

ORIGINAL RESEARCH

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The effect of splint use duration on pronator quadratus muscle repair in the fixation of distal radius fractures using volar plates

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Abstract

Distal radius fractures are among the most common orthopedic traumas. Stable fractures can be successfully treated with closed reduction and casting. Fragmented and unstable fractures result in serious complications if they are not properly treated, and a large majority of intra-articular fractures are treated surgically. We hypothesized that the use of long arm splint for 10 days is enough to reduce the tear of the repaired PQ muscle and positively affect the clinical results. After fracture fixation, the PQ muscle was repaired along the radial margin, and three radiopaque hemoclips were attached to the radial margin of the muscle. Patients were divided into groups with 10 days or 20 days of splint application. Follow-up X-ray evaluations were performed at 10 and 20 days, and at 1, 2, and 3 months postoperatively. Hemoclip displacement of ≥ 1 cm following surgical follow-up indicated repair failure. The mean time from injury to surgery was 11.2 h. A total of 30 patients, 19 (63%) men, and 11 (37%) women, with complete follow-up records, were evaluated and divided into two groups based on splint use duration. The maximum change in hemoclip location was 6 mm. Hemoclip displacement was not detected in any of the 30 patients. No statistically significant differences were found between the two groups. PQ muscle repairs are generally durable after fixation of distal radius fractures with anatomical volar plates. The splint use duration had no radiological or clinical effects on the PQ repair.

Keywords: Distal radial fracture, watershed line, pronator quadratus muscle, hemoclips, long-arm splint, volar plate

Introduction

Distal radius fractures are among the most common orthopedic traumas [1,2]. Stable fractures can be successfully treated with closed reduction and casting. Fragmented and unstable fractures result in severe complications if they are not correctly treated [2], and a vast majority of intra-articular fractures are treated surgically [3]. Although several surgical methods can be used, volar plate and screw fixation have an essential place among the available methods. Application of a volar plate for internal reduction of a distal radius fracture requires dissection of the pronator quadratus (PQ) muscle from the radial distal end or margins or both. In the USA, 83% of hand surgeons repair the PQ muscle during this procedure [4]. Covering the plate with PQ muscle creates an interposition barrier between the plate and the flexor tendons, which significantly reduces tendon irritation and the risk of tendon rupture [5]. Suturing of the PQ muscle has been reported to increase fracture stability because of the anatomical relationships [6].

The purpose of this study was to verify whether the repaired area of the PQ muscle was torn in patients suffering from distal radius

fractures treated surgically with distal anatomic volar plates by post-operative clinical and radiological examination. We hypothesized that the use of splint for 10 days is enough to reduce the tear of the repaired PQ muscle and positively affect the clinical results.

Material and Methods

Patients

Thirty patients with at least 6-month follow-up among 36 patients who were surgically treated for isolated distal radius fracture between June 2015 and December 2016 at the Second Orthopedics and Traumatology Clinic were included in the study, and their results were evaluated. The study design is a prospective cohort. Hospital ethical committee of clinical research approval was obtained for the study. Ethical protocol number of the research is 2016-185. Patients between 18 and 72 years of age who suffered from closed distal radius fractures and provided written consent were considered eligible for this study. Patients younger than 18 years of age, patients with inflammatory arthritis, neuromuscular disorders, history of wrist surgery, open fractures, history of brain damage, as well as pregnant patients, were excluded. Anteroposterior (AP) and lateral wrist X-ray imaging was performed in all patients following evaluation and physical examination in the emergency service. Patients also underwent computed tomography to evaluate the joint surface better.

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Surgical Treatment

According to the AO/ASIF classification, unstable type b and type c fractures were surgically treated by the trans-flexor carpal radial approach. The radial margin of the PQ muscle, together with fibrous tissue, was subperiosteally dissected 1 mm proximal to the watershed line (Figure 1). Following the reduction of the distal radius fracture, an anatomical volar plate was used for fixation. The PQ muscle was then reattached to the distal radius using 1.0 absorbable sutures, and three radiopaque hemoclips were positioned on the radial margin (Figure 2). A minivac drain was placed to prevent hematomas, and a long-arm splint was applied.



Figure 3. Water shed line

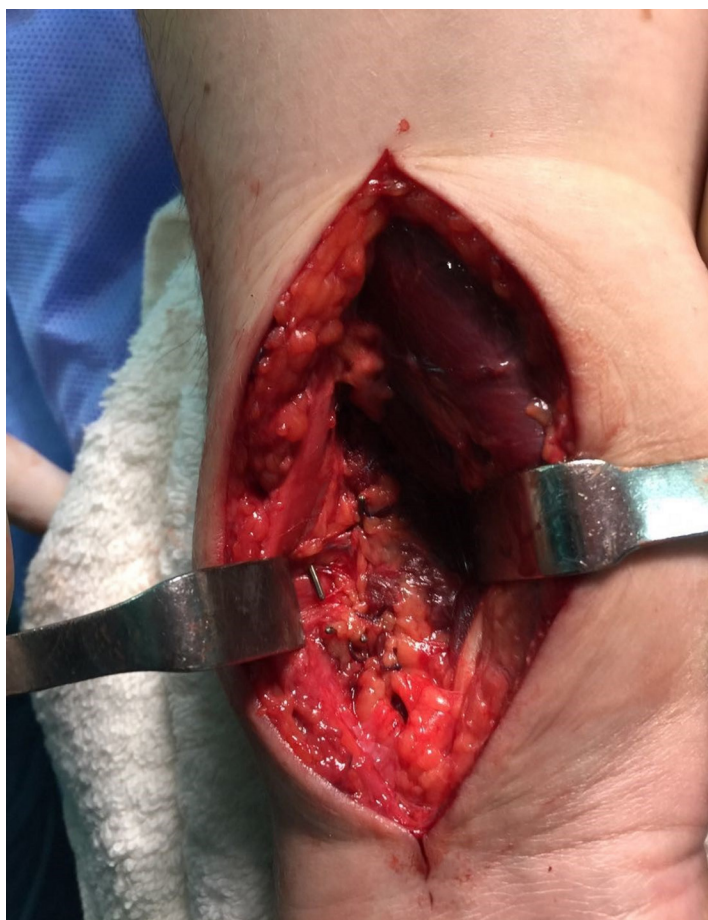


Figure 3. Radiopaque hemoclips were positioned on the radial margin, intraop imagine

Postoperative management

Active finger movement was started only to the extent tolerated by the patient. Perioperative AP and lateral X-ray imaging of the hand and wrist were performed, and patients with no early complications were discharged. The mean duration of the hospital stay was 3 days. Patients were called at 10 and 20 days and at 1, 2, and 3 months for postoperative follow-up, which included physical and radiological examinations (Figure 3).

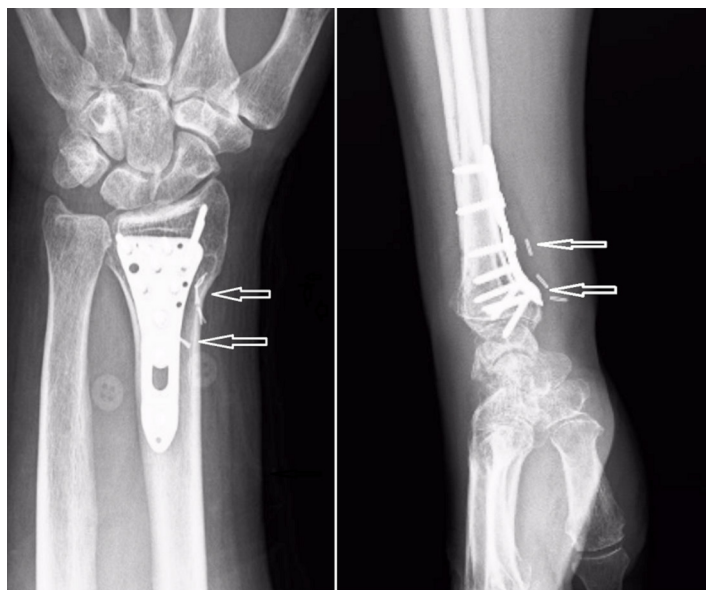


Figure 3. Radiopaque hemoclips were positioned on the radial margin

The patients were divided into two groups by long-arm splint duration. In Group 1 ($n = 16$), the splints were removed on day 10. In Group 2 ($n = 14$), the splints were removed on day 20. Physiotherapist-supervised rehabilitation was started on splint removal. The AP X-rays of patients at follow-up visits were digitally evaluated using Sectra LiteView and were compared in millimeters. Differences in the distance of up to 10 mm, indicating muscle contraction, were considered normal, and differences >10 mm were considered clinically significant [4].

Results

The mean time from injury to surgery was 11.2 h. All surgical procedures were performed under general anesthesia and under an air pressure of 200 mm Hg. A total of 30 patients, 19 (63%) men, and 11 (37%) women, with complete follow-up records, were evaluated and divided into two groups based on splint use duration. One patient was lost to follow-up because of a change in residence (Table 1). The maximum change in hemoclip location was 6 mm. No loosening of hemoclips was observed in any patient.

Table 1. Change in hemoclip distance

	Day 10	Day 20	Day 30	Month 2	Month 3
Group 1	1.3 ± 1.4	1.5 ± 1.5	2.8 ± 1.9	3.5 ± 2.0	4.0 ± 2.0
Group 2	1.1 ± 1.2	1.3 ± 1.2	2.1 ± 1.8	3.3 ± 1.8	3.8 ± 1.8

Data are mean distance (mm) $\pm$ standard deviation

Pronation-supination and flexion-extension range of motion at 6 weeks and 3 months are shown in Table 2. No significant between-group differences in joint range of motion were observed. Although

at the early follow-up, the range of motion in Group 1 patients was greater than that in Group 2, the difference was not apparent in the 6th week and 3rd month. The Disabilities of the Arm, Shoulder, and Hand (DASH) Scores and PQ repair in the two groups were also not statistically significant ($p = 0.03$).

Table 2. Change in range of motion

Range of motion	Week 6	Month 3	P
Flexion–Extension	60° ± 12°	69° ± 12°	0.65
Supination–Pronation	120° ± 32°	130° ± 29°	0.73

Data are mean ± standard deviation

Intra-articular screw penetration was not observed in any of the patients. All surgical procedures were performed by a single physician. Postsurgical infections, nonunion, acute carpal tunnel syndrome, and other complications were not observed.

Discussion

In the open reduction of distal radial fractures with volar plates, most orthopedic surgeons reattach the PQ muscle because of functional effects on fracture stabilization and considerations for improving the blood supply of the fracture line [7]. The repair of PQ muscle contributes to forearm power and stabilization, which constitutes 21% of the torque during pronation [8]. Gordon et al. reported that the deep head of the PQ muscle is a dynamic stabilizer of the radioulnar joint and that it assists in grasping through muscle contraction during pronation–supination [9]. During the surgical revision of 20 patients with distal radius fractures and PQ muscle repair, Brown and Lifchez found that the tendon of the flexor pollicis longus muscle was accelerated or eroded by the volar plate [10]. Berglund et al. suggested that after volar plate surgery, the repaired PQ muscle acted as a soft tissue barrier that blocked tendon irritation [11]. In a cadaver study, Tanaka et al. found increased tendon irritation when plates were placed distal to the watershed line. They also noted the risk of screw penetration of the joint [12]. In order to minimize these risks, Aldemir et al. have noted the importance of placing the plates in the proximal of the watershed line to prevent tendon irritation. They also measured the depth of the lunate fossa, which is the deepest part of the wrist joint, like 2.58 mm, and showed that plates applied according to this distance prevented intra-articular screw penetration [13,14]. In our study, all surgeries were performed by the same surgeon. Irritation or rupture of the flexor tendon and intra-articular screw penetration were not observed.

In a study of 112 patients with or without PQ repair, Hershman et al. found no significant differences between two groups in wrist range of motion or visual analog score at a mean of 1-year follow-up [15]. However, four patients required a second surgery, extensor tendon rupture occurred in two, and intra-articular screw penetration was observed in one. Swigart et al. placed radiopaque hemoclips on the repaired PQ muscles of 24 patients and found no significant differences in the PQ muscle injury level, wrist flexion–extension, pronation–supination, or grip strength at 3 months postoperatively [4].

Conclusion

In our study, no loosening was observed in the hemoclips after PQ

repair. The maximum clip separation was 6 mm, which was not clinically significant. The range of motion of the hand–wrist joints in the two groups was similar. The splint use duration had no effect on the outcomes expected from the repair of the PQ muscle.

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Ethical approval

This article contains studies with human participants, and This article does not contain any studies or animal participant performed by any of the authors.

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