. Functional outcome was assessed using ROM, Quick DASH-Score, Modified Mayo Wrist Score (MMWS) and VAS.

ROM at 6 weeks

Table 1: Difference in ROM at 6 weeks

	PQ repair (n = 36) Mean (Range)	No repair (n = 36) Mean (Range)	T test value Value (UL - LL)	P value
EF Arc	80 (40 - 150)	86 (20 - 120)	1.258 (3.658 - 16.158)	0.213
PS Arc	165 (120 - 180)	153 (50 - 180)	2.022 (0.150 - 21.517)	0.047
RU Arc	50 (25 - 70)	45 (15 - 80)	1.286 (1.912 - 8.856)	0.203

UL: Upper limit of the Confidence interval, LL: Lower limit of the Confidence interval

ROM at 12 weeks

Table 2: Difference in ROM at 12 weeks

	PQ repair (n = 36) Mean (Range)	No repair (n = 36) Mean (Range)	T test value Value (UL - LL)	P value
EF Arc	120 (100 - 180)	135 (40 - 180)	2.551 (3.607 - 29.449)	0.013
PS Arc	170 (160 - 180)	170 (160 - 180)	0.756 (2.275 - 5.053)	0.452
RU Arc	60 (40 - 100)	65 (25 - 90)	1.349 (2.261 - 11.706)	0.182

UL: Upper limit of the Confidence interval, LL: Lower limit of the Confidence interval

Quick DASH-Score

At 6 weeks postoperatively, the Quick DASH score showed a mean of 21 (range 11–43) points in group A and 28 (range 11–50) points in group B. After 12 weeks, the values strongly decreased with a mean Quick DASH score of 7 (range 5–21) points in group A and 12 (range 11–27) points in group B indicating an improved functional outcome. A statistically significant difference was seen in the Quick DASH scores between group A and group B at 6 weeks (t 3.375 p = 0.001) and 12 weeks (t 3.008 p = 0.004).

Modified Mayo Wrist Score (MMWS)

Table 3: MMWS at 6 weeks and 12 weeks

	6 weeks		12 weeks	
	Group A (n = 36) n (%)	Group B (n = 36) n (%)	Group A (n = 36) n (%)	Group B (n = 36) n (%)
Excellent	12 (33.3)	10 (27.8)	28 (77.8)	22 (61.1)
Good	12 (33.3)	17 (47.2)	05 (13.9)	10 (27.8)
Fair	04 (11.1)	04 (11.1)	00	00
Poor	08 (22.2)	05 (13.9)	03 (08.3)	04 (11.1)

About the Mayo-Wrist-Score, both groups showed satisfying results after 6 weeks and values improved in both groups at 12 weeks. But, no significant differences found between groups ($t = 0.240, p = 0.811$ at 6 weeks; $t = 0.641, p = 0.524$ at 12 weeks). After 6 weeks the mean score was 79.31 (range 30–100) points in group A (including 12 excellent, 12 good, 4 satisfying, and 8 bad outcomes), and 78.33 (range 50–110) points in group B (including 10 excellent, 17 good, 4 satisfying, and 5 bad outcomes). At 12 weeks the values improved in both groups representing excellent results with mean 90.14 (range 40–100) points in group A (28 excellent, 5 good, 3 bad outcomes) and 87.78 (range 50–100) points in group B (22 excellent outcomes, 10 good outcomes, 4 bad outcome). No statistically significant differences could be found between the two groups ($t = 0.240, p = 0.811$ at 6 weeks; $t = 0.641, p = 0.524$ at 12 weeks).

VAS

With a pain level between 0 and 2 in 16 (44.44%) of the patients in group A versus only 0% in group B, a significant reduction of pain was found in group A (Chi square = 4.645, $p = 0.031$) at 6 weeks postoperatively, while no significant difference could be seen (Chi square = 0.061, $p = 0.806$) between groups at 12-weeks post operatively with pain level between 0 and 2 in group A—35 (97.2 %) and group B—36 (100 %).

DISCUSSION

Distal radius fractures are one of the commonly encountered fractures in orthopaedic practice and repair of Pronatus Quadratus muscle following volar plating is practiced still with lot of controversies. However, a recent survey has showed that the majority of surgeons attempt to repair the PQ muscle after plate fixation.²¹ In this study, the age in years ranged from 24 to 60 years. The mean age was 47.4 years, similar to other studies conducted by Sandra Häberle *et al.*³² in which average age was 54 years (range 22–77 years) and Saeed Asadollahi *et al.*³³ in which the mean age of patients was 61 years (range 30–85). Females were more (69.44%) compared to males (30.56%) in the present study, similar to other studies (78.33% females and 21.67% males)³² and (67.65% females and 32.35% males)³³. In the present

study, Group A (Subjected to Pronatus Quadratus repair) had 36 patients with mean age of 46.26 years and included 24 (66.7%) females and 12 (33.3%) males, whereas Group B (Not subjected to pronatus quadrates repair) had 36 patients with a mean age of 48.54 years and included 26 (72.2%) females and 10 (27.8%) males, similar to another study in which 31 patients (group A) with a mean age of 52 years (range 22–77 years; 24 females and 7 males) had a PQ repair, whereas 29 patients (group B) with a mean age of 56 years (range 25–76 years; 24 females and 5 males) had no PQ muscle repair.³² At 6 weeks post –operatively, there was a statistically significant better improvement in ROM with regard to PS arc in Group A compared to Group B ($t = 2.022, P = 0.047$) and at 12 weeks post – operatively, there was a statistically significant better improvement in ROM with regard to EF arc in Group B compared to Group A ($t = 2.551, P = 0.013$). This is quite different from other studies which have not showed any significant difference between the two groups either at 6 weeks or 12 weeks post – operatively.³² At 6 weeks post – operatively, the *Quick* DASH-Score showed a mean of 21 (range 10–43) points in group A and 28 (range 11–50) points in group B. After 12 weeks, the values strongly decreased with a *Quick* DASH of 7 (range 5 – 21) points in group A and 12 (range 8–27) points in group B indicating an improved functional outcome. A statistically significant difference was seen in the *Quick* DASH scores between group A and group B at 6 weeks ($t 3.375 p = 0.001$) and 12 weeks ($t 3.008 p = 0.004$), unlike another study in which, the *Quick* DASH-Score showed a median of 34 (range 0–75) points in group A and 30 (range 5–57) points in group B at 6 weeks postoperatively, while after 12 weeks, the values strongly decreased with a *Quick* DASH of 3.5 (range 0–55) points in group A and 5 (range 0–23) points in group B indicating an improved functional outcome, but with no statistical significance at 6 weeks ($p = 0.789$) and ($p = 0.887$)³² In the present study, satisfying Mayo-Wrist-Score results were shown after 6 weeks in both groups with a mean of 79.31 (range 30–100) points in group A (including 12 excellent, 12 good, 4 satisfying, and 8 bad outcomes), and 78.33 (range 50–110) in group B (including 10 excellent, 17 good, 4 satisfying, and 5 bad outcomes). At 12 weeks the values

improved in both groups representing excellent results with mean 90.14 (range 40–100) points in group A (28 excellent, 5 good, 3 bad outcomes) and 87.78 (range 50–100) points in group B (22 excellent outcomes, 10 good outcomes, 4 bad outcome). No significant differences could be verified between groups ($t = 0.240$, $p=0.811$ at 6 weeks; $t=0.641$, $p = 0.524$ at 12 weeks). Similar results were found in another study, with a median of 70 (range 30–100) points in group A (including 8 excellent, 6 good, 7 satisfying, and 10 bad outcomes), and 70 (range 50–110) in group B (including 1 excellent, 8 good, 13 satisfying, and 7 bad outcomes) at 6 weeks, while at 12 weeks the values improved in both groups representing excellent results with median 100 (range 40–100) points in group A (25 excellent, 4 good, 2 bad outcomes) and 95 (range 50–100) points in group B (23 excellent outcomes, 5 good outcomes, 1 bad outcome) and no significant differences between groups ($p=0.994$ at 6 weeks; $p=0.657$ at 12 weeks).³² With regard to VAS score, at 6 weeks postoperatively, a significant reduction of pain was found with a pain level between 0 and 2 in 16 (44.44%) of the patients in group A versus only 0% in group B (Chi square=4.645, $p = 0.031$) while at 12-weeks post operatively, no significant difference could be seen (pain level between 0 and 2 in group A-97.1 % and group B-100 %; (Chi square = 0.061, $p = 0.806$), similar to other study in which a significant reduction of pain was found following repair of the PQ muscle with a pain level between 0 and 2 in 84 % of the patients in group A versus only 62 % in group B ($p=0.017$) at 6 weeks postoperatively while no significant difference could be seen (pain level between 0 and 2 in group A-91 % and group B-93 %; $p=1.000$) at the 12-week follow-up.³²

CONCLUSIONS AND RECOMMENDATIONS

Unlike many other studies, a significant improvement in ROM, Quick DASH score and pain (VAS) has been seen in distal radius fractures treated with volar plating followed by PQ muscle repair compared to those treated without PQ muscle repair. However, the findings may not be generalize-able due to small sample size and one – setting study. Hence, repair of PQ muscle could be considered as an attempt for improved outcome following volar plating in distal radius fractures. More studies in large samples and different settings are to be conducted to provide further evidence for confirmation of the results.

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