Readmission Rate of Outpatient Distal Radius Fixation Surgery with Brachial Plexus Block and Midline Pronator Quadratus Approach in the COVID-19 Era: A Retrospective Case Series Report in a Secondary Care Hospital in Thailand

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ABSTRACT

Objective: To demonstrate the readmission rate after distal radius fixation surgery performed with a brachial plexus block and the midline pronator quadratus approach in an ambulatory manner in a secondary care hospital.
Materials and Methods: This retrospective study analyzed data on distal radius fracture patients treated with ambulatory surgery. The patients were enrolled from 1 January 2020 to 28 February 2022, which was during the COVID-19 pandemic. The primary outcome was the readmission rate within 30 days after the surgery. The secondary outcomes were complications, postoperative pain, radiographic outcome, and functional score. All patients were followed up for at least 1 year after the surgery.
Results: Thirty-one patients were enrolled in this study. Their mean age was 58.5 years, and the fractures were mainly caused by low-energy trauma. No postoperative complications were reported, and no readmission after surgery was observed. Overall radiographic parameters were in the acceptable range (radial inclination = 21.9, radial height = 10.26, volar tilt = 2.65, and ulna variance = 1.33). All patients returned to their preinjury statuses within 5 months.
Conclusion: Distal radius fixation surgery can be managed in an ambulatory manner with a low readmission rate, even in secondary care hospitals. This repair technique provides adequate soft tissue coverage of the volar radius plate while decreasing the risk of iatrogenic radial artery injuries.

Keywords: Distal radius fracture; pronator quadratus repair; distal radius plate; osteosynthesis (Siriraj Med J 2023; 75: 494-500)

INTRODUCTION

According to a recent network meta-analysis, fractures of the distal radius treated with volar locking plate fixation tend to have superior outcomes to fractures treated with other methods.[1,2] Fixation surgery can be performed as an ambulatory procedure using an advanced technique such as "wide awake local anesthesia no tourniquet" (WALANT).[3] Performing distal radius fixation surgery in an ambulatory manner decreases hospital occupation rates while ensuring that fractures indicated for surgery are adequately treated. These benefits are particularly significant during the COVID-19 era when hospital beds must be preserved for patients suffering severe respiratory failure.[4,5] However, only a few hospitals in Thailand perform distal radius fixation surgery on an outpatient basis.

The volar Henry approach is the mainstay for open reduction and internal fixation of the distal radius.[6-8] The pronator quadratus (PQ) muscle is classically incised at its most radial attachment to access the fracture site.[9,10] Although the subsequent repair of the PQ muscle protects the flexor tendons from attrition due to plate prominence, the procedure is technically demanding.[9,11] In the classic volar Henry approach, the PQ muscle is incised close to the radial border of the radius bone. Occasionally, however, the muscle is not amenable to repair by suturing.[7] Additionally, incising the PQ muscle at the radial border may cause iatrogenic radial artery injury and, in turn, postoperative bleeding, a common reason for readmission after surgery. These potential drawbacks influence surgeons to perform the surgery on an inpatient basis.

A mid-belly approach makes distal radius fracture repair more suitable for ambulatory surgery and decreases iatrogenic neurovascular structure injury. The mid-belly technique ensures that there is adequate soft tissue to repair. Additionally, using monofilament suture material to avoid cutting through muscle gives reliable strength at the repair site. This study reports the results of 31 cases of operated distal radius fixation surgery performed as an ambulatory procedure during the COVID-19 era.

MATERIALS AND METHODS

This retrospective study analyzed data on distal radius fracture patients treated with ambulatory surgery at the Golden Jubilee Medical Center, a secondary care hospital in Thailand. The patients were enrolled from 1 January 2020 to 28 February 2022 during the COVID-19 pandemic. The inclusion criteria were as follows: isolated closed distal radius fracture, aged 18 or older, community ambulator, no contraindication for surgery, no allergy to the anesthetic drug, no cognitive impairment, and accompanied by a caregiver on the day of surgery. The indications for surgery were distal radius fractures that were unstable or demonstrated inadequate reduction. "Unstable fractures" were defined as those that were unable to maintain a reduction or had dorsal comminution or intra-articular involvement. The following radiographic parameters defined an adequate reduction: radial height > 5 mm, radial inclination > 15°, volar tilt from 15° to neutral, ulnar variance < 2 mm, and articular step-off or gap < 2 mm. After counseling, the patients selected the treatment option: conservative treatment with a cast, surgical treatment on an inpatient basis, or surgical treatment as an ambulatory procedure. Only patients who elected to undergo ambulatory surgery were enrolled in this study.

Surgical procedure

Ultrasound-guided axillary brachial plexus block is the anesthetic method of choice. Each patient was placed in the supine position, with the head turned away from the arm to be blocked. The arm was abducted to 90 degrees, and the elbow was flexed. After skin preparation, a transducer was placed in the short axis orientation just distal to the axilla, enabling identification of the axillary artery and the nerves surrounding it. A 5-cm 22-gauge needle was advanced (in-plane technique) until the tip was adjacent to the targeted nerve. An incremental, slow injection was administered, with the frequent aspiration of the local anesthetic drug to avoid intravascular injection. The goal was to deposit local anesthetic around the axillary artery and the musculocutaneous nerve. A subcutaneous injection just distal to the axilla was performed to block the intercostobrachial nerve. The combination of intercostobrachial nerve block and intravenous sedation helped the patient tolerate tourniquet pain.

The modified Henry approach was performed, with the skin incision made above the flexor carpi radialis muscle. The flexor carpi radialis tendon was retracted to access the deep fascia (Fig 1a). After blunt dissection, the PQ muscle was fully visualized above the radius bone. A sharp, full-thickness cut at the mid-belly of the PQ muscle was made deep to the radius bone to access the fracture site (Fig 1b). To keep the muscle brim sharp and repairable, the PQ muscle was meticulously detached subperiosteally to form a muscle flap. The articular surface was reduced under a fluoroscope by accessing the fracture site via the metaphysis and lifting the fracture fragments to restore the articular surface. The volar ulnar corner and distal radioulnar joint were comfortably accessible, with little muscle belly obstructing the surgical site. With this reduction technique, the joint capsule proximal to the watershed line was preserved (Fig 2a). After volar locking plate placement, the PQ muscle was closed using monofilament absorbable suture material to minimize soft tissue trauma. The mid-portion of the PQ muscle and the thick underlying periosteum were sutured using the figure-of-8 closure technique to avoid cut-through of the muscle. The PQ muscle was repaired from the distal to the proximal end to ensure adequate distal coverage (Fig 2b). The subcutaneous tissue and skin were subsequently closed.

Postoperative protocol

Postoperatively, dry dressing, compression dressing with a cotton wrap, and conformable stretch bandaging were applied to the surgical wound. Each patient was counseled about postoperative care and advised to visit
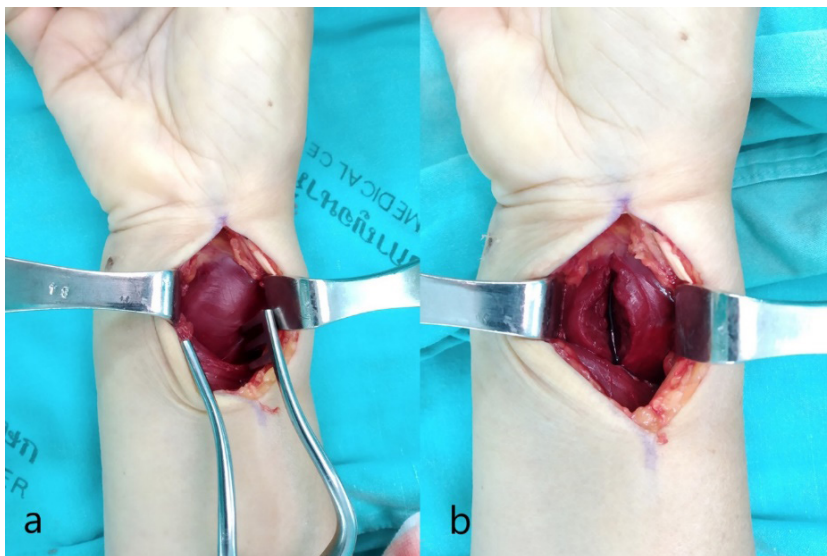
Fig 1a. The flexor carpi radialis tendon was identified and retracted to access the deep fascia. The pronator quadratus muscle was identified by excising the deep fascia and bluntly dissecting the soft tissue.

Fig 1b. A full-thickness dissection of the pronator quadratus muscle was undertaken at the mid-belly portion to access the fracture site. The incision is recommended at the mid-portion of the radius bone or slightly ulnar to gain improved visualization of the lunate facet.
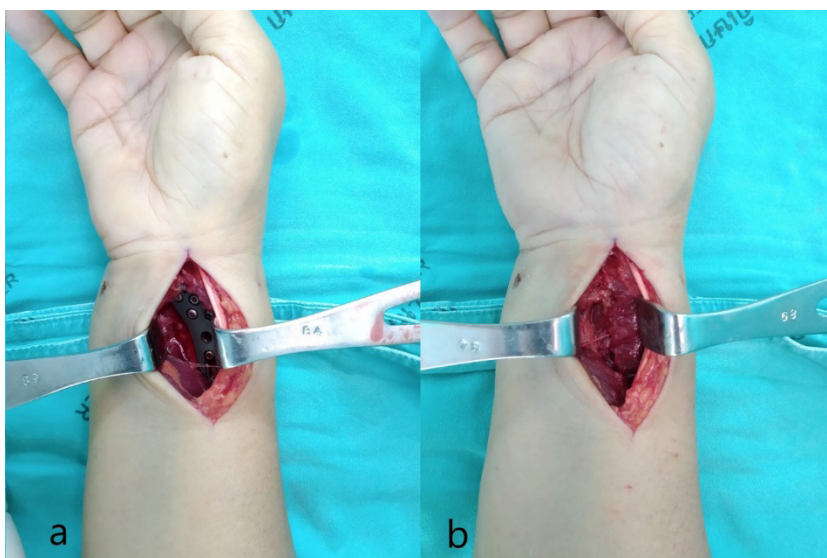
Fig 2a. The plate position should be proximal to the watershed line. Limited exposure to the distal musculotendinous junction is recommended if the reduction is successful with the closed technique.

Fig 2b. A monofilament absorbable suture is recommended for repair of the pronator quadratus muscle. Appropriate tension and approximation facilitate the repair process and ensure adequate distal coverage

the hospital if complications developed. Wrist motion was allowed immediately after surgery. The patient was requested not to carry heavy objects during the first postoperative month but was encouraged to increase weight bearing gradually, as tolerated, afterward.

Data collection

Patient demographic data were obtained. Any postoperative complications and the readmission rate within 30 days after the surgery were ascertained from operative notes and medical records. Per the surgical protocol, postoperative pain was evaluated by phone calls within the 3-day postoperative period. Immediate postoperative radiographs were obtained before each patient was discharged (Fig 3). Removal of the stitches and routine wound care were performed during the first follow-up visit (2 weeks postoperatively). Radiographic evaluations of the fracture fixation were performed at routine follow-ups until callus formations were noted.

The functional outcomes were evaluated by the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire at each follow-up. Pain sensation was evaluated with a visual analog scale.

Statistical analysis

Demographic data are reported as the means and standard deviations for continuous data, while categorical data are presented as frequencies and percentages. The readmission rate, the primary outcome, is reported as the number of cases and percentages. The postoperative complications are reported in the same manner as categorical data. Visual analog scale scores, radiographic parameters, and Quick-DASH scores are reported as the means with standard deviations.

RESULTS

The study enrolled 31 patients who underwent distal radius fixation surgery in an ambulatory manner. Their

Fig 3. Preoperative radiographs were obtained to facilitate surgical planning. This representative preoperative radiograph (top row) shows a fracture categorized as Type III under the Fernandez classification system. The subsequent postoperative radiograph (bottom row) shows decreased articular stepping and adequate volar tilt of the distal fragment.

Fig 4. This picture demonstrates the postoperative surgical wound at 2 weeks. A minimal hematoma was observed, with no surgical-site infection reported.

mean age was 58.5 years, and most patients were female. The most common injury mechanism was low-energy trauma, and the affected side was indifferent, being either right or left. Most patients had a fracture pattern with an American Orthopedic/Orthopedic Trauma Association classification of 2R3A3. Other demographic data are detailed in Table 1.

None of the 31 cases in this study were readmitted. The average operative time was 95.58 minutes, and the average intraoperative bleeding volume was 6.2 ml. The PQ muscle was successfully repaired in all 31 cases with adequate plate coverage, skin closure, and no plate prominence. No immediate postoperative complications

were reported, and no hematomas or surgical wound complications were noted at the 2-week follow-up (Fig 4).

One patient came for an early follow-up visit with swelling of the hand that had been operated on as the chief complaint. After counseling and advising the patient to perform active finger motion with the appropriate arm position, the patient's symptoms were relieved. The patient attended the subsequent scheduled follow-up visit. Another 5 patients had postoperative numbness, but their symptoms had resolved by 8 weeks postoperatively. Although most of the 31 patients had wrist stiffness 4 weeks after surgery, their wrist motion had returned to normal by 8 weeks after surgery. In addition, callus formations were noted in plain radiographs 8 weeks postoperatively. No revision surgery or postoperative infections were found in this study.

Most of the radiographic parameters were in an acceptable range. The mean radial height was restored to 10.26 mm along with radial inclination (mean = 21.97°). Most patients' distal radii were reduced in neutral to slightly volar flexion in the lateral view, with minimal to no articular stepping and a slightly positive ulnar variance

TABLE 1. Demographic data of the patients.

Variable	N	% of sample
Age		
Mean = 58.6 ± 11.05 years		
≤ 40	1	3.2%
41-60	16	51.6%
> 60	14	45.2%
Sex		
Male	8	25.8%
Female	23	74.2%
Mechanism of injury		
Low energy	27	87.1%
High energy	4	12.9%
Affected side		
Rt.	15	48.4%
Lt.	16	51.6%
AO classification: 2R3		
A2	4	12.9%
A3	14	45.2%
B2	1	3.2%
C1	6	19.4%
C2	4	12.9%
C3	2	6.5%
ASA classification		
1	14	45.2%
2	15	48.4%
3	2	6.4%
Time to surgery (days)		
Mean = 10.3 ± 4.6		
≤ 5 4	12.9%	
6 - 15	22	70.9%
>15	5	16.2%

(Table 2). The mean QuickDASH scores at the 1-month, 2-month, and 5-month follow-ups were 46.55, 20.44, and 0.6, respectively. During the first night, the patients experienced maximum postoperative pain, which was relieved by oral analgesic drugs. The pain score on the first postoperative day was below 5, decreasing steadily thereafter.

DISCUSSION

Distal radius fixation surgery is one of several feasible orthopedic procedures for ambulatory surgery. Ambulatory or day surgery is appropriate and feasible in secondary care hospitals or higher. A peripheral nerve block or local selective nerve block is adequate for intraoperative pain control. Although the postoperative complications are quite low, the commonly reported causes of readmission are postoperative pain and bleeding complications. A meticulous surgical approach and an appropriate anesthetic technique are essential for reducing complications and readmission rates.

The volar Henry approach is the mainstay for the osteosynthesis of distal radius fractures. Although recent studies have shown no significant differences in functional outcomes[12,13], most surgeons prefer to repair the PQ muscle after plate fixation to ensure coverage and prevent flexor tendon rupture.[8,9,11,14] The classic volar

TABLE 2. Postoperative radiographic parameters of the affected distal radius.

Variable	N	% of sample	Mean	Median
Incline			21.97 ± 3.2	22.0
< 20	9	29%		
> 20	22	71%		
Radial height (mm)			10.3 ± 1.4	10.5
≤ 10	12	38.7%		
> 10	19	61.3%		
Tilt			2.65 ± 4.8	4.0
≤ 0	10	32.3%		
> 0	21	67.7%		
Step (mm)			0.24 ± 0.6	0
= 0	26	83.9%		
> 0	5	16.1%		
Variance (mm)			1.33 ± 1.9	1.7
≤ 0	10	32.3%		
> 0	21	67.7%		

Henry approach is preferred to incise the PQ muscle at the radial-most attachment at the musculotendinous junction. An incision too close to the radial border leaves a small tendinous attachment that is typically challenging to repair and risks iatrogenic radial artery injury.[6]

The principle of the authors' technique is based on the anatomic repair of the PQ muscle. Through meticulous subperiosteal elevation of the PQ muscle, the intact periosteum reinforces the muscle belly, thereby maintaining the belly's integrity and strengthening the muscle edge. Furthermore, the monofilament absorbable suture material helps to decrease soft tissue trauma, thus further increasing the muscle's integrity after suturing. Moreover, by using the figure-of-8 closure technique as the first suturing knot, the sharp edge of the PQ muscle is held appropriately. The tension force is also decreased by holding the forearm in the semipronated position. Both of these outcomes facilitate the repair process.

Coverage of the most distal portion of the PQ muscle is problematic for all current techniques for repairing the muscle.[8,9,11] Because the watershed area lacks a muscle belly[15], coverage by the PQ muscle alone is insufficient in some cases. Adequate reduction is needed to minimize plate prominence at the distal part of the radius.[11,16-18] With a variable angle screw, the plate can be placed proximal to the watershed area with satisfactory screw placement.[15]

The integrity and durability of the PQ muscle are topics of interest. Muscle-to-muscle suturing may give a poor result due to the questionable strength and integrity of the repair site.[8,18] Interestingly, 6 patients in this study underwent plate removal after a 1-year follow-up due to patient preference. The intraoperative findings showed intact PQ muscle with full plate coverage (Fig 5). These 6 patients had gained a full range of motion of the affected wrist with no hand-grip strength impairment.
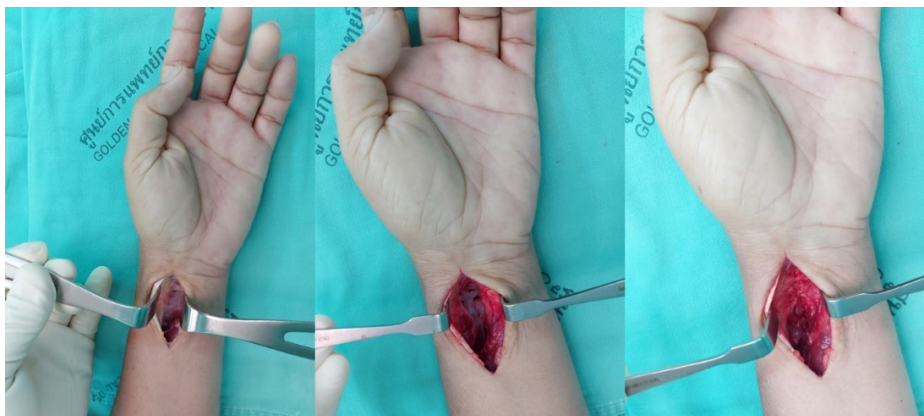

Fig 5. The pronator quadratus muscle was intact, with complete coverage of the distal radius volar locking plate observed during the retrieval surgery. The pronator quadratus muscle was repaired after plate removal.

Good repair of the PQ muscle may also help decrease postoperative hematoma. In this study, postoperative pain was minimal, peaking on the first night after the surgery, and no hematomas or wound infections were reported, which are common reasons for readmission.[19] Pain from the soft tissue trauma was decreased through meticulous soft tissue handling. With the PQ muscle intact after its repair, a hematoma is also limited within a closed space; minimal postoperative bleeding was observed at the 2-week follow-up when the surgical stitches were removed. Further study is needed to determine this effect.

This technique has a limitation based on PQ muscle quality. Old patients with generalized muscle wasting may have insufficient PQ muscle thickness, making the muscle not repairable. Furthermore, severe articular comminution is not amendable with this technique. This is because an extensile approach may be needed, and plate placement needs to be in the watershed area[7,11,15], making it too bulky for coverage. In this situation, brachioradialis tendon coverage[8] or PQ-muscle splitting[9] is an alternative.

CONCLUSION

Distal radius fixation surgery is feasible for ambulatory surgery with minimal postoperative complications or readmission rates. An appropriate anesthetic technique and a meticulous surgical approach are essential to perform the procedure as ambulatory surgery. Meticulous repair of the PQ muscle after mid-belly splitting gives adequate coverage with promising durability in selected patients. This repair technique provides adequate soft tissue coverage of the volar radius plate while decreasing the risk of iatrogenic radial artery injuries.

Conflicts of interest

All authors declare that there are no personal or professional conflicts of interest and that no financial support was provided by the companies that produced the materials described in this report.

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