# Difference between early versus delayed postoperative physical rehabilitation protocol following arthroscopic rotator cuff repair

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**Background**

Early passive motion exercise has been the standard rehabilitation protocol following rotator cuff repair. However, recent research studies show that longer immobilization may enhance tendon healing.

**Aim**

The aim of this study was to compare early passive range of motion (ROM) exercise with a delayed rehabilitation protocol with regard to the effectiveness of stiffness reduction and functional improvements and rates of tendon healing in patients undergoing arthroscopic repair for torn rotator cuffs.

**Patients and methods**

This study was performed on 164 patients having a full-thickness tear of the supraspinatus muscle that was repaired using the arthroscopic single-row suture anchor technique along with subacromial decompression. The patients were divided into two groups, early (group 1) and delayed ROM (group 2). In group 1, 78 patients were started on passive elevation and rotation exercises on the second day after surgery. In group 2, 86 patients had their shoulder immobilized for 6 weeks, after which passive motion exercise was started. Patients were followed-up clinically for a minimum of 12 months, and rotator cuff healing was assessed using MRI.

**Results**

Both groups had a statistically significant difference between preoperative and postoperative results. As regards American Shoulder and Elbow Surgeon scores, the early group improved from 45.4 preoperatively to 90.9 postoperatively ($P<0.0001$) and the delayed group improved from 44.59 preoperatively to 91.6 postoperatively ($P<0.0001$). As regards Constant score, the early group improved from 35.7 preoperatively to 86.5 postoperatively ($P<0.0001$) and the delayed group improved from 37.8 preoperatively to 88.1 postoperatively ($P<0.0001$). However, there were no statistically significant differences in rotator cuff healing between the two groups. The follow-up mean of visual analog scale was significantly better in group 2 compared with group 1 at 6 weeks postoperatively but no difference was found after 3 months. In contrast, ROM was better in group 1 compared with group 2 at 6 months postoperatively but no difference was found after 1 year.

**Conclusion**

Significant improvement in pain, ROM, and function after arthroscopic rotator cuff repair was seen at 1 year postoperatively, regardless of early or delayed postoperative rehabilitation protocols. However, early motion increases pain scores and may increase the possibility of rotator cuff retear but with early regain of ROM. A delayed rehabilitation protocol with immobilization for 6 weeks would be better for tendon healing without risk for retear or joint stiffness and easily convalescence with less postoperative pain.

**Keywords:**

arthroscopic, magnetic resonance imaging, physical therapy, rotator cuff, suture anchors

## Introduction

Indeed, rotator cuff repair is one of the most successful treatment modalities in orthopedics, and most patients enjoy functional recovery after the procedure. Skillful surgical technique and a well-programmed rehabilitation protocol are the key factors for successful tendon healing and satisfactory functional outcome. The postoperative rehabilitation is a major contributor to successful outcomes after rotator cuff repair. In general, rehabilitation protocols need to consider the slow process of tendon healing to the bone [1].

Despite the prolonged healing process of the tendon to bone, several authors allow early mobilization with passive range of motion (ROM) to overcome postoperative stiffness [2]. These authors state that early motion does not have a negative effect on tendon healing [3]. In contrast, many authors prefer immobilization for ~6 weeks with only little passive exercises and showed a lower incidence of fibrous ankylosis and stated that the patient returned to sports after 6 months [1,4–6]. In fact, there is an existing debate on when to start mobilization of the shoulder after surgery. Some surgeons prefer early mobilization in an effort to minimize adhesions and stiffness [7]. A potential concern with this approach is that early ROM may put stresses at the repair site during the early weeks of tendon healing. Delaying motion after surgery may allow for less strain at the repair site as the tendon begins to heal. The drawback of this approach is adhesions that can develop and eventually limit the patient's ROM [8]. We conducted a prospective, randomized, comparative study to verify the difference between early and delayed rehabilitation protocols and their effects on functional and anatomic outcomes after arthroscopic repair in patients with rotator cuff tears. We assumed that early passive motion after arthroscopic rotator cuff repair does not demonstrate a significant difference as regards ROM, function, or cuff healing compared with the protocol of delayed ROM.

## Patients and methods

We prospectively enrolled 172 consecutive patients from February 2010 to November 2014 from the Orthopedics Department and Outpatient Clinics, Kasr Al-Aini, Cairo University Hospitals, who met the following inclusion criteria: (i) a small-to-medium-sized full-thickness rotator cuff tear (<3 cm) confirmed by means of preoperative MRI and arthroscopy; and (ii) chronic cases. All cases had arthroscopic subacromial decompression in conjunction with the rotator cuff repair; MRI was performed to assess rotator cuff healing at 6 and 12 months, and consent to be randomized into the early ROM (86 patients) or the delayed ROM group (86 patients) was taken. Eight patients from group 1 were lost to follow-up and were excluded from the study. We excluded patients with preoperative shoulder stiffness, concomitant glenohumeral injuries (superior labral anterior–posterior lesion, and Bankart lesion), partial thickness tears, tears that extended into the subscapularis or the infraspinatus, diabetic patients or those with associated cervical disc prolapse, those having accompanying adhesive capsulitis at the time of

repair, those who underwent any previous shoulder surgery, and those having massive cuff tears (>3 cm in size or two tendon tears). Full history taking, MRI of the shoulder, laboratory investigations for medical conditions such as diabetes, and cervical MRI in patients with cervical pain were carried out to assess exclusion criteria. Finally, 164 patients (78 patients in group 1 and 86 patients in group 2) met the inclusion and exclusion criteria and were included in this study and followed up for at least 12 months postoperatively.

The patients were operated upon by three surgeons and were subjected to full physical examination, including ROM and visual analog scale (VAS) for pain [9]. The American Shoulder and Elbow Surgeons (ASES) score [10] and the Constant score [11] were assessed the day before surgery. Patients were randomly classified into two groups according to randomization list (odd: early motion; even: delayed motion) with the planned therapy type placed in sealed envelopes. There were 78 patients in group 1 because eight patients were lost to follow-up and 86 patients in group 2. Group 1 consisted of 50 men and 28 women and included 44 right and 34 left shoulders. Group 2 consisted of 40 men and 46 women and included 46 right and 40 left shoulders. The average age of the patients was 56.2 years for group 1 and 57.8 years in group 2 (range: 45–68 years) (Table 1).

### Postoperative protocols for rehabilitation

A shoulder immobilizer was applied for all patients after surgery, with instructions to wear it for 6 weeks after surgery. The immobilizer could be removed for physical therapy sessions and during daily hygiene. All patients were allowed to perform active ROM of the elbow, wrist, and hand for keyboarding and writing.

Group 1was instructed to perform passive forward elevation and external rotation, starting on day 2 postoperatively. The sessions of physical therapy were performed three times a week. During the first 6 weeks, patients were progressed to passive forward

Table 1 Comparison between group 1 and group 2 as regards demographic variables

| Variables | Group 1 (78 patients) | Group 2 (86 patients) |
| --- | --- | --- |
| Age | 56.2 (45–68) | 57.8 (45–68) |
| Sex | | |
| Male | 50 | 40 |
| Female | 28 | 46 |
| Smokers | 14 | 18 |
| Side affected | | |
| Right shoulder | 44 | 46 |
| Left shoulder | 34 | 40 |

elevation as tolerated and passive external rotation to 45°. Patients were instructed to perform gentle circular pendulum exercises three times a day for 10 min per session at home when possible. Patients discontinued the shoulder immobilizer and started active assisted ROM with the therapist at 6 weeks, progressed to a full active ROM by 12 weeks, and began strengthening at 12 weeks. Group 2 was not allowed to perform formal outpatient physical therapy until 6 weeks after the surgery. They were instructed to strictly immobilize their shoulder for the first 6 weeks and only minimal passive abduction for hygiene was allowed. No passive forward elevation or external rotation was performed. The shoulder immobilizer was removed at 6 weeks and the patients began formal outpatient physical therapy 3 days per week, with passive forward elevation limited to 120° and passive external rotation to 30°. At the beginning of week 9, the patients progressed to active assisted ROM with the therapist, progressed to a full active ROM by week 12, and began strengthening at week 12, and all sports activities were permitted from 6 months after the operation for both groups. All rehabilitations were referred to the Rehabilitation Department and Outpatient Clinic at Kasr Al-Aini, Cairo University Hospitals.

### Postoperative evaluation of outcome
ROM of the shoulder and VAS for pain were assessed at regular follow-up visits (6 weeks and 3, 6, and 12 months postoperatively). The VAS for pain was scaled from 0 to 10, with 0 representing no pain and 10 representing worst imaginable pain. For measurement of ROM, forward elevation, external rotation, and internal rotation were evaluated with a goniometer. We used the ASES score and the Constant score to assess the functional outcome. We checked them at preoperative admission and at regular follow-up visits (6 weeks and 3, 6, and 12 months postoperatively). We assessed tendon healing by means of MRI examination as MRI is the most accurate procedure to assess tendon healing because it provides multiplanar imaging of the shoulder. MRI scan was performed at 1 year postoperatively. All studies were performed using a 1.5 T with the use of the routine pulse sequences. The images were assessed by an experienced senior radiologist. When a high signal (fluid) or discontinuity of the supraspinatus, infraspinatus, or subscapularis tendon was found on T2-weighted or proton density-weighted image, the diagnosis of retear was made [12].

### Statistical analyses
The results were analyzed using the SPSS computer software package (version 15.0; SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean±SD and frequencies (number of cases) and relative frequencies (percentages) for categorical variables. Differences between two groups were compared using Student's *t*-test for quantitative normally distributed variables. Pretreatment and post-treatment differences within the same group were compared using the Paired sample *t*-test. Ninety-five percent confidence intervals were calculated. Differences were considered to be significant when the $P$ value was less than 0.05.

## Results
The outcome scores and ROM data are summarized in Tables 2 and 3,. The ASES scores of both groups showed similar improvements when comparing scores preoperatively and at 1 year postoperatively: group 1 improved from a score of 45.4±5.1 to 90.9±2.76 ($P<0.001$), and group 2 improved from a score of 44.59±5.3 to 91.6±3.5 ($P<0.001$). There was no statistical difference between the two groups ($P=0.75$). Each group showed similar results for the Constant score: group 1 improved from 35.7±4.3 to 86.5±4.3 ($P<0.001$) and group 2 improved from 37.8±5.1 to 88.1±3.5 ($P<0.001$). Once again, there was no statistical difference between the two groups ($P=0.073$).

**Table 2 Comparison of preoperative and postoperative American Shoulder and Elbow Surgeons and Constant scores of group 1 and group 2**

| Variables | Preoperative evaluation | 1-year postoperative evaluation | *P* value |
|---|---|---|---|
| Total ASES score | | | |
| Group 1 | 45.4±5.1 | 90.9±2.76 | 0.001 |
| Group 2 | 44.59±5.3 | 91.6±3.5 | 0.001 |
| *P* value | 0.48 | 0.75 | |
| Total Constant score | | | |
| Group 1 | 35.7±4.3 | 86.5±4.3 | 0.001 |
| Group 2 | 37.8±5.1 | 88.1±3.5 | 0.001 |
| *P* value | 0.015 | 0.073 | |

ASES, American Shoulder and Elbow Surgeons.

**Table 3 Comparison of preoperative and postoperative range of motion of group 1 and group 2**

| Shoulder movements | Preoperative evaluation | Latest follow-up evaluation | P value |
|---|---|---|---|
| Forward elevation | | | |
| 6 months | | | |
| Group 1 | 125.3±20.3 | 173.5±5.25 | 0.001 |
| Group 2 | 130.1±21.1 | 163.8±7.9 | 0.001 |
| P value | 0.3 | 0.001 | |
| 12 months | | | |
| Group 1 | – | 174.8±4.05 | – |
| Group 2 | – | 173.8±5.4 | – |
| P value | – | 0.4 | |
| External rotation | | | |
| 6 months | | | |
| Group 1 | 40.5±3.9 | 41.9±3.16 | 0.001 |
| Group 2 | 40.4±4.05 | 41.7±3.25 | 0.001 |
| P value | 0.95 | 0.8 | |
| 12 months | | | |
| Group 1 | – | 41.9±3.16 | – |
| Group 2 | – | 42.6±2.7 | – |
| P value | – | 0.25 | |
| Full internal rotation | | | |
| 6 months | | | |
| Group 1 | 47.9±6.56 | 73±6.8 | 0.001 |
| Group 2 | 48±6.7 | 66.1±6.7 | 0.001 |
| P value | 0.96 | 0.001 | |
| 12 months | | | |
| Group 1 | – | 82.1±2.5 | – |
| Group 2 | – | 80±4.36 | – |
| P value | – | 0.007 | |

The preoperative ROM for both groups was nearly identical, with no statistically significant difference between groups. Preoperative forward elevation averaged 125.3±20.3° (range: 90–160°) in group 1 and 130.1±21.1° (range: 90–170°) in group 2. External rotation averaged 40.5±3.9° (range: 35–45°) in group 1 and 40.4±4.05° (range: 35–45°) in group 2. Internal rotation averaged 47.9±6.56° (range: 40–60°) in group 1 and 48±6.7° (range: 40–65°) in group 2. At 6 months, group 1 demonstrated a greater average forward elevation of 173.5±5.25° (range: 165–180°) compared with 163.8 ±7.9° (range: 150–180°) in group 2 ($P<0.001$). The difference in external rotation at 6 months was negligible, with group 1 averaging 41.9±3.16° (range: 35–45°) compared with 41.7±3.25° (range: 35–45°) in group 2 ($P=0.8$). There was a statistically significant difference in internal rotation, with group 1 averaging 73±6.8° (range: 60–85°) compared with 66.1±6.7° (range: 60–80°) in group 2 ($P<0.001$). At the 1-year postoperative assessment, the final analysis of the ROM revealed similar results in both groups except for internal rotation, which was better in group 1. Group 1 achieved a forward elevation average of 174.8±4.05° (range: 170–180°) compared with 173.8±5.4° (range:

160–180°) in group 2 ($P=0.4$). The difference in external rotation was not significant: group 1 averaged 41.9±3.16° (range: 35–45°) and group 2 averaged 42.6±2.7° (range: 35–45°; $P=0.25$). As regards internal rotation range, group 1 achieved 82.1±2.5° (range: 80–85°) compared with 80±4.36° (range: 70–85°) in group 2 ($P=0.007$).

The VAS of both groups showed similar improvements (Table 4) on comparing scores preoperatively and at 6 weeks postoperatively: group 1 improved from a score of 8 to 4.5 ($P<0.001$), and group 2 improved from a score of 7.9 to 1 ($P<0.001$). There was a statistically significant difference between the two groups at 6 weeks, with group 2 averaging 1.06±0.85 compared with 4.56±1.4 in group 1 ($P=0.001$). There was no statistically significant difference between the two groups at 3 months, with group 2 averaging 0.65±0.53 compared with 0.82±0.643 in group 2 ($P=0.19$). However, both groups were improved when comparing values at 6 weeks and 3 months ($P=0.001$).

The MRI examination of the rotator cuff after 1 year postoperatively revealed a healed repair in 70 of 78 (89%) in group 1 and in 84 of 86 (97%) in group 2. The difference between the two groups with respect to healing was not statistically significant; however, this might have been due

**Table 4 Comparison of preoperative and postoperative visual analog scale of group 1 and group 2**

| Variables | Preoperative evaluation | Last follow-up evaluation | *P* value |
|---|---|---|---|
| VAS | | | |
| 6 weeks | | | |
| Group 1 | 8.02±1.18 | 4.56±1.4 | 0.001 |
| Group 2 | 7.97±1.26 | 1.06±0.85 | 0.001 |
| *P* value | 0.85 | 0.001 | |
| 3 months | | | |
| Group 1 | – | 0.82±0.643 | – |
| Group 2 | – | 0.65±0.53 | – |
| *P* value | – | 0.19 | |

VAS, visual analog scale.

to a lack of power to detect a difference. All patients with recurrent tears (ten patients) were smokers and underwent revision rotator cuff repair.

## Discussion

The decision to start passive motion after rotator cuff repair is very difficult. Minimizing pain, protecting the repaired tendon, and restoring normal range to the shoulder are the determining factors. Some surgeons prefer the early passive ROM to decrease the adhesions that develop after surgery and ultimately lead to stiffness in the shoulder [13,14]. Starting early passive ROM will minimize the chances of shoulder stiffness, but will increase postoperative pain and may affect rotator cuff healing by making strain or micromotion at the repair site. The concept of delayed passive ROM was supported by studies that showed that, even with passive elevation, the rotator cuff muscles do fire at a low level, which may produce stress at the repair site. This was proved by many electromyographic studies that showed that passive forward flexion produces low-level stress at the repair site and can cause tendon failure if the force is applied repetitively [15,16]. Keener *et al.* [3] in a randomized and prospective study evaluated 123 patients to compare results between early passive ROM and delayed ROM for 6 weeks. They reported no significant differences between the two groups as regards tendon healing and functional outcome. Thus, the authors concluded that early passive mobilization is very important to decrease the incidence of postoperative stiffness and stated that early motion does not have an effect on tendon healing. Cofield *et al.* [13], Gristina *et al.* [17], and Lastayo *et al.* [2] reported faster recovery of ROM and more favorable functional outcome with early passive motion exercise. In contrast, Parsons *et al.* [18] reported that immobilization for a certain period after surgical repair did not

lead to postoperative shoulder stiffness; furthermore, Gimbel *et al.* [19] and Thomopoulos *et al.* [20] stated that delayed shoulder motion could promote tendon healing to bone. Rokito *et al.* [1] and Severud *et al.* [4] investigated rehabilitation after open, mini-open, and all-arthroscopic rotator cuff repairs, respectively. Both authors advocate immobilization for ~6 weeks. Severud *et al.* [4] showed a lower incidence of fibrous ankylosis after all-arthroscopic techniques with delay motion and stated that the patients returned to sports after 6 months. Arndt *et al.* [21] compared in a randomized study early versus delayed passive ROM followed by formal physiotherapy in 92 patients with nonretracted, isolated tear of the supraspinatus muscle repaired arthroscopically, using Constant score at 12 months, and showed a statistically significant difference in favor of the early group. This difference is not regarded as clinically important. No statistically significant differences were found between groups in terms of retear rate [21]. Cuff and Pupello [22] compared early versus delayed ROM in 68 patients using ASES score at 12 months and showed that no statistically significant differences were found between groups, including retear rate. Düzgün *et al.* [23] had compared an accelerated rehabilitation program versus a delayed program. The study was conducted on 29 patients with rotator cuff rupture repaired arthroscopically and showed a statistically and clinically significant difference in favor of the accelerated group at 8, 12, and 16 weeks, but no significant difference was found by 24 weeks [23]. Kim *et al.* [24] studied early passive ROM versus delayed ROM in 105 patients using American Shoulder and Elbow score at 6 and 12 months and showed no statistically significant differences between groups, including retear rate. We observed in this prospective randomized study that the early and delayed ROM groups had similar clinical outcomes at 1 year after the

arthroscopic repair. The early ROM group regained their ROM faster, with slightly more forward elevation at 6 months. However, these values had equalized at the end of the first year, with no statistical differences between the two groups. However, a greater percentage of patients in the delayed group demonstrated healing of the rotator cuff by means of MRI assessment compared with the early group, but this did not reach statistical significance. All patients with failed repair were smokers. This study demonstrates that there may be no significant advantage to start formal physical therapy with the early passive ROM for patients who underwent arthroscopic repair of a full-thickness supraspinatus tear. Delaying physical therapy may be more beneficial to the patient for several reasons, as it may provide a more optimal healing environment for the rotator cuff during the first 6 weeks after surgery. As we observed in this study, the rotator cuff repair in the delayed group was protected for a longer period (6 weeks) without compromising the patient's long-term function and resulted to some extent in a higher healing rate, although the difference in the healing rate did not reach statistical significance. Another potential benefit relates to postoperative pain for the patients, as VAS was much better in group 2 and this facilitates a smooth postoperative period of rehabilitation with less pain and reduces the patient's need for analgesics after surgery. The strengths of this study are the prospective, randomized design with a homogenous group of patients who did not have concomitant labral or bicep procedures at the time of arthroscopic repair of the full-thickness supraspinatus tear. The weaknesses of this study were a relatively limited number of patients and the short follow-up period (1 year) and having three surgeons performing the procedure along with the lack of a precise method for assessment of the ROM.

## Conclusion

Early passive motion after arthroscopic repair of rotator cuff does not demonstrate a significant difference in terms of ROM, function, or cuff healing compared with a protocol of delayed ROM. Each group demonstrated very similar clinical outcomes and ROM at 1-year follow-up. We observed that a slightly higher rotator cuff healing rate on MRI was found in patients of the delayed ROM group, as well as less postoperative pain, indicating that there may be a potential benefit of delayed postoperative motion in an effort to protect the repaired cuff.

**Conflicts of interest**
There are no conflicts of interest.

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