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In situ Repair for Partial Thickness Articular Surface Rotator Cuff Tear

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ABSTRACT

Background: Partial thickness articular surface rotator cuff tears [PTRCTs] are a common cause of shoulder pain and dysfunction. In situ repair is a surgical technique that involves repairing the torn tendon without detaching it from the bone.

The Aim of the work: The purpose of this study is to evaluate the clinical outcomes of in situ repair for PTRCTs.

Patients and Methods: A prospective observational analysis was conducted on 30 patients who underwent in situ repair for PTRCTs greater than 50% of tendon thickness. The primary outcome measure was the Constant-Murley Score [CMS]. Secondary outcome measures included range of motion, strength, and patient satisfaction.

Results: The mean follow-up period was 21.8 months [range, 12-36 months]. The mean CMS score improved significantly from 51.31 preoperatively to 81.8 post-operatively [P<0.001]. The mean range of motion improved from 140° to 163° in forward flexion [P<0.001] and from 115° to 153° in abduction [P<0.001]. The overall patient satisfaction rate was 93.3%.

Conclusion: In situ repair is a viable surgical option for the treatment of PTRCTs. It is associated with significant improvements in clinical outcomes, including pain relief, range of motion, strength, and patient satisfaction. To validate these results, it is necessary to conduct additional studies with bigger sample sizes and extended follow-up periods.

Keywords: Arthroscopy; Rotator Cuff Injuries; Shoulder Injuries.

INTRODUCTION

Rotator cuff tear is one of the most common shoulder problems treated by orthopedic surgeons [1]. Rotator cuff tears may be partial or full thickness [2]. Partial tears can occur either at the articular portion [inside the joint] or bursal portion [outside the joint] of the tendon [3].

Partial-thickness Articular Surface rotator cuff tears [PTRCTs] are common shoulder injuries that involve the articular surface of the rotator cuff tendon, primarily affecting the supraspinatus tendon [4].

The prevalence of PTRCTs can vary depending on the population studied and the diagnostic criteria used. However, research has indicated that PTRCTs are a relatively common pathology encountered in clinical practice [2, 4, 5]. They often result from repetitive microtrauma, degenerative changes, or acute traumatic events [6]. PTRCTs can cause pain, functional impairment, and reduced quality of life for affected individuals [7].

Managing PTRCTs presents a challenge to clinicians as the optimal treatment approach is still a subject of debate [8]. Non-surgical interventions such as physical therapy, anti-inflammatory medications, and activity modification are often attempted as a first-line treatment. However, these conservative approaches may not always provide satisfactory outcomes, especially in cases where patients experience persistent symptoms and functional limitations, where the tear progresses or fails to heal [9-11].

Surgical intervention becomes necessary when conservative measures prove ineffective or when the tear progresses to a full-thickness tear. Surgical interventions for PTRCTs have shown promising results in restoring shoulder function and providing pain relief [9-11]. Traditional repair techniques involve complete tendon-to-bone reattachment, typically performed through an open or arthroscopic approach [12]. However, these procedures may cause additional trauma to the healthy tissue, leading to complications and prolonged recovery. In addition, despite advancements in surgical techniques, the optimal management approach for PTRCTs remains uncertain [4, 6, 13].

In situ repair involves the reattachment of the torn tendon to its original attachment site on the articular surface, without detaching it completely. The rationale behind in situ repair is to preserve as much of the native tissue as possible while achieving a secure and stable repair. By maintaining the continuity of the tendon and its attachment, this technique aims to promote healing and restore the integrity of the rotator cuff complex. This technique offers potential advantages, including reduced surgical invasiveness, and potential for improved healing outcomes [8, 12].

The rationale for undertaking this research stems from the need to optimize treatment strategies and improve patient outcomes for individuals with PTRCTs. By exploring the effectiveness of in situ repair, we aim to contribute valuable insights to the existing body of knowledge and provide evidence-based recommendations for the management of PTRCTs.

By conducting this study, we aim to evaluate the clinical outcomes, functional improvements, and patient satisfaction associated with in situ repair for PTRCTs.

PATIENTS AND METHODS

This prospective observational study included 30 patients subjected to in situ repair for PTRCTs at the Orthopedic Department of Al-Azhar University Hospitals in Damietta and Cairo between March 2020 and August 2023.

The inclusion criteria: Patients aged 18 to 65 years with symptomatic PTRCTs > 50% confirmed through clinical examination, imaging studies [MRI], and arthroscopic evaluation [Ellman classification II and III], who have failed conservative treatment measures for at least 3 months.

Exclusion criteria were: 1] Patients with concomitant full-thickness rotator cuff tears or other shoulder pathologies requiring alternative surgical interventions, **2]** Patients with a history of previous shoulder surgery or significant shoulder trauma, and **3]** Patients with systemic conditions that may impair healing or affect outcomes [e.g., rheumatoid arthritis, diabetes mellitus].

Ethical consideration: This research was conducted in accordance with ethical guidelines and regulations. Institutional review board [IRB] approval was obtained from Damietta Faculty of Medicine, Al-Azhar University, and informed consent was obtained from all participants before enrollment.

Data collection

Detailed history was obtained including age, sex, occupation, degree of physical demand, previous trauma, site and severity of pain, function of the shoulder and weakness during daily activity. Physical examination included range of motion [active and passive in flexion, abduction, external, and internal rotation]. Plain radiograph AP and supraspinatus outlet views were done to detect the narrowing of the subacromial space and the presence of acromial spurs. MRI shoulder was done for every patient to confirm the diagnosis.

Surgical Technique

All surgeries were performed by a single experienced orthopedic surgeon following a standardized in situ repair technique. All surgeries were done under general anesthesia.

The posterior portal was established 1.5 cm inferior and 1 cm medial to the posterolateral corner of the acromion [figure 1]. A spinal needle was used to identify an anterior portal midway between the anterolateral corner of the acromion and the coracoid tip. An obturator cannula was introduced at this site. Assisted with a hook probe, a thorough diagnostic survey was performed viewing alternately from the posterior and then the anterior portal. A partial articular-sided tear of the supraspinatus was confirmed and may extend into the infra-spinatus.

The torn tendon tissue was debrided back to a healthy margin [figure 2]. The anteroposterior dimension of the repair is measured with a calibrated hook probe. We verified that the cuff margin of the deep layer can be reduced to the tuberosity with the arm in an adducted position.

To do a trans-tendon repair, the arthroscope was re-established in the subacromial space using the same skin entry as for the glenohumeral access. While viewing from the posterior, a spinal needle enters the bursa 1 cm posterior and 2 cm lateral to the anterolateral corner of the acromion. A stab incision was created and the shaver and radiofrequency device were alternately used from that lateral approach to resect enough bursal tissue to obtain an unobstructed view of the greater tuberosity and cuff insertion [figure 3].

Verifying reasonable cuff integrity on the bursal surface and the absence of a bursal-sided cuff defect was the final confirmation that a transtendon repair was a reasonable treatment option.

The arthroscope was then re-established into the glenohumeral joint posteriorly. The region of the exposed footprint should be excoriated with the shaver. With the arm in the adducted position, the spinal needle was introduced immediately adjacent to the lateral border and 1 cm posterior to the anterolateral border of the acromion. The needle was passed through the intact cuff to identify an acceptable approach to the medial aspect of the footprint. At the selected site, a 3- or 4-mm stab incision was made through the skin and down through the bursal layer of the cuff parallel to the tendon fibers.

We used a metallic double-loaded anchor, and then a loop grasper retrieves all of the anchor suture limbs out of the anterior portal [figure 4]. The margin of the rotator cuff was reduced to the cuff footprint during the delivery of the repair sutures. The arm was brought into approximately 45 degrees of abduction this facilitates the introduction of the spinal needle used for suture delivery to be relatively parallel to the surface of the tuberosity and the creation of an anatomical repair. Once the cuff was reduced with a loop grasper, the spinal needle was introduced approximately 2 cm lateral to the acromion, through the intact bursal layer of the cuff, and into the deep layer approximately 3 mm from the margin. We passed each of the anchor sutures through the deep cuff layer [figure 5-7].

The arthroscope was then re-established into the subacromial space where the anchor suture limbs should be apparent laterally near the tuberosity. The sliding knot of choice was tied, delivered, and secured by 4 half hitches. All pairs are tied similarly. The arthroscope was returned to the glenohumeral joint and using a hook probe, palpation, and direct visualization confirm the security and integrity of the repair construct during flexion, extension, abduction, and adduction of the arm. The arthroscope and anterior cannula were removed, the portals irrigated, and the skin is closed. After the dressing was placed on the shoulder wounds, the shoulder is secured in a padded sling with mild abduction.

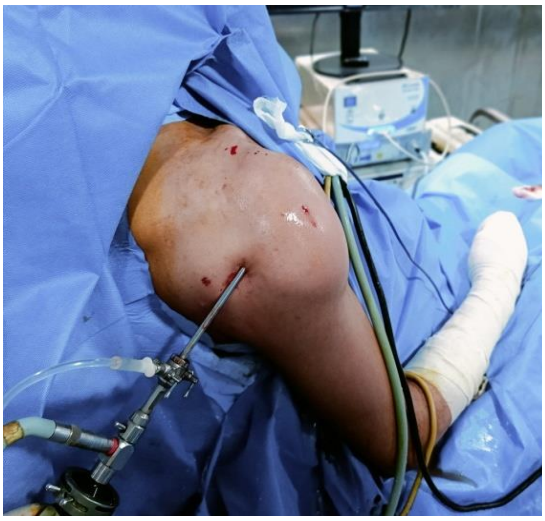

Figure [1]: Posterior portal was established 1.5 cm inferior and 1 cm medial to the posterolateral corner of the acromion

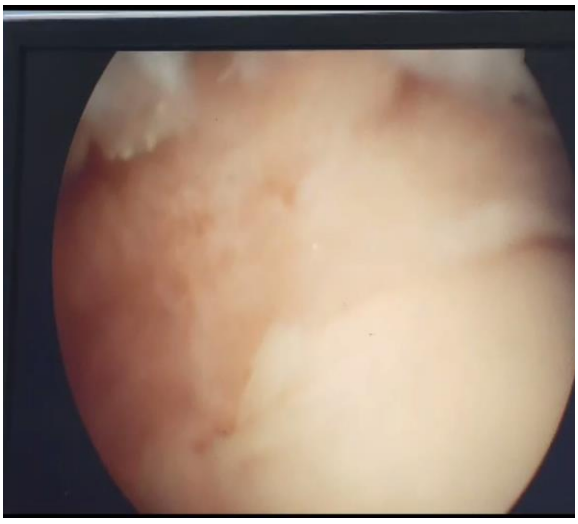

Figure [2]: An arthroscopic view after debride the torn tendon tissue back to a healthy margin

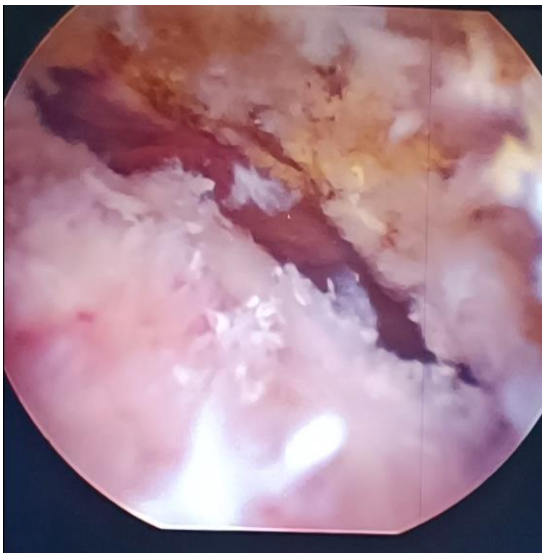

Figure [3]: An arthroscopic view for subacromial space after bursectomy

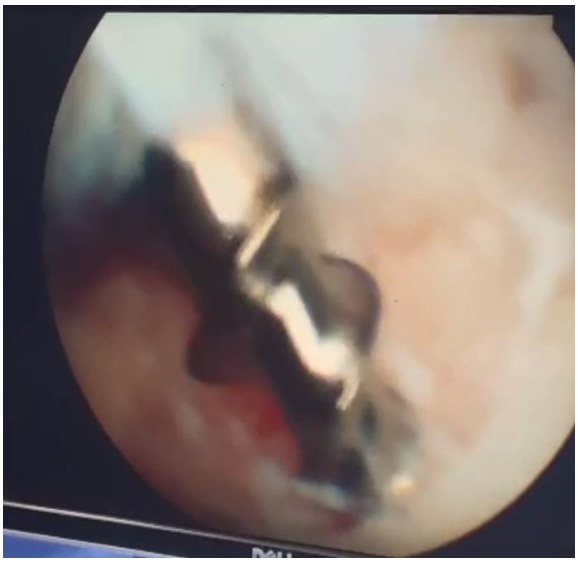

Figure [4]: An arthroscopic view for Insertion of the anchor adjacent to the lateral edge of humeral head cartilage

Figure [5]: Four suture limbs of the suture anchor were placed in the healthy portion of the partially torn rotator cuff tendon

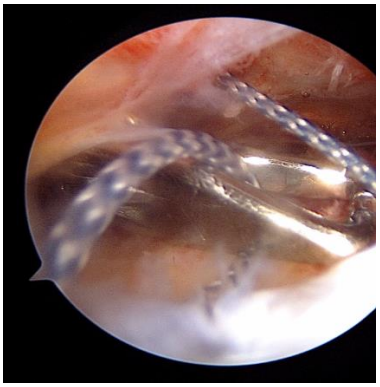

Figure [6]: An arthroscopic image of subacromial space showing fiber wire.

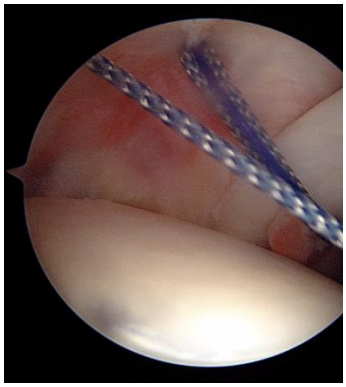

Figure [7]: An arthroscopic image from glenohumeral joint showing suture anchor crossing from normal articular surface of RCT

Outcomes

Constant-Murley Score: A validated shoulder-specific functional assessment tool. encompasses multiple components to assess different aspects of shoulder function and pain, with a total score of 100. These components include subjective pain assessment [15 points], activities of daily living [ADL] [20 points], range of motion [ROM] [40 points], and muscle strength [25 points]. A total score of 86-100 is considered excellent, scores between 71 and 85 are good, scores of 56-70 are fair, and scores < 56 are poor [14].

Patient satisfaction was measured using the visual analogue scale [0-10] where 0 indicates no pain and 10 indicates pain of maximum intensity.

Muscle forces were tested by a trained examiner using Manual Muscle Testing [MMT].

Follow-up: Participants were followed up at regular intervals postoperatively [3 months, 6 months, 1 year] to evaluate the progress of their recovery and assess the outcomes measures mentioned above. The follow up period is at least 1 year for each patient. The measured scores were documented at 6 months.

Statistical analysis: The software SPSS for Windows Release 10 [SPSS Inc, Chicago, Illinois, USA] was used for all statistical calculations. Continuous data were described as mean and standard deviation. Categorical variables described as frequency and percentage. Pre- and post-operative data were compared using paired t-test. Pearson correlation coefficient [r] was applied to correlate CMS score with different variables. Data significance was set at the P value less than 0.05

RESULTS

The age ranged from 29 to 65 years, with mean ± SD of 49.7 ± 9.45 years. Regarding sex, the study included 13 males and 17 female patients. Out of the total number of patients, 17 had the right shoulder affected while 13 had the left shoulder affected. The occupation distribution of the patients was as follows: 14 [46.7%] had heavy work, 7 [23.3%] had light work, and 9 [30%] were housewives. Regarding comorbidities, hypertension [30%] was the most commonly associated co-morbidities observed among the patients. Additionally, there were five cases of hypothyroidism, one case of epilepsy, one case of cardiac disease, and one case of bronchial asthma. Out of 30 patients, 8 [26.7%] were smokers [table 1].

Additionally, 7 cases had tendinopathy of the long head of the biceps tendon, which was treated with either tenotomy or tenotomy followed by tenodesis. A Superior Labrum from Anterior to Posterior tear [SLAP] lesion was detected in one case [3.33%] and treated with tenotomy. An acromioplasty was performed in 8 cases [26.66%] when a type II or III acromion was noted.

Of the cases included in the study, 70% were determined to be without trauma. The majority of patients [60%] had duration of complaint of less than 12 months, with a mean [SD] duration of 17.8 [15.33] months, ranging from 1.0 to 72 months. According to Ellman classification, 11 cases had grade II and 19 had grade III [table 2].

At a mean follow-up of 21.8 months [range 12-36], there was a significant improvement in the Constant-Murley Score [CMS]. The CMS improved from a preoperative mean of 51.3 [range 20-61] to a postoperative mean of 81.8 [range 64-93], with a mean improvement of 30.5 [range 17-56]. Improvements of all components of the CMS score was achieved [P<0.001] [table 3].

The mean degree of forward flexion improved significantly from 140° preoperatively to 163° postoperatively [P<0.001]. Similarly, the mean degree of abduction also showed significant improvement from 115° preoperatively to 153° postoperatively [P<0.001]. Although muscle force in external and internal rotation showed improvement postoperatively when compared to preoperative scores, there was no significant difference [table 4].

Statistically significant improvement in patient satisfaction was observed between preoperative and postoperative assessments [p < 0.001]. Out of the 30 patients, 28 reported satisfaction with the procedure, final results, and function of their shoulder [table 4].

Complications: Only two patients had post-operative complications. One of these patients was a 54-year-old female with articular-sided and subscapularis tears who experienced adhesive capsulitis after the surgery. Although

she showed some improvement over time, her condition persisted. The other patient was a 53-year-old male who experienced persistent pain in the anterior arm and shoulder, which was suspected to be biceps tendonitis. The patient was advised to undergo arthroscopic biceps tenodesis, but he declined further surgical intervention.

No significant correlation was found between final CMS and different variables [age, sex duration of complaint].

Table [1]: Demographic and general data of studied patients

Variables		Results
Age [years]	Mean ± SD [range]	49.7 ± 9.45 [29-65]
Sex, No. [%]	Females Males	17 [56.7] 13 [43.3%]
Affected side	Right side Left side	17 [56.7] 13 [43.3%]
Occupation	Heavy work Light work Housewives	14 [46.7%] 7 [23.3%] 9 [30%]
Comorbidities	Hypertension Hypothyroidism Epilepsy Hepatic dysfunction Cardiac disease Bronchial asthma	9 [30%] 5 [16.7%] 1 [3.3%] 1 [3.3%] 1 [3.3%] 1 [3.3%]
Smoking	Yes	8 [26.7%]

Table [2]: Etiology and clinical assessment of studied patients

Variables		Results
Trauma	No trauma Road traffic accident Fall from height	21 [70%] 6 [20%] 3 [10%]
Duration of complaint	Mean ± SD ≤ 12 months > 12 months	17.8 ± 15.33 18 [60%] 12 [40%]
Ellman classification	Grade II Grade III	11 [36.7%] 19 [63.3%

Table [3]: Constant-Murley Score among studied patients

		Preoperative	Postoperative	P value
Pain [maximum of 15]		5.46 ±1.82	11.5 ± 1.47	**< 0.001**
Activities [maximum of 20]		9.35 ±2.11	15.8 ± 1.52	**< 0.001**
Movement [maximum of 40]		22.1 ± 3.4	33.83 ± 2.53	**< 0.001**
Strength [maximum of 25]		14.4 ± 3.7	20.63 ± 2.04	**< 0.001**
Total score		51.31 ± 7.35	81.8 ± 6.78	**<0.001**
Score description	Excellent Good Fair Poor	0 0 10 [33.3% 20 [66.7%]	13 [43.3%] 15 [50%] 2 [6.7%] 0	**<0.001**

Table [4]: Active range of motion and muscle force measurements among studied patients

		Preoperative	Final follow-up	P-value
Active ROM	Forward flexion [°]	140	163	**<0.001**
	Abduction [°]	115	153	**<0.001**
Muscle force	Forward flexion	3.20 ± 0.71	4.07 ± 0.58	**<0.001**
	Abduction	3.17 ± 0.69	4.23 ± 0.67	**<0.001**
	Internal rotation	4.07 ± 0.52	4.20 ± 0.61	0.103
	External rotation	4.00 ± 0.45	4.10 ± 0.55	0.083
Patient satisfaction	Mean ± SD	4.53 ± 2.39	8.53 ± 1.54	**<0.001**

Table [5]: Correlation between final Constant-Murley Score and different variables

Variable		Final Constant-Murley Score	Results
Age		R P	- 0.147 0.438
Duration of complaint		R P	0.112 0.540
Sex	Males [n=13] Females [n=17]	82.91 ± 6.81 80.95 ± 6.85	t= 0.78 P = 0.44

DISCUSSION

The present study evaluated the clinical outcomes of in situ repair for partial thickness articular surface rotator cuff tears [PTRCTs] in 30 patients. The results showed that in situ repair is a viable surgical option for the treatment of PTRCTs, as it is associated with significant improvements in clinical outcomes, including pain relief, range of motion, strength, and patient satisfaction.

There are various advantages that have been put forward for carrying out an in-situ repair using arthroscopic techniques. Preserving the remaining tendon results in a more precise reconstruction of the anatomical footprint. The remaining tendon and trans-tendon anchor have two points of fixation, which leads to greater contact with the footprint and potentially improves the mechanical strength of the structure and the healing area. This is similar to the double-row repair technique used for complete rotator cuff tears [6, 15].

Osti *et al.* [16] conducted a review of 18 studies that were published between 2005 and 2016, which focused on the in-situ repair of partial articular supraspinatus tendon avulsions [PASTAs]. The review revealed that most of the studies reported positive outcomes with low rates of complications. However, it is worth noting that the majority of the studies were case series with a limited number of patients.

Ranalletta *et al.* [17] conducted a study on 80 patients with an average age of 51 years who had undergone arthroscopic in situ repair for painful partial articular supraspinatus tendon avulsions [PARCTs] and were followed up for at least two years. The study found that most patients experienced significant improvements in function and pain relief, with a low incidence of complications during the midterm follow-up. Additionally, 92% of patients reported satisfaction with their results. The study also showed that concurrent procedures performed during supra-spinatus repair, such as biceps tenotomy/ tenodesis or subscapular repair, did not affect functional outcomes.

Although it is currently standard practice to debride PTRCTs lesions that account for less than 50% of tendon thickness and repair high-grade tears that account for more than 50% of the tendon thickness, the data supporting one specific therapeutic strategy are inconsistent and sparse. To arthroscopically address PTRCTs lesions, a number of techniques have been published. There are several options for treating the tear, such as removing damaged tissue with or without removing part of the acromion bone, repairing the tear through the tendon, or changing the tear into a complete tear and then repairing it. Although the therapeutic significance of this result is unknown, a bigger footprint of repair may enhance the healing and mechanical strength of restored tendons [18].

The study's functional results demonstrated a significant enhancement in comparison to the preoperative scores on the Constant-Murley scale, with a rise of 30.5 points. This improvement exceeded the minimum clinically important difference [MCID] of 10.4 points, which was previously established as the threshold for the CMS in patients with rotator cuff tears [19].

Many surgical approaches to partial-thickness rotator cuff tears have been reported, with considerable variation in outcomes. In a recent meta-analysis, **Ono *et al.*** [20] did not identify any significant distinctions between two repair methods, namely completion and transtendon repair, in relation to functional outcomes, incidence of complications, and the integrity of repairs as assessed by MRI during a follow-up period of short to medium duration. These data imply that switching to a full-thickness rip and repair does not improve functional outcomes or healing rates, despite the biomechanical advantage of maintaining tendon integrity.

On the other hand, a study by **Sun *et al.*** [21] discovered that the transtendon method had a

decreased retear rate. As far as we are aware, there aren't many data in the literature right now about potential indicators of success after arthroscopic repair of PTRCTs lesions. Although the role of patient age at surgery on repair integrity has been mentioned, no information regarding the prognosis of clinical outcomes for PTRCTs lesions has previously been published.

Our approach did not involve making the tear a complete one. Instead, we kept the articular fibers intact, which served three purposes: the intact fibers acted as a splint to protect the repair on the bursal side, the footprint was recreated in a wide and anatomical manner, and any mismatch in length-tension was minimized as the tissue was not excessively moved to the side with the repair. We believe that by debriding and repairing the tendon, we were able to stabilize the insertion mechanism, which helped to distribute the loads from the muscle to the bone and prevented excessive loads from being concentrated on the neighboring intact articular fibers. This is likely why debridement alone has been reported to have poor results.

In the present study, A considerable proportion of patients underwent additional procedures, such as acromioplasty and biceps tendon procedures, during the initial surgery, which had an impact on the clinical outcomes. However, it was difficult to assess a group of patients who had only isolated PTRCTs and were similar in terms of their characteristics and treatment.

We found no significant correlation between age and postoperative CMS. However, a previous retrospective study conducted over a short period had already identified patient age as a predictor of favorable surgical outcomes [22].

The findings of our study have important clinical implications. In situ repair can be considered as a viable treatment option for patients with symptomatic PTRCTs who have failed conservative management. The preservation of native tissue, reduced surgical invasiveness, and favorable functional outcomes make in situ repair an attractive choice for orthopedic surgeons. However, individual patient factors and tear characteristics should be considered when deciding the most suitable surgical technique.

It is important to take into account various potential drawbacks of this study when interpreting the outcomes. One of the main limitations is the relatively small number of participants, which was only 30 patients, and this could restrict the applicability of the results. Secondly, the study was a prospective observational study, which means that there was no control group for comparison. This limits the ability to draw conclusions about the efficacy of in situ repair compared to other treatment options or no treatment. Thirdly, the study had a relatively short follow-up period of 12-36 months, which may not be sufficient to assess the long-term outcomes of in situ repair. Fourthly, the study did not assess the impact of different surgical techniques or approaches on the outcomes. This limits the ability to draw conclusions about the optimal surgical technique for in situ repair. Finally, the study did not assess the potential impact of patient comorbidities or other factors on the outcomes. This limits the ability to draw conclusions about the potential impact of these factors on the effectiveness of in situ repair.

Conclusion: In conclusion, the results of this study suggest that in situ repair is a safe and effective surgical option for the treatment of PTRCTs. The significant improvements in clinical outcomes, including pain relief, range of motion, strength, and patient satisfaction, indicate that this technique should be considered as a treatment option for patients with symptomatic PTRCTs who have failed conservative treatment measures. To validate these findings, additional studies with larger groups of participants and longer periods of follow-up are necessary.

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