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Distal Radius Fracture Fixation Outcome Covering With Proneter Quadratus Muscle Comparing to Non Covering

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Abstract: **Background:** Distal radius fractures (DRF) are common upper limb fractures, often requiring surgical intervention. The role of pronator quadratus (PQ) muscle coverage in improving surgical outcomes remains unclear. This study aims to evaluate the impact of PQ muscle coverage on the functional and clinical outcomes of DRF treated with volar locking plate fixation.

Methods: A comparative observational study was conducted at Al-Kindy Teaching Hospital in Baghdad, Iraq, from June 2023 to July 2024. Twenty patients with DRF were divided into two groups: Group A (with PQ muscle coverage) and Group B (without PQ muscle coverage). Data were collected prospectively at baseline and during follow-up (1 week, 2 weeks, 1 month, and 3 months post-surgery), focusing on demographics, complications, functional outcomes (measured by DASH and Modified Mayo Wrist Scores), pain, grip strength, range of motion, and overall functional status.

Results: The mean age of participants was 53.5 years, Infection rates were similar between both groups ($p = 0.581$). Flexor tendon irritation was significantly lower in Group A (0%) compared to Group B (20%) ($p = 0.006$). No significant differences were observed in pain, grip strength, range of motion, or overall functional status between the two groups. At 3 months post-surgery, both groups showed substantial functional recovery, with the majority returning to regular activities. The Modified Mayo Wrist Score revealed no significant differences between the groups ($p = 0.171$).

Conclusions: PQ muscle coverage did not significantly improve overall functional outcomes, including pain levels, grip strength, range of motion, or functional status. However, it did reduce the incidence of flexor tendon irritation.

Keywords: Distal radius fracture, volar locking plate, pronator quadratus muscle, muscle coverage.

CHAPTER ONE

Introduction

1.Background

Distal radius fractures (DRF) are among the most common skeletal injuries encountered in orthopedic practice, especially following falls on an outstretched hand or direct trauma to the wrist. As the distal radius plays a pivotal role in wrist function and forearm stability, the management of these fractures is critical to ensuring a successful recovery of hand functionality. Treatment options vary based on fracture complexity, patient activity level, and functional demands, with fixation techniques evolving to accommodate these diverse needs.,consist of superfascial head act on pronation and deep head act as stabilizer of distal RUJ

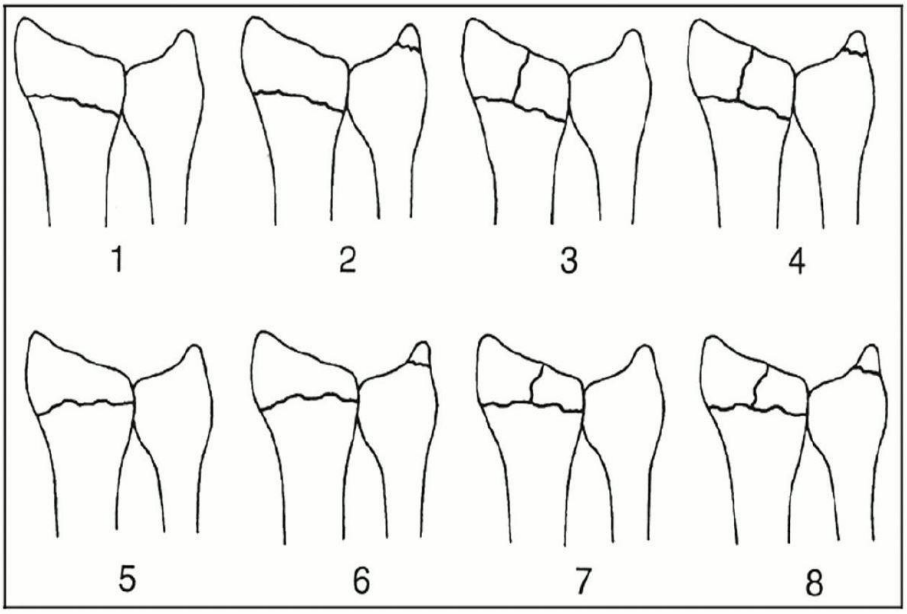
In surgical practice, the pronator quadratus (PQ) muscle, located at the distal forearm, often plays a critical role during fixation. This square-shaped muscle, responsible for forearm pronation, supply by anterior interosseous nerve lies just above the distal radius and serves as a barrier between the bone and nearby tendons. Surgeons often decide between covering the volar plate with the PQ muscle or leaving it exposed, aiming to optimize healing, minimize complications, and promote functionality. [2]

2. Classification of Distal Radius Fractures

2.1. Frykman Classification

The Frykman classification is one of the most widely used systems, categorizing fractures based on the involvement of the radioulnar joint and the presence or absence of an ulnar styloid fracture. [3]

This classification identifies eight types, ranging from extra-articular fractures (Types I and II) to more complex intra-articular fractures (Types III to VIII). The presence of ulnar styloid fractures or damage to the radioulnar joint can significantly influence treatment decisions and patient outcomes, as they may lead to instability or prolonged recovery times. [4]



Frykman Classification

Distal Radius Fracture	Distal Ulna Fracture	
	Absent	present
Extraarticular	I	II
Intraarticular involving radiocarpal joint	III	IV
Intraarticular involving distal radioulnar joint (DRUJ)	V	VI
Intraarticular involving radiocarpal and DRUJ	VII	VIII

Figure 1.1.: Frykman classification of distal radius fractures. [5]

- Type I and II: Extra-articular fractures without or with ulnar styloid fracture, respectively.
- Type III and IV: Intra-articular fractures of the radiocarpal joint, without or with ulnar styloid fracture.
- Type V and VI: Intra-articular fractures involving the distal radioulnar joint, without or with ulnar styloid fracture.

- Type VII and VIII: Complex intra-articular fractures involving both the radiocarpal and distal radioulnar joints, without or with ulnar styloid fracture.

The Frykman classification is valuable in determining the stability of the wrist and forearm following injury. Surgeons may operate for PQ coverage in more complex fractures (e.g., Types VII and VIII) to provide additional support to the distal radius, thus reducing the risk of soft tissue complications. (6)

2.2. Fernandez Classification

The Fernandez classification is mechanism-based, categorizing fractures based on the force and direction of trauma rather than specific anatomical landmarks. This approach helps in understanding the underlying injury mechanisms, guiding treatment in a way that aligns with the forces that caused the fracture. (7)

- Type I: Bending fractures caused by axial loading, often treated with closed reduction or casting.
- Type II: Shearing fractures involving the articular surface, typically requiring surgical intervention.
- Type III: Compression fractures, where axial loading crushes the bone, common in osteoporotic patients.
- Type IV: Avulsion fractures caused by a sudden pulling force, generally requiring fixation.
- Type V: Combined or complex fracture patterns with elements of the above types.

For complex fractures like Type V, the PQ muscle may serve as a protective layer during fixation, particularly in cases where volar plating is necessary to achieve stable fixation. The Fernandez classification thus aids in customizing treatment to the nature of the injury. (8)

FRACTURE TYPES (ADULTS) BASED ON THE MECHANISM OF INJURY	CHILDREN FRACTURE EQUIVALENT	STABILITY/ INSTABILITY: high risk of secondary displacement after initial adequate reduction	DISPLACEMENT PATTERN	NUMBER OF FRAGMENTS	ASSOCIATED LESIONS carpal ligament, fractures, median, ulnar nerve, tendons, ipsilat. fx upper extremity, compartment syndrome	RECOMMENDED TREATMENT
TYPE I BENDING FRACTURE OF THE METAPHYSIS	DISTAL FOREARM FRACTURE SALTER II	STABLE UNSTABLE	NON-DISPLACED DORSALLY Colles VOLARLY Smith PROXIMAL COMBINED	ALWAYS 2 MAIN FRAGMENTS + VARYING DEGREE OF METAPHYSEAL COMMINUTION (instability)	UNCOMMON	CONSERVATIVE (stable fx) PERCUTANEOUS PINNING (extra- or intrafocal) EXTERNAL FIXATION (exceptionally BONE GRAFT)
TYPE II SHEARING FRACTURE OF THE JOINT SURFACE	SALTER IV	UNSTABLE	DORSAL Barton RADIAL Chauffeur VOLAR rev. Barton COMBINED	TWO-PART THREE-PART COMMINUTED	LESS UNCOMMON	OPEN REDUCTION SCREW-/PLATE FIXATION
TYPE III COMPRESSION FRACTURE OF THE JOINT SURFACE	SALTER II, IV, V	STABLE UNSTABLE	NON-DISPLACED DORSAL RADIAL VOLAR PROXIMAL COMBINED	TWO-PART THREE-PART FOUR-PART COMMINUTED	COMMON	CONSERVATIVE CLOSED, LIMITED, ARTHROSCOPIC ASSISTED OR EXTENSILE OPEN REDUCTION PERCUTANEOUS PINS EXTERNAL FIXATION INTERNAL FIXATION PLATE, BONE GRAFT
TYPE IV AVULSION FRACTURES, RADIO CARPAL FRACTURE DISLOCATION	VERY RARE	UNSTABLE	DORSAL RADIAL VOLAR PROXIMAL COMBINED	TWO-PART (radial styloid ulnar styloid) THREE-PART (volar, dorsal margin) COMMINUTED	FREQUENT	CLOSED OR OPEN REDUCTION PIN OR SCREW FIXATION TENSION WIRING
TYPE V COMBINED FRACTURES (I - II - III - IV) HIGH VELOCITY INJURY	VERY RARE	UNSTABLE	DORSAL RADIAL VOLAR PROXIMAL COMBINED	COMMINUTED and/or BONE LOSS (frequently intra-articular, open, seldom extra-articular)	ALWAYS PRESENT	COMBINED METHOD

Figure 1.2.: Fernandez classification of distal radius fractures. (5)

2.3. AO Classification

The AO (Arbeitsgemeinschaft für Osteosynthesefragen) classification system is highly detailed and widely adopted for assessing fracture severity and treatment planning. It categorizes fractures into three main groups, with subgroups for further granularity: [9]

- Type A (Extra-articular): Fractures that do not involve the joint surface, usually simpler and more stable.
- Type B (Partial articular): Fractures involving a portion of the articular surface, requiring careful alignment to avoid joint dysfunction.
- Type C (Complete articular): Fractures involving the entire articular surface, often comminuted, demanding advanced fixation techniques for stability.

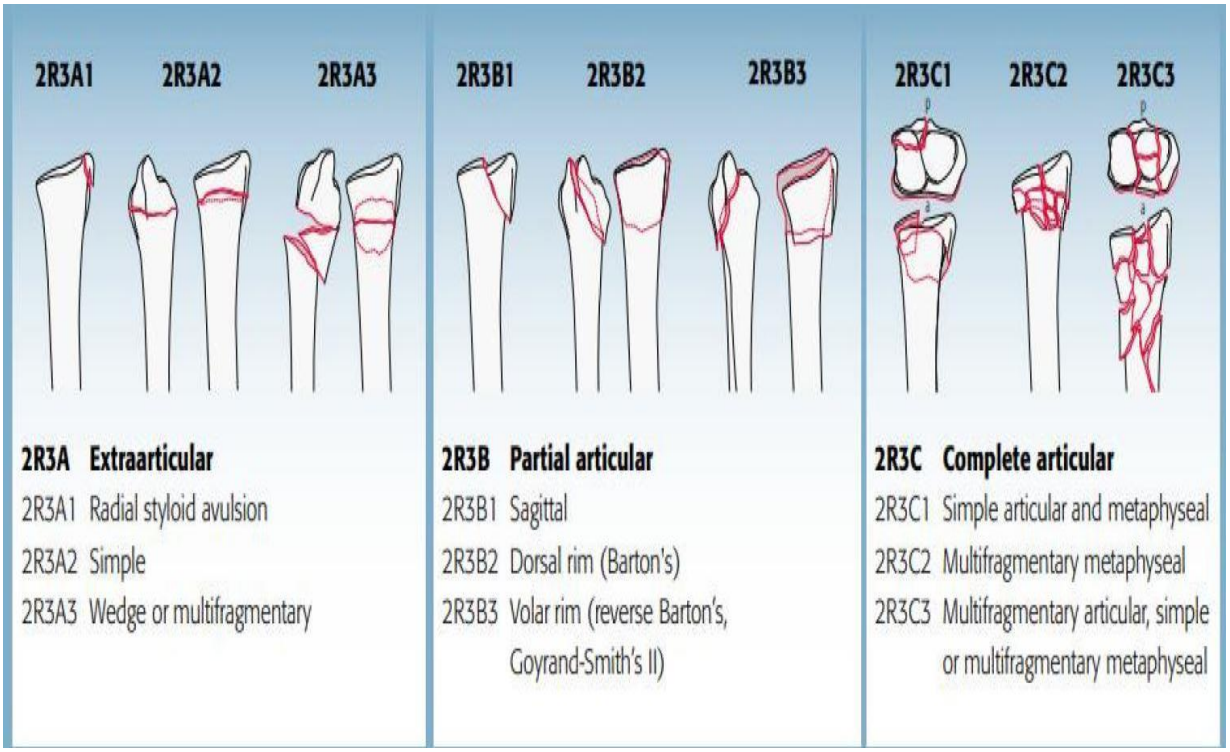


Figure 1.3.: AO classification of distal radius fractures. [10]

In high-complexity fractures (e.g., AO Type C), surgeons may prefer PQ muscle coverage to enhance the stability of the volar plate, reduce the risk of soft tissue irritation, and promote more robust healing. The AO classification, with its focus on fracture complexity, thus directly influences surgical decisions in favor of or against PQ muscle coverage. [11]

3. Anatomy and Functional Role of the Pronator Quadratus Muscle

The pronator quadratus muscle is located in the distal forearm, spanning from the ulna to the radius. It plays a crucial role in pronation, or inward rotation, of the forearm, and lies just above the distal radius, offering an anatomical shield to the tendons and nerves in the area. Its proximity to the distal radius makes it a practical candidate for covering fixation hardware, particularly in volar plating.[12]

Functionally, the PQ muscle aids in stabilizing the distal forearm, particularly after trauma to the radius. Covering the volar plate with the PQ muscle during surgery is thought to protect nearby tendons from irritation caused by the hardware, potentially reducing complications such as tendonitis or hardware-related discomfort. Alternatively, leaving the plate uncovered can decrease surgical time and simplify recovery, though it may increase the likelihood of soft tissue irritation. [13]

4. Surgical Techniques for DRF Fixation

4.1. Common Fixation Techniques:

Main indication for internal fixation are

***dorsal angulation more than 5 degree,comminution,intra articular fracture >2mm,,radial shortening>5mm,,associated ulnar fracture and osteoporosis**

Distal radius fractures are frequently treated using volar plating, which has become the preferred fixation method due to its stability and versatility, particularly for complex or intra-articular fractures. Volar plating involves placing a metal plate on the volar (palm side) aspect of the distal radius, providing a stable fixation point for bone fragments. This technique is especially useful in elderly patients or those with osteoporotic bones, where bone quality may not support traditional casting or external fixation methods. (14)

Volar plating offers reliable structural support, enabling patients to begin early mobilization, which can improve functional outcomes. However, the proximity of the plate to tendons, nerves, and other soft tissues increases the risk of complications, such as tendon irritation or hardware impingement. This consideration has led surgeons to explore the benefits of covering the volar plate with the pronator quadratus (PQ) muscle to reduce these risks. (15)

4.2. Fixation with PQ Muscle Coverage

In the fixation approach with PQ muscle coverage, the volar plate is covered with the PQ muscle after placement. This technique involves suturing the muscle over the plate to create a soft tissue barrier between the hardware and the overlying tendons, particularly the flexor pollicis longus (FPL) tendon, which is at high risk for irritation or rupture. Covering the plate with the PQ muscle is thought to reduce complications related to soft tissue irritation and provide additional stabilization to the distal radius. (16)

In cases with complex fractures, particularly those classified as AO Type C, PQ coverage is often considered beneficial. This extra layer of protection can be advantageous in fracture types where soft tissue involvement is significant, or where the risk of tendon injury is heightened. Despite its potential benefits, the technique requires additional surgical time and may increase complexity, particularly in patients with significant tissue damage or scarring. (17)

4.3. Fixation without PQ Muscle Coverage

Another approach is to perform DRF fixation without covering the volar plate with the PQ muscle. In this method, the PQ muscle is either minimally retracted or left in its original position without covering the plate, simplifying the procedure and reducing operative time. By leaving the PQ muscle undisturbed, surgeons may decrease recovery time and minimize muscle trauma, which can be beneficial in certain patients. (18)

Leaving the plate uncovered may be preferred in straightforward fractures, such as AO Type A fractures, where additional soft tissue support is less critical. However, without PQ muscle coverage, there is a higher risk of soft tissue complications, particularly involving the FPL and flexor tendons, which are in close proximity to the plate. This technique might be advantageous for patients who prioritize shorter surgery times or who present with lower risk of tendon complications due to their fracture type or activity level. (1

5. Comparative Analysis of Outcomes

- **Functional Recovery**

The choice between covering the volar plate with the PQ muscle or leaving it exposed can significantly impact postoperative functional recovery. Studies have shown that covering the plate with the PQ muscle can provide additional support and reduce the risk of soft tissue irritation, allowing patients to regain wrist mobility and strength with fewer complications. (20)

Patients undergoing fixation with PQ coverage often report improved early postoperative grip strength and forearm pronation. This is partly attributed to the muscle's protection of surrounding tendons, which reduces pain and allows for more comfortable movement during rehabilitation. In contrast, patients who undergo fixation without PQ coverage may experience a faster recovery in terms of muscle trauma and flexibility, but with a potentially higher risk of tendon irritation, which can hinder functional gains over time. [21]

- **Pain and Complications**

One of the primary goals in DRF fixation is to minimize postoperative pain and prevent complications related to hardware and tendon irritation. Covering the plate with the PQ muscle has been associated with lower rates of hardware-related pain, as the muscle acts as a cushion that reduces direct contact between the plate and tendons. This approach may lower the likelihood of hardware removal or revision surgery, as it reduces inflammation and irritation in soft tissues. [22]

In contrast, fixation without PQ coverage has been linked to a higher incidence of tendon irritation, particularly involving the FPL tendon. Studies have reported cases of tendonitis, rupture, and persistent pain in patients who underwent fixation without PQ muscle coverage. However, the simplified approach may reduce pain associated with muscle manipulation, which some patients find beneficial, particularly in lower-risk fractures. [23]

- **Healing and Radiographic Outcomes**

The healing process following DRF fixation can be influenced by the choice of PQ muscle coverage. While both techniques generally result in successful radiographic union, some evidence suggests that PQ coverage may improve healing rates in complex fractures by providing additional stability. In fractures classified as AO Type B or C, where intra-articular involvement increases the risk of nonunion, PQ muscle coverage may offer biomechanical support that promotes more efficient healing. [24]

Without PQ muscle coverage, healing outcomes are typically similar in simple fractures, with minimal differences observed in union rates or healing time. However, for more severe fractures, the absence of PQ coverage can lead to minor malunions or delayed healing, particularly in cases with high tendon involvement or complex fracture patterns. [25]

- **Aesthetic and Long-Term Implications**

Aesthetic outcomes and long-term implications also vary based on the choice of technique. Covering the volar plate with the PQ muscle can result in better cosmetic outcomes due to reduced scarring and muscle atrophy, as the PQ muscle remains functional and intact. This approach also minimizes the risk of visible deformities associated with tendon irritation or muscle atrophy. [26]

On the other hand, leaving the plate uncovered may be associated with subtle visible changes in forearm structure over time, particularly in patients with complex fractures that experience PQ muscle atrophy. While these changes are usually minor, they may impact the overall appearance and long-term comfort of the forearm, especially in physically active patients or those with high cosmetic expectations. [27]

- **Patient Satisfaction and Quality of Life**

Patient-reported outcomes on satisfaction and quality of life have generally favoured PQ muscle coverage in cases of complex fractures, as the technique tends to result in fewer soft tissue complications and improved functional recovery. [28]

Many patients appreciate the reduced incidence of hardware discomfort and the additional protection provided to the tendons. Conversely, for simple fractures, patients often report comparable satisfaction levels with the non-coverage technique, as the simplified procedure reduces surgical time and potential muscle-related pain. [29]

6. Justification of the study

Distal radius fractures (DRFs) are among the most prevalent injuries, particularly affecting older adults due to falls and younger individuals involved in high-impact activities. The effective management of these fractures is essential, as they can severely impact wrist function, grip strength, and overall quality of life. With surgical treatment often preferred for complex or unstable fractures, selecting the optimal fixation method has become critical to reducing complications and enhancing recovery. Up to the best of our knowledge there is no local study covering the subject in Iraq.

Aim of the study

To compare treatment of DRF with and without PQ muscle coverage and compare the two modalities in terms of function, pain, union and post operative infection.

CHAPTER TWO

Patients and Method

2.1. Study Design

A comparative observational design to evaluate the treatment outcomes of distal radius fractures (DRF) with and without pronator quadratus (PQ) muscle coverage.

2.2. Study Setting

The study was conducted at Al-Kindy Teaching Hospital, Baghdad, Iraq, over a period of one year from June 2023 to July 2024. Patient data were collected after the study protocol received approval from the Iraqi Board of Medical Specializations and the local council of orthopedic surgery at Al-Kindy Teaching Hospital.

Patients were collected from the hospital orthopedic ward after being admitted for treatment for DRF based on senior orthopedic surgeon decision, the type of treatment was also selected based on senior orthopedic surgeon

2.3. Sample selection

- Group A: Ten patients who underwent surgical fixation of DRF with pronator quadratus (PQ) muscle coverage.
- Group B: Ten patients who underwent surgical fixation of DRF without PQ muscle coverage.

Inclusion Criteria

1. Patients aged 18 years and older.
2. Patients with a confirmed diagnosis of DRF based on clinical and radiological assessments.
3. Patients who consented to participate in the study.
4. Patients eligible for surgical intervention according to standard orthopedic practices.

Exclusion Criteria

1. Patients with a history of previous wrist surgery or fracture in the affected wrist.
2. Patients with pathological fractures (e.g., due to malignancy or osteoporosis).
3. Patients with significant comorbidities that may affect healing (e.g., uncontrolled diabetes, immunosuppression).
4. Patients unable to provide informed consent.

2.4. surgical procedure

Patients were admitted to the orthopedic ward and prepared for surgery after fasting for 8 hours, the required investigations for general anaesthesia were done (CBC, virology screen, CXR) and then admitted to the theatre.

Patients were positioned supine with the arm on a radiolucent hand table, general anesthesia was administered, the surgical site was prepared and draped in a sterile manner.

A standard volar incision was made over the distal radius, extending distally toward the wrist crease, the flexor carpi radialis (FCR) tendon sheath was opened to expose the volar aspect of the distal radius, the fracture fragments were identified and reduced under fluoroscopic guidance.

A volar locking plate was chosen and positioned to cover the distal radius fracture site, the plate was secured with screws placed proximally and distally.

For group A patients the pronator quadratus (PQ) muscle was carefully lifted from the volar surface of the distal radius, ensuring no damage to its neurovascular supply. After securing the plate, the PQ muscle was repositioned over the plate to provide soft tissue coverage and then sutured back to its original position.

For group B patients the plate remained exposed to surrounding tissues without soft tissue coverage.

Hemostasis was ensured, subcutaneous tissue and skin were closed in layers and a sterile dressing was applied.

The wrist was immobilized in a splint for 1-2 week for initial stabilization and the patients were discharged to the ward after awaking from anaesthesia.

2.5. Data Collection

Data were collected prospectively for each participant after obtaining verbal consent. A structured paper form (questionnaire) was used, designed by the researcher, which included:

- Demographic Data: Age, sex, and relevant medical history.
- Clinical Outcomes:

1. Incidence of postoperative complications: infection and flexor tendon irritation.
2. Assessment of function using:

- **DASH system** (Disabilities of the Arm, Shoulder, and Hand). The DASH questionnaire consists of 30 items that evaluate the patient's ability to perform daily activities and the impact of arm, shoulder, or hand conditions on quality of life. Each item is scored on a scale from 1 (no difficulty) to 5 (unable to do). The scores are transformed into a scale from 0 (no disability) to 100 (complete disability). (Appendix I)
- **Modified Mayo Wrist Score:** the scoring system included:

1. Pain (25 points): No pain: 25 points, Mild pain: 20 points, Moderate pain: 15 points, Severe pain: 0 points
2. Grip Strength (25 points): Grip strength is measured with a dynamometer and is compared with the contralateral (uninjured) side.

- Normal grip strength (≥90% of the opposite side): 25 points
- Mild weakness (75%-89% of the opposite side): 15 points
- Moderate weakness (50%-74% of the opposite side): 10 points
- Severe weakness (<50% of the opposite side): 0 points

3. Range of Motion (25 points): The range of motion is compared with the contralateral wrist, focusing on wrist flexion, extension, pronation, and supination.

- Full range of motion (≥120° total for flexion-extension, ≥80° for pronation-supination): 25 points
- Mild restriction (100°-119° for flexion-extension, 60°-79° for pronation-supination): 15 points

- Moderate restriction (80°-99° for flexion-extension, 40°-59° for pronation-supination): 10 points
- Severe restriction (<80° for flexion-extension, <40° for pronation-supination): 0 points

4. Functional Status (25 points)

- Returned to regular work and activities: 25 points
- Able to perform most activities, but limited in some: 20 points
- Able to perform only light activities: 15 points
- Unable to return to regular activities: 0 points

The points from each category are summed to yield a total score out of 100.

Interpretation of Scores was as the following:

- 90 - 100: Excellent
- 80 - 89: Good
- 65 - 79: Fair
- <65: Poor

Patients were followed up at regular intervals (1 week, 2 weeks, 1 month and 3 months post-surgery) to assess recovery and complications.

Assessment of flexor tendon irritation was done by testing the flexor policies longos holding stationary the proximal phalanx of the thumb is held while flexing the distal phalanx against resistsnce.

Data from each patient questionnaire is then transformed to excel sheet and sent for statistical analysis

2.6. Ethical approval

1. The study protocol was approved by the Iraqi board of medical specialization/ ethical committee of orthopedic surgery.
2. Patients verbal consents were obtained prior to participation in the study
3. Data and information of the participants were kept confidential.
4. Administrative approvals were granted from the Al-Kindy teaching hospital.

2.7. Statistical Analysis

Data analysis was done using IBM® Statistical Package for Social Sciences (SPSS) version 27 for Microsoft® Windows 11, results were presented in simple measures of frequency, percentage, mean, Range and standard deviation and illustrated as tablets and figures.

An independent t test was used to evaluate the association between numerical variables. Categorical data presented by frequencies and percentages. Chi square test was used to assess the association between categorical variables, while fisher exact test was used when the expected frequency was less than 5.

A level of p- value less than 0.05 was considered statistically significant.

Figure 2.1.: fixation of DRF without PQ muscle coverage.

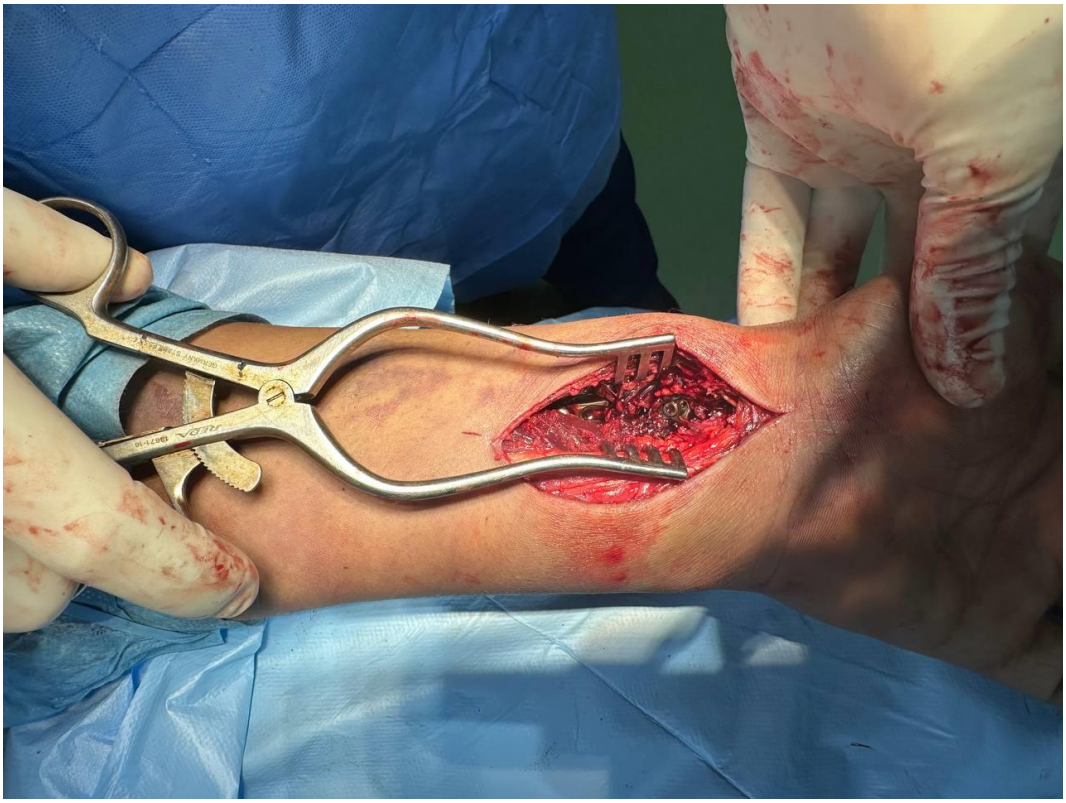


Figure 2.2.: fixation of DRF with PQ muscle coverage.

CHAPTER THREE

Results

The study involved 20 patients equally divided between Group A (10 patients) with PQ muscle cover and Group B (10 patients) treated with PQ muscle cover. The mean age in Group A is 54.3 years with a standard deviation (SD) of 12.5 years, while in Group B, the mean age is 52.7 years with an SD of 11.8 years. The overall mean age for both groups is 53.5 years with an SD of 12.2 years.

The age range for Group A is 22 to 77 years, while Group B's range is 24 to 75 years, leading to an overall range of 22 to 77 years. In terms of age distribution, 30% of Group A and 50% of Group B fall in the 18–29 years category, contributing to 40% of the total sample. For the 30–39 years category, 40% of Group A and 20% of Group B, totaling 30% of the sample. In the 40–49 years range, both groups contribute equally with 20% each, making up 20% overall., 10% of each group is aged 50 years or older. Regarding sex distribution, Group A includes 70% males and 30% females, while Group B includes 60% males and 40% females. Across both groups, males comprise 65% of the sample and females 35%. As shown in table 3.1.

Table 3.1.: Demographics variable of the study sample (n=20)

Variable	Group A (With PQ)	Group B (Without PQ)	Total
Number of Patients	10	10	20
Age			
Mean ± SD	54.3 ± 12.5	52.7 ± 11.8	53.5 ± 12.2
Range	22-77 years	24-75 years	22-77 years
18-29 years	3 (30%)	5 (50%)	8 (40%)
30-39 years	4 (40%)	2 (20%)	6 (30%)
40-49 years	2 (20%)	2 (20%)	4 (20%)
≥50 years	1 (10%)	1 (10%)	2 (10%)
Sex			
Male	7 (70%)	6 (60%)	13 (65%)
Female	3 (30%)	4 (40%)	7 (35%)

The rate of complications in both groups was recorded during follow up, infection occurred in 1 patient in Group A compared to 2 patients in Group B, with a p-value of 0.581, no significant difference.

Flexor tendon irritation occurred in 20% of Group B but was not observed in Group A. This difference is statistically significant, with a p-value of 0.006. Malunion was present in 10% of each group, with p-value of 0.183, showing no statistically significant difference. As shown in table 3.2.

Table 3.2.: incidence of complication comparison between the two groups through 3 months of flow up

Complication	Group A (With PQ)	Group B (Without PQ)	p-value
Infection	1 (10%)	2 (20%)	0.581
Flexor Tendon Irritation	0	3 (20%)	0.006
Malunion	1 (10%)	1 (10%)	0.183

The mean DASH scores of both groups were compared at various follow-up intervals. At one week, Group A had a mean score of 65.3 ± 11.1, while Group B scored 70.1 ± 12.2, with a p-value of 0.25, indicating no significant difference. At two weeks, Group A mean was 55.7 ± 9.4 compared to 63.2 ± 11.5 for Group B, with a p-value of 0.28.

At one month, Group A mean was 40.4 ± 8.2, and Group B was 42.6 ± 9.3, with a p-value of 0.22. Finally, at three months, Group A mean was 15.2 ± 5.7, and Group B mean was 16.7 ± 6.1, with a p-value of 0.15. with no statistically significant differences were observed. As shown in table 3.3. and figure 3.2.

Table 3.3.: mean DASH score comparison between the two groups at 3 months post op.

Follow-Up Interval	Group A (Mean ± SD)	Group B (Mean ± SD)	p-value
1 week	65.3 ± 11.1	70.1 ± 12.2	0.25
2 weeks	55.7 ± 9.4	63.2 ± 11.5	0.28
1 month	40.4 ± 8.2	42.6 ± 9.3	0.22
3 months	15.2 ± 5.7	16.7 ± 6.1	0.15

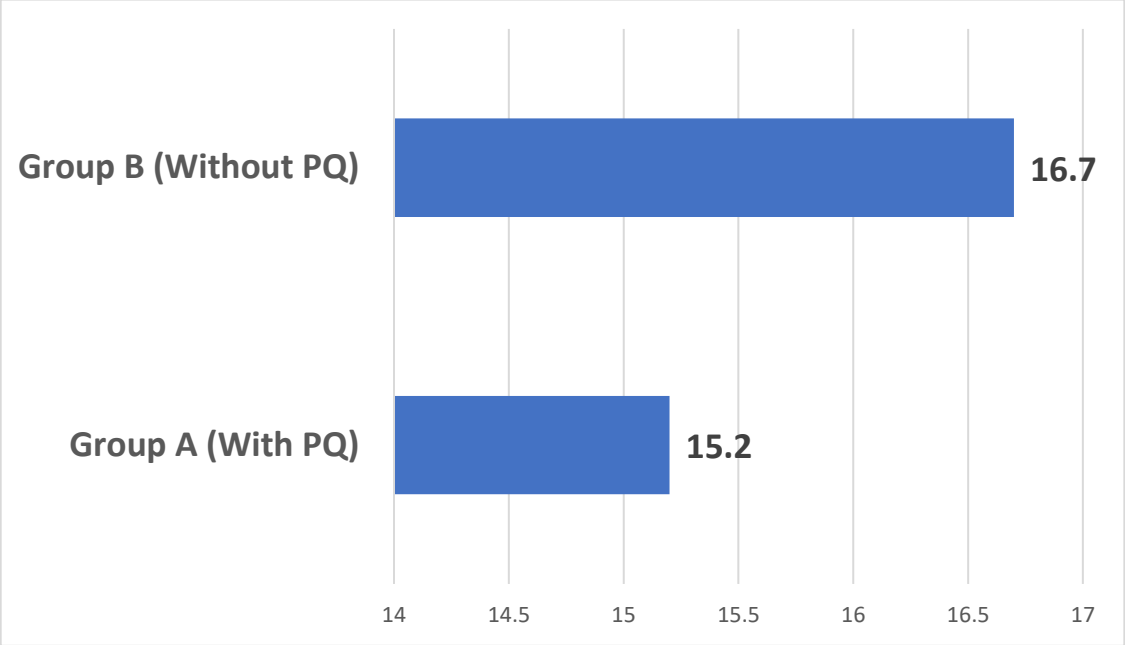


Figure 3.1.: total DASH score comparison between the two groups at 3 months post op.

Pain levels were assessed after the operation as part of the Modified Mayo Wrist Score 1 month after the operation. In Group A, 60% of patients reported no pain compared to 50% in Group B, with a p-value of 0.257, showing no significant difference. Mild pain was reported by 30% of patients in each group. Moderate pain affected 10% of Group A and 20% of Group B. Severe pain was not reported in either group. As shown in table 3.4.

Table 3.4.: late post-operative pain comparison between the two groups.

Pain Level	Group A (With PQ)	Group B (Without PQ)	p-value
No Pain (25 points)	6 (60%)	5 (50%)	0.257
Mild Pain (20 points)	3 (30%)	3 (30%)	
Moderate Pain (15 points)	1 (10%)	2 (20%)	
Severe Pain (0 points)	0 (0%)	0 (0%)	

Grip strength was also assessed as part of the Modified Mayo Wrist Score at one month. In Group A, 70% of patients had normal grip strength (≥90%) compared to 60% in Group B, with a p-value

of 0.189, indicating no significant difference. Mild weakness (75%-89%) was found in 20% of Group A and 30% of Group B. Moderate weakness (50%-74%) was found in 10% of patients in each group.

No patient reported severe weakness (<50%) in both groups. As shown in table 3.5.

Table 3.5.: grip strength comparison between the two groups at 1 month post op.

Grip Strength	Group A (With PQ)	Group B (Without PQ)	p-value
≥90% (Normal) (25 points)	7 (70%)	6 (60%)	0.189
75%-89% (Mild Weakness) (15 points)	2 (20%)	3 (30%)	
50%-74% (Moderate Weakness) (10 points)	1 (10%)	1 (10%)	
<50% (Severe Weakness) (0 points)	0 (0%)	0 (0%)	

Then the range of motion was calculated as part of the Modified Mayo Wrist Score at one month. Full range of motion (≥120° flexion/extension and ≥80° pronation/supination) was achieved by 70% of Group A and 60% of Group B, with a p-value of 0.158, indicating no significant difference. Mild restriction was present in 20% of patients in each group. Moderate restriction was seen in 10% of group A and 20% of group B, and no severe restrictions were reported. As shown in table 3.6.

Table 3.6.: range of motion comparison between the two groups at 1 month post op.

Range of Motion	Group A (With PQ)	Group B (Without PQ)	p-value
Full (≥120° flex/ext, ≥80° pron/sup) (25 points)	7 (70%)	6 (60%)	0.158
Mild Restriction (15 points)	2 (20%)	2 (20%)	
Moderate Restriction (10 points)	1 (10%)	2 (20%)	
Severe Restriction (0 points)	0 (0%)	0 (0%)	

functional status was then assessed as part of the Modified Mayo Wrist Score at one month after the operation. In Group A, 80% of patients returned to regular activities, compared to 70% in Group B, with a p-value of 0.87, indicating no significant difference. The ability to perform most activities was reported by 10% of Group A and 20% of Group B. Light activities only were possible for 10% of patients in each group, and no patients were unable to return to activities in both groups. As shown in table 3.7.

Table 3.7.: functional status comparison between the two groups at 1 month post op.

Functional Status	Group A (With PQ)	Group B (Without PQ)	p-value
Returned to Regular Activities (25 points)	8 (80%)	7 (70%)	0.87
Able to Perform Most Activities (20 points)	1 (10%)	2 (20%)	
Light Activities Only (15 points)	1 (10%)	1 (10%)	
Unable to Return to Activities (0 points)	0 (0%)	0 (0%)	

The total Modified Mayo Wrist Score was calculated using the previous sections of pain, grip strength, range of motion and functional status collectively to form a scale of 0-100 and to compare between the two groups. In Group A, 50% pf patients had excellent scores (90-100), compared to 40% in Group B, with a p-value of 0.171, showing no significant difference. Good scores (80-89) were recorded by 30% in each group. Fair scores (65-79) were recorded in 20% of Group A and 30% of Group B. No patients have poor score (<65) in both groups as shown in table 3.8. and figure 3.2.

Table 3.8.: Overall Modified Mayo Wrist Score comparison between the two groups.

Score Interpretation	Group A (With PQ)	Group B (Without PQ)	p-value
Excellent (90-100)	5 (50%)	4 (40%)	0.171
Good (80-89)	3 (30%)	3 (30%)	
Fair (65-79)	2 (20%)	3 (30%)	
Poor (<65)	0 (0%)	0 (0%)	

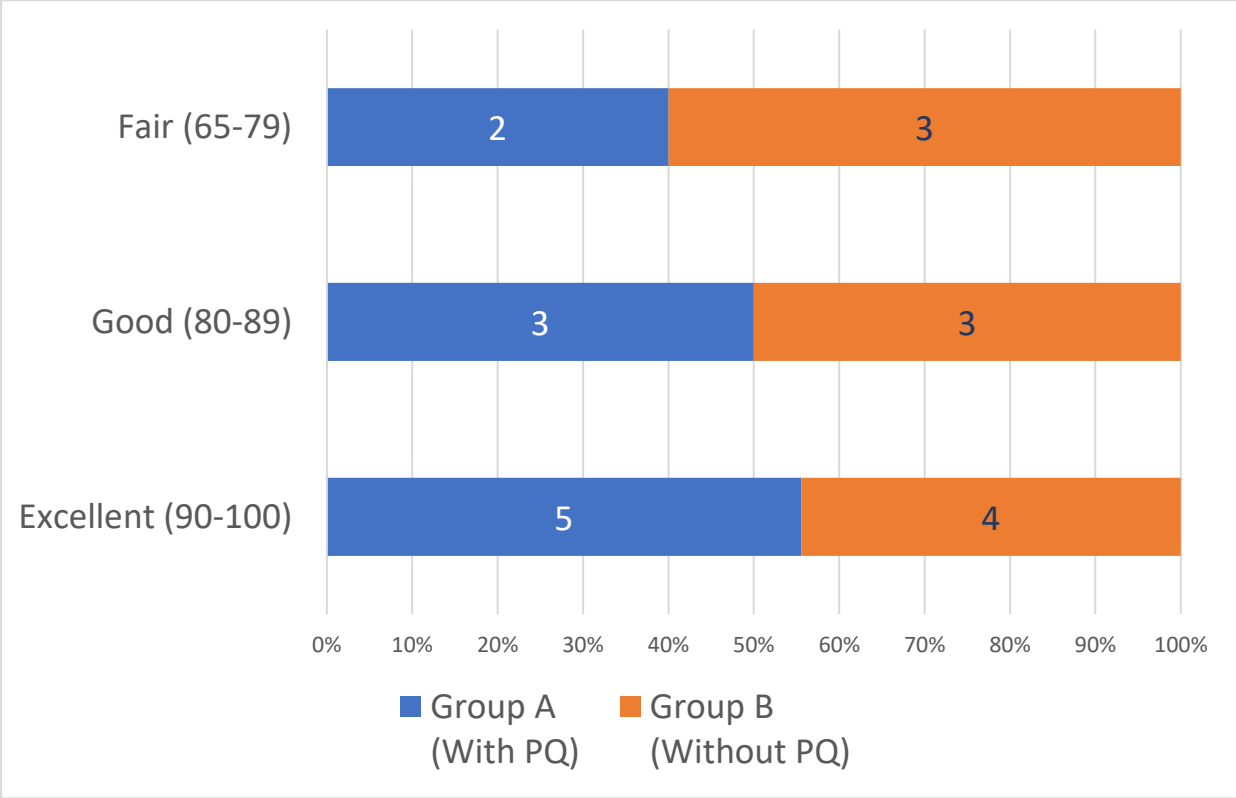


Figure 3.2.: Overall Modified Mayo Wrist Score

CHAPTER FOUR

Discussion

The current study results show that the mean age of participants was 53.5 years. This is comparable to the findings of a study by **Nellans et al.** who reported that Distal radius fractures are among the most frequently occurring fractures in children and adolescents, young adults, and the elderly and that both the pediatric and elderly populations are considered to be at high risk for this type of injury. They also reported a higher prevalence of males, likely due to the higher rate of traumatic injuries in male populations. [30]

While **Ando et al.** study on A total of 258 patients with distal radius fractures (DRF) in Japan reported that 190 (73.6%) were female and the average age was 67±21.5 years. [31]

The incidence of complications, particularly infections, did not differ significantly between the two groups (p = 0.581), which is in line with findings from **Rundgren et al.** in their study they found

that while infection rates were present, they were not significantly influenced by soft tissue coverage techniques rather than the surgical technique with external fixation having the highest risk [32]

The observed difference in flexor tendon irritation (20% in Group B compared to 0% in Group A, p = 0.006) is significant and aligns with results from **Hershman et al.** who demonstrated that muscle coverage or additional soft tissue layers may help reduce friction and irritation of tendons in wrist surgeries. Their study noted that the presence of protective muscle layers reduced the likelihood of tendon-related complications such as irritation, which may explain why our study Group A (with PQ muscle cover) had no cases of tendon irritation. This finding reinforces the hypothesis that muscle cover provides a protective layer, reducing direct tendon contact with other anatomical structures. [33]

Regarding the scores, no significant differences were found between the two groups at any time point (p-values > 0.05), which aligns with findings from **Ayik et al.** study on 77 patients, they found that all groups showed similar functional improvement, despite differences in surgical techniques or interventions. This lack of significant difference may indicate that the PQ muscle cover does not have a substantial effect on overall upper limb function as measured by the DASH score, which assesses global upper limb disability. Other factors such as rehabilitation and recovery protocols may have had a more pronounced impact on functional outcomes. They final concluded that although no significant difference was found between the groups regarding function but covering the plate could help prevent long-term complications. [34]

Lu et al. also reported similar findings during their meta-analysis that used data from Five randomized controlled studies and six retrospective case-control studies, suggesting that while different surgical techniques can influence some aspects of recovery, the overall functional improvement in terms of global disability (as measured by the DASH) tends to be similar across various interventions. [35]

The absence of significant differences in pain levels between the groups (as assessed by the Modified Mayo Wrist Score) is consistent with findings from **Mulders et al.** Their study concluded that at the 12-month follow-up, no statistically significant differences were found in DASH scores or range of motion between the pronator quadratus group and the no cover group. Additionally, complication rates were comparable between both groups. Therefore, at 12 months, there appears to be no benefit to performing pronator quadratus covering following volar plate fixation of the distal radius. They also found no significant difference in pain scores postoperatively, suggesting that pain control may be more closely related to factors such as analgesia management, type of surgery, and individual patient factors, rather than the specific surgical approach or use of muscle coverage. [36]

Similarly, **Ahsan et al.** on 110 patients with distal radius fractures and ORIF with volar locking plate found that grip strength recovery was not significantly influenced by the use of muscle cover or other soft tissue reconstructive techniques in ORIF of DRF. They reported that both groups in their study showed good recovery of grip strength, which aligns with our study's findings, where 70% of Group A and 60% of Group B showed normal grip strength. This suggests that while muscle coverage may provide some localized benefits, such as reducing tendon irritation, it does not seem to significantly influence grip strength recovery, which is influenced more by rehabilitation protocols and tendon healing. Thye also noted no difference in range of motion or post operative complications. [37]

The current study results also showed no significant difference between the two groups regarding range of motion, **Armangil et al.** found that after volar plating of distal radius fractures there is a significant loss in pronator strength of the forearm which may affect the range of motion and recovery but it was more dependent on the extent of the initial injury and the timing of rehabilitation than on the surgical technique itself and that early mobilization is a key factor in range of motion recovery after wrist surgery, regardless of the type of soft tissue reconstruction. [38]

No significant differences in functional status were observed between the two groups, with 80% of Group A and 70% of Group B returning to regular activities. This is consistent with findings from **Shi F et al.** analysis of 203 patients with pronator quadratus (PQ) repair and 180 patients without their results showed no statistically significant difference in DASH scores between the two groups and no differences in grip strength or pronation strength. [39]

The **Modified Mayo Wrist Score**, which combines pain, grip strength, range of motion, and functional status, also showed no significant differences between the groups ($p = 0.171$). This finding is in agreement with **Häberle et al.** they reported that the overall functional outcomes, as assessed by scales like the Modified Mayo Wrist Score, were not significantly different between the two groups. [40]

Tahririan et al. also concluded that the repair of the pronator quadratus (PQ) in distal radius fractures has been proposed to help protect the flexor tendons. However, the clinical evidence on its benefit in terms of functional outcomes, such as improving tendon protection, grip strength, or range of motion, is inconclusive. While PQ cover might theoretically offer additional protection to the flexor tendons. [41]

Study limitations

1. Small Sample Size and Short Follow-up Duration which may not fully capture long-term functional outcomes or complications.
2. Factors like fracture severity, patient activity levels, and comorbidities were not fully controlled.
3. While the Modified Mayo Wrist Score and DASH Score are validated, they still rely on self-reported data and both contain some subjective measures.

CHAPTER FIVE

Conclusions and Recommendation

Conclusions

1. There were no significant differences in the overall functional outcomes (including pain levels, grip strength, range of motion, and functional status) between the two groups (with and without PQ muscle coverage) at 1 month and 3 months post-surgery.
2. The incidence of flexor tendon irritation was significantly lower in the PQ muscle coverage group (Group A).
3. The overall rate of infection and malunion was similar between the two groups
4. Both groups showed rapid improvement in the short term, with the majority of patients returning to regular activities by 3 months, regardless of the surgical approach used.

Recommendations

1. Consider PQ muscle coverage in patients at higher risk of flexor tendon irritation**,** such as those with complex fractures or those requiring extensive soft tissue injury.
2. Encourage early, controlled wrist mobilization to improve long-term outcomes and prevent stiffness, once the fracture is stabilized.
3. Explore improved plate designs that better accommodate soft tissue and reduce the need for additional coverage.
4. Further studies with larger sample size and longer follow-up period are recommended to better assess the long-term functional outcomes, complications.

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