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# Early and Delayed Postoperative Rehabilitation after Arthroscopic Rotator Cuff Repair: A Comparative Study of Clinical Outcomes

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**Background:** The duration of immobilization after arthroscopic rotator cuff repair and the optimal time to commence rehabilitation are still the subject of ongoing debates. This study was undertaken to evaluate the functional outcome and rotator cuff healing status after arthroscopic rotator cuff repair by comparing early and delayed rehabilitation.
**Methods:** Totally, 76 patients with small, medium, and large sized rotator cuff tears underwent arthroscopic repair using the suture-bridge technique. In early rehabilitation group, 38 patients commenced passive range of motion at postoperative day 2 whereas 38 patients assigned to the delayed rehabilitation group commenced passive range of motion at postoperative week 3. At the end of the study period, clinical and functional evaluations (Constant score, the University of California, Los Angeles [UCLA] shoulder score) were carried out, subsequent to measuring the range of motion, visual analogue scale for pain, and isokinetic dynamometer test. Rotator cuff healing was confirmed by magnetic resonance imaging at least 6 months after surgery.
**Results:** No significant difference was obtained in range of motion and visual analogue scale between both groups. Functional outcomes showed similar improvements in the Constant score (early: 67.0–88.0; delayed: 66.9–91.0; $p<0.001$) and the UCLA shoulder score (early: 20.3–32.3; delayed: 20.4–32.4; $p<0.001$). Furthermore, rotator cuff healing showed no significant differences between the groups (range, 6–15 months; average, 10.4 months).
**Conclusions:** Delayed passive rehabilitation does not bring about superior outcomes. Therefore, early rehabilitation would be useful to help patients resume their daily lives.
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**Key Words:** Rotator cuff injuries; Arthroscopy; Rehabilitation; Shoulder

## Introduction

Arthroscopic rotator cuff repair is currently the most successful treatment for rotator cuff pathology, providing good functional results. However, despite advances in arthroscopic techniques, the non-healing rate after rotator cuff repair remains between 20% to 94%.[1,2]

Many factors are responsible for successful tendon healing and good clinical outcomes. A well programmed rehabilitation protocol may be one such factor. Traditionally, 22 to 26 weeks of rehabilitation after rotator cuff surgery is required.[3] However, there is an existing debate on the optimal timing of commencing physical therapy and the duration of immobilization after surgery.

The proponents of early rehabilitation protocol emphasize the importance of minimizing the incidence of postoperative shoulder stiffness and adhesion, which are common complications after arthroscopic rotator cuff repair. Some authors suggest that early continuous passive motion (CPM) after surgery has a good effect on the range of motion (ROM) and pain relief.[4] Other animal studies report that CPM enhances the tendon-bone recovery after rotator cuff repair.[5]

Conversely, proponents of the delayed rehabilitation protocol contend that prolonged immobilization after arthroscopic repair

improves the rate of tendon healing and does not increase stiffness and adhesion.[6] Some authors suggest that early rehabilitation causes strain and micromotion at the repair site, and could therefore have a negative effect on tendon healing.[1] Few animal studies have shown that prolonged immobilization had markedly higher collagen orientation and nearly normal extracellular matrix.[7]

Current studies have, however, suggested that there is no difference in terms of ROM, functional outcome or tendon healing in early passive motion and delayed immobilization.[8]

This study therefore aimed to compare the clinical and functional outcomes between early rehabilitation group and the delayed rehabilitation group, by a prospective, randomized evaluation.

## Methods

### Inclusion and Exclusion Criteria

From January 2013 to December 2014, 76 patients undergoing arthroscopic rotator cuff repair at our institution were enrolled for the study. Strict inclusion and exclusion criteria were applied to ensure a homogenous group of patients.

The inclusion criteria were (1) full thickness small, medium, and large sized (less than 5 cm) rotator cuff tear confirmed by magnetic resonance image and arthroscopy, (2) arthroscopic repair with suture-bridge technique, (3) consent to be randomized into the early or delayed rehabilitation therapy group, (4) magnetic resonance image to assess rotator cuff healing at least 12 months after surgery, and (5) at least 12 months of clinical follow-up.

The exclusion criteria were as follows: (1) partial thickness rotator cuff tear, and massive rotator cuff tear, (2) preoperative shoulder stiffness with limitation of both passive and active motion in at least 2 directions (forward flexion and abduction <100°, external rotation <20°, or internal rotation <L3), (3) concomitant glenohumeral lesion (e.g., arthritis, superior labrum anterior to posterior [SLAP] lesion, Bankart lesion, etc.), and (4) previous shoulder surgery.

Totally, 76 patients (38 male, 38 female) met the inclusion criteria and were monitored for at least 12 months postoperatively. The mean age of the patients was 62.8 years (range, 42–82 years). Clinical characteristics of the patients are presented in Table 1.

### Postoperative Rehabilitation

Patients were randomly assigned into the 2 rehabilitation groups: 38 patients (19 male, 19 female) were assigned to group 1 (early rehabilitation group), and 38 patients (19 male, 19 female) were assigned to group 2 (delayed rehabilitation group).

All patients were subjected to shoulder immobilization with abduction brace for 6 weeks after surgery. The immobilizer was

removed during physical therapy sessions and for daily hygiene. Shrugging of shoulder, active ROM of the elbow (flexion and extension), active forearm supination and pronation, and active wrist and hand motion were allowed immediately after surgery for both groups. A different rehabilitation protocol was applied for each group.

Group 1 patients began physical therapy 3 days a week, with passive motion limited to 120° of forward elevation and 30° of external rotation, using a CPM device. Briefly, the shoulder immobilizer was removed, and tolerable active ROM was commenced by week 6; the patients progressed to full active ROM by week 10, and began strengthening exercises at week 12.

For group 2, no formal physical therapy was initiated until 3 weeks after surgery. Only gentle circular pendulum exercises were started, thrice a day for 5 minutes per session. Passive forward flexion and external rotation were not allowed. At 3 weeks, the patients began physical therapy thrice a week, with passive motion limited to 120° of forward elevation and 30° of external rotation using a CPM device. The shoulder immobilizer was removed, and tolerable active ROM was initiated by week 6; the patients progressed to full active ROM by week 10, and strengthening exercises were commenced at week 12.

All rehabilitations were referred to the Department of Rehabilitation at Jeju National University Hospital.

### Outcome Evaluation

The ROM and the visual analogue scale (VAS) were checked at preoperative appointment and regular follow up visits (3, 6, and 12 months postoperatively). The ROM of shoulder consists of forward flexion and abduction. Forward flexion and abduction were checked using a goniometer, with the patient in the supine position and keeping arm at the side. The VAS scale ranged from 0 to 10, with a rating of 10 indicating highest level of pain.

Table 1. Demographic Information

| Variable | Total | Early | Delayed | $p$-value |
|---|---|---|---|---|
| Sex (n)* | 76 | 38 | 38 | 1.000 |
| Male | 38 | 19 | 19 | |
| Female | 38 | 19 | 19 | |
| Age (yr) | 62.8 (42–82) | 62.4 (42–82) | 63.2 (42–76) | 0.652 |
| DM (n) | 12 | 4 | 8 | 0.208 |
| Tear size (n) | | | | 0.144 |
| Small | 14 | 8 | 6 | |
| Medium | 45 | 23 | 22 | |
| Large | 17 | 7 | 10 | |

DM: diabetes mellitus.
*No. of Shoulders.

Functional outcome was assessed by the Constant score and the University of California, Los Angeles (UCLA) shoulder score. These scores were assessed at preoperative appointment and 12 months postoperatively.

Repair integrity was assessed with magnetic resonance imaging (MRI) (Achieva 3.0T; Philips, Amsterdam, Netherlands) at minimum 6 months after rotator cuff repair. The MRI images were assessed by a single experienced musculoskeletal radiologist at our institution. The classification by Sugaya et al. was applied to evaluate the repair integrity of rotator cuff via the follow-up MRI (Type I, sufficient thickness with homogeneous low intensity; Type II, sufficient thickness with partial high intensity; Type III, insufficient thickness without discontinuity; Type IV, presence of a minor discontinuity; Type V, presence of a major discontinuity). Types IV and V were defined as retear.

The muscle strength recovery was evaluated by the power of forward flexion ratio between the affected side and the healthy side. Examination was performed using an isokinetic dynamometer (HUMAC NORM, CSMi, Stoughton, MA, USA).

### Statistical Methods

All statistical data were analyzed with the PASW software package (ver. 18.0; IBM Corp., Armonk, NY, USA). A $p$-value less than 0.05 ($p<0.05$) was set as the level of statistical significance. In each group, the preoperative and postoperative data were assessed using a paired t-test. Comparison of data between the two groups were performed with an independent t-test.

## Result

There were 8 small, 23 medium, and 7 large size rotator cuff tears in group 1, and 6 small, 22 medium, and 10 large size tears in group 2. No significant demographic differences were obtained between both groups. No statistically significant differences were observed in the preoperative clinical outcome scores (Constant, UCLA), ROM and VAS between the groups (Table 2).

The MRI examination performed minimum 6 months after surgery detected 8 recurrent tears. Both groups showed the same retear rate of 4 cases each: 3 of 23 medium size tears (13.0%) and 1 of 7 large size tears (14.3%) in the early ROM group, and 1 of 22 medium size tears (4.6%) and 3 of 10 large size tears (30.0%) in the delayed ROM group ($p=0.400$; Table 3).

The Constant score of both groups showed similar improvements when comparing the preoperative and at 1 year postoperative scores, with no statistical difference between groups: group 1 improved from 67.0 to 88.0 ($p<0.001$), and group 2 improved from 66.9 to 91.0 ($p<0.001$).

Both groups also showed similar improvements in the UCLA score: 20.3 to 32.3 ($p<0.001$) in group 1, and 20.4 to 32.4 ($p<0.001$) in group 2. There was no statistical difference between the groups (Table 4).

Preoperative forward elevation averaged 168.3° (range, 100°–180°) in group 1 and 168.6° (range, 100°–180°) in group 2. Abduction averaged 163.3° (range, 100°–180°) in group 1 and 164.0° (range, 90°–180°) in group 2 ($p=0.961$).

The ROM at 3, 6, and 12 months after surgery are presented in Table 5. At 3 months after surgery, group 1 showed similar average forward flexion of 159.3° (range, 80°–180°) compared to the 159.7° (range, 80°–180°) in group 2, whereas abduction averaged 155.7° (range, 80°–180°) in group 1 and 159.7° (range, 80°–180°) in group 2 ($p=0.953$).

At 6 months after surgery, group 1 showed a lesser average forward flexion of 167.0° (range, 90°–180°) as compared to 171.2° (range, 155°–180°) in group 2; abduction averaged 167.8° (range, 90°–180°) in group 1 and 171.2° (range, 155°–180°) in group 2. However, the difference was statistically not significant ($p=0.313$).

At 1 year after surgery, the final analysis of ROM showed similar results for both groups. Group 1 showed similar average forward flexion of 174.7° (range, 155°–180°) as compared with 174.6° (range, 160°–180°) in group 2; abduction averaged

Table 2. Preoperative Clinical Outcomes

| Variable | Early | Delayed | $p$-value |
|---|---|---|---|
| Constant score | 67.0 | 66.9 | 0.991 |
| UCLA score | 20.3 | 20.4 | 0.957 |
| Preoperative ROM (°) | | | 0.961 |
| FF | 168.3 | 168.6 | |
| ABD | 163.3 | 164.0 | |
| Pain (VAS) | 5.8 | 5.8 | 0.912 |

UCLA: University of California, Los Angeles, ROM: range of motion, FF: forward flexion, ABD: abduction, VAS: visual analogue scale.

Table 3. Radiologic Assessment

| Variable | Early | Delayed | $p$-value |
|---|---|---|---|
| Retear* | | | 0.400 |
| Small | 0 (0) | 0 (0) | |
| Medium | 3 (13.0) | 1 (4.6) | |
| Large | 1 (14.3) | 3 (30.0) | |

Values are presented as number (%).
*Sugaya IV-V.

Table 4. Postoperative Clinical Outcomes (Score)

| Score | Early | Delayed | $p$-value |
|---|---|---|---|
| Constant score | 88.0 | 91.0 | 0.166 |
| UCLA score | 32.3 | 32.4 | 0.904 |

UCLA: University of California, Los Angeles.

**Table 5.** Postoperative Clinical Outcomes (ROM)

| Postoperative ROM (°) | Early | Delayed | *p*-value |
|---|---|---|---|
| 3 mo | | | 0.953 |
| FF | 159.3 | 159.7 | |
| ABD | 155.7 | 159.7 | |
| 6 mo | | | 0.313 |
| FF | 167.0 | 171.2 | |
| ABD | 167.8 | 171.2 | |
| 1 yr | | | 0.956 |
| FF | 174.7 | 174.6 | |
| ABD | 174.8 | 174.6 | |

ROM: range of motion, FF: forward flexion, ABD: abduction.

**Table 6.** Postoperative Clinical Outcomes (VAS)

| Pain (VAS) | Early | Delayed | *p*-value |
|---|---|---|---|
| 3 mo | 2.8 | 2.6 | 0.717 |
| 6 mo | 1.4 | 1.6 | 0.746 |
| 1 yr | 0.9 | 1.2 | 0.287 |

VAS: visual analogue scale.

**Table 7.** Postoperative Clinical Outcomes (Muscle Strength)

| | Early | Delayed | *p*-value |
|---|---|---|---|
| Cybex (%)* | 89.5 | 84.4 | 0.679 |

*Affected/unaffected.

174.8° (range, 155°–180°) in group 1 and 174.6° (range, 160°–180°) in group 2 (*p*=0.956).

VAS for pain at 3, 6, and 12 months after surgery are presented in Table 6. At 3 months and 6 months after surgery, group 1 showed similar average VAS of 2.8 and 1.4, respectively, as compared to 2.6 and 1.6, respectively, in group 2 (*p*=0.717 and *p*=0.746, respectively). At 1 year after surgery, group 1 showed a slightly lower average VAS of 0.9 compared with 1.2 obtained in group 2 (*p*=0.287).

Assessment of muscle strength test revealed a greater average affected/unaffected ratio of 89.5% (range, 26.1%–226.1%) in group 1 as compared to 84.4% (range, 20.4%–326.7%) in group 2, but with no statistical difference (*p*=0.679; Table 7).

## Discussion

Numerous factors are involved in deciding commencement of passive shoulder rehabilitation in the postoperative period after rotator cuff repair. These factors include minimizing pain, protecting the repaired muscle and tendon, and eventually, restoring function to the shoulder.

Historically, early passive shoulder rehabilitation is the established protocol after rotator cuff repair, to decrease the chance of adhesion and stiffness following open surgery.[9] Many surgeons recommend early rehabilitation after rotator cuff repair in an effort to get faster recovery of ROM and more favorable functional outcomes.[10]

Some reports advocate early passive shoulder rehabilitation since it decreases the adhesions that develop after surgery, leading to shoulder stiffness.[11] A few authors have also reported faster recovery of ROM and more favorable clinical outcomes with early passive shoulder rehabilitation.[10,12] Cuff et al.[13] suggested in their prospective randomized study that early rehabilitation helps regain ROM faster, with slightly more forward elevation, at 6 months. However, their study showed no statistical difference

between early and delayed rehabilitation after 1 year.

Conversely, Sonnabend et al.[14] reported that the rotator cuff repair site is still in the early healing phase and remains histologically immature at 4 weeks after surgery. Some studies report that early passive rehabilitation with minimal passive elevation could lead to stress at the repair site. These studies are supported by electromyographic studies that show passive forward flexion produces stress at the repair site, resulting in tendon failure.[15,16] Surgeons would therefore prefer avoiding stress or strain at the repair site during the early phase. In addition, Gimbel et al.[17] suggested that delayed shoulder motion allows for increase in the organization of collagen fibers, which subsequently improves tendon to bone healing in the rat model. More recently, several surgeons reported that delayed rehabilitation does not cause postoperative adhesion and stiffness,[6,18] and some period of immobilization could promote tendon to bone healing.[19]

These differing opinions have resulted in numerous studies on rehabilitation. Our current study showed no significant difference between the early and delayed rehabilitation protocol with respect to ROM, functional outcome and tendon healing. In a randomized prospective study, Keener et al.[20] also reported no significant difference between the two groups for functional outcome and tendon healing. Kim et al.[8] also reported no statistical difference in ROM, function score and retear rate between the two rehabilitation protocols.

Considering all the data, the current prospective case-matching comparative study was conducted to evaluate the difference of ROM, functional outcome and tendon repair in early and delayed rehabilitation protocol after arthroscopic rotator cuff repair.

In the current study, we observed no significant difference in ROM between the two groups at 3, 6, and 12 months after surgery. Also, results of the functional score, tendon healing, and muscle strength recovery showed no statistically significant difference between both groups. Taken together, our results indicate that timing of rehabilitation is not the only factor affecting ROM, functional outcomes and tendon healing. Other factors,

including method of tendon repair, experience of the surgeon, and initial amount of tendon injury, may also affect surgical outcomes. The postoperative rehabilitation protocol can therefore be personalized according to tear size, shape, tendon quality, and patient compliance.

There are several limitations of the current study. The 1-year follow-up period after surgery is short. For accurate measurement of functional outcomes and tendon healing, a longer observation follow-up period is necessary. Furthermore, the patient group was also small for assessing the effect of early or delayed rehabilitation protocol.

## Conclusion

This study showed similar outcomes for ROM, functional outcomes and tendon healing between early and delayed ROM therapy. Our results indicate that delayed rehabilitation does not lead to a superior outcome for small, medium, and large size rotator cuff tears. Therefore, early rehabilitation would be a good way for patients to resume their daily activities at the earliest.

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