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**Early Versus Delayed Rehabilitation After
Arthroscopic Rotator Cuff Repair**

Abigail Chang, PA-S & Jessica Dennis, PA-S

ABSTRACT

Objective: To determine how the timing of rehabilitation, early versus delayed, affects clinical results and tendon healing rates after arthroscopic rotator cuff repair. **Design:** Systematic literature review. **Methods:** Searches were done in PubMed, utilizing the terms arthroscopic rotator cuff repair, rehabilitation, early, and delayed. In PubMed the following filters and terms were used: published in the last 10 years, humans, randomized controlled trial, free full-text articles, and English. **Results:** The Keener et al study was included because it evaluated clinical results and tendon healing rates after arthroscopic repair using two distinct rehabilitation protocols, early versus delayed ROM. The Cuff et al study was included because it evaluated patient outcomes and rotator cuff healing after arthroscopic repair using two different physical therapy protocols: early passive motion versus delayed. The Kim et al. study was included because it compared clinical results of two rehabilitation protocols, early passive motion exercises versus delayed motion, in post-arthroscopic rotator cuff repair patients for functional outcome and tendon healing. Lastly, all three studies included subjective and objective data. **Conclusion:** The implementation of early versus delayed rehabilitation after arthroscopic rotator cuff repair yielded no significant difference in clinical results and tendon healing.

INTRODUCTION

The shoulder is one of the most complex joints of the body; it has an intricate design composed of many muscles, ligaments, tendons, and bony structures that enable its wide range of motion. However, such a high degree of function and movement also predisposes the shoulder joint to injuries, making shoulder pain one of the most common upper extremity complaints that compels patients to seek medical care each year.

Amongst various shoulder pathologies, rotator cuff (RC) tear is one of the most recognizable causes of shoulder pain and dysfunction. Although it can occur after an acute trauma or injury to the shoulder, it is generally atraumatic in onset, and patients often present with gradual progression of shoulder pain and weakness over time.

RC tears are classified as partial, complete, or massive. This classification is based on the number of tendons involved, size of tear, amount of tendon retraction, and degree of fatty atrophy of the RC muscles. The treatment modalities differ accordingly. RC tears that are described as high-grade partial or greater, meaning there is more than 50% of total tendon area involvement, usually require surgical intervention for better prognosis in terms of pain control and restoration of the tendon function. In the United States, it is estimated that over 270,000 RC repair surgeries are performed each year.¹ However, rate of postoperative defect and insufficient healing still remains at 20 – 90% of all repair cases.²

Postoperative healing is affected by various factors, e.g. patient's age, comorbidities, quality and tear size of RC tissue, and repair technique, among others. Postoperative management and rehabilitation also play a major role in determining structural integrity and functional outcome of the repaired RC, hence the focus of our review.

Generally, two major components that are considered during the postoperative period are immobilization and appropriate rehabilitation.² Early joint motion after surgery has been recommended with previous studies finding early passive motion after surgery advantageous for the knee and ankle joints. However, standard postoperative protocols are currently lacking for RC repairs. Different opinions exist on the optimal timing of rehabilitation exercises after RC repair, and it still remains a grey area for

many orthopedic surgeons today. Therefore, this study aims to compile the most up-to-date evidence to investigate whether or not there is a statistically significant difference as well as a clinically significant difference in outcome of the repaired RC when early versus delayed rehabilitation protocol are compared.

This is a systematic literature review that compared three clinical trials with level 1 evidence [Adapted from Sackett; see Appendix 4⁵] to see if clinical outcomes differed based on the type of rehabilitation protocol used after RC repair: early versus delayed. Each study quantified and compared the outcomes between the early (start passive motion exercises immediately following repair) and delayed (immobilization for at least 6 weeks following surgery) group by measuring the degree of range of motion of the repaired shoulder, conducting patient surveys using the Simple Shoulder Test (SST) and American Shoulder and Elbow Surgeons (ASES) score system, and evaluating postoperative tendon healing via ultrasound.

CLINICAL SCENARIO

JC is a 21-year-old male collegiate swimmer who recently underwent arthroscopic rotator cuff repair for a full thickness tear of the right supraspinatus muscle. His primary concern is to be able to participate in the U.S. Olympic Team Trials that are being held next summer. He wants to know which rehabilitation protocol (early versus delayed) will give him the best clinical results, tendon healing rate and return of normal rotator cuff function.

CLINICAL QUESTION

In patients who have undergone arthroscopic rotator cuff repair, does early rehabilitation protocol immediately following surgery produce better tendon healing and regain of function in comparison to delayed rehabilitation protocol?

METHODS

Our initial search began with PubMed. Search terms included, “arthroscopic rotator cuff repair, rehabilitation, early, delayed.” Studies published in the last 10 years that were randomized controlled trials, cohort, or meta-analyses were considered. Studies that did not meet inclusion and exclusion criteria were not considered. (See Table 1 and Appendix 1)

Table 1. Study Criteria	
Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> - Randomized Controlled Trial - Cohort - Meta-Analysis - English - Humans - Free full-text 	<ul style="list-style-type: none"> - Case Review - Publication date over 10 years ago - Small population size - Open rotator cuff repair - Studies comparing different surgical methods, pharmacologic therapies, or diagnostic modalities

We eliminated studies that did not compare rehabilitation protocols in post-arthroscopic rotator cuff repair patients. We wanted studies only comparing early versus delayed rehabilitation. More specifically, we were looking for all studies that began physical therapy in their early group as soon as possible postoperatively with the delayed group starting physical therapy at six weeks. This left us with three prospective randomized trials that compared early and delayed rehabilitation programs after arthroscopic rotator cuff repair (See Table 2). Other databases were used to look for additional studies, but yielded no further results.

Table 2. Quality Assessment Criteria			
	Keener et al. (Study 1)	Cuff et al. (Study 2)	Kim et al. (Study 3)
Sample Size	124	68	105
Year Published	2014	2012	2012
Journal Published In	Journal of Bone and Joint Surgery	Journal of Shoulder and Elbow Surgery	The American Journal of Sports Medicine
Level of Evidence*	1	1	1

*Levels of evidence, adapted by Sackett, are assigned to studies based on the methodological quality of their design, validity, and applicability to patient care. These decisions give the "grade (or strength) of recommendation." The lower the score, the better the study. Scoring is from 1 to 5.⁵ [Appendix 4]

RESULTS

Study 1

Rehabilitation Following Arthroscopic Rotator Cuff Repair. Keener et al.

Study Objective: To compare clinical results and tendon healing rates following arthroscopic rotator cuff repair utilizing two distinct rehabilitation protocols (early versus delayed).

Study Design

This was a prospective randomized trial that included 124 patients under the age of 65 that underwent arthroscopic repair of a full-thickness rotator cuff tear less than 30 mm in width. The study was carried out over a 30-month period. In addition to a standardized surgical technique, the surgeon was blinded to each subject's rehabilitation group prior to surgery. Postoperatively, patients were randomized to either a traditional rehabilitation program with early range of motion or to an immobilization group with delayed range of motion for six weeks (See Table 3). Sixty-five subjects composed the traditional rehabilitation group, and fifty-nine subjects made up the immobilization group. Subjects in both groups were instructed to wear a sling at all times for the initial six weeks after surgery, with few exceptions. In addition, subjects were expected to perform an individualized home exercise program in accordance with their stage of rehabilitation. An independent, blinded examiner obtained outcome measures and performed the follow-up examinations. The clinical outcomes were

assessed using a visual analog pain scale score, American Shoulder and Elbow Surgeons (ASES) score (See Appendix 2), Simple Shoulder Test (SST) (See Appendix 3), relative constant score, and strength measurements at six, twelve, and twenty-four months postoperatively.³ In addition, independent, blinded radiologists assessed tendon integrity by ultrasound at a minimum of twelve months postoperatively.³

Statistical calculations were performed using SAS/Stat software. An alpha level of 0.05 was chosen to represent significance, for all comparisons. Comparisons of means between groups were performed with a t test or Wilcoxon test. Chi-square test was used to perform proportional comparisons. Mixed- model analysis of variance was used to investigate the simultaneous effects of time and rehabilitation on specific outcomes. Post hoc tests used the Tukey- Kramer correction to adjust for multiple comparisons.³ Prior to the onset of this study, a power analysis was performed on the basis of cuff tendon healing. Previous research from the institution noted a healing rate of approximately two-thirds of rotator cuff tears following repair of similar sized tears with a double-row technique. A theoretical difference in healing of 20% between the two types of postoperative rehabilitation was assumed. Choosing an alpha level of 0.05 and beta level of 0.20, power analysis suggested that seventy subjects per group would be needed.³

Time	Traditional Rehabilitation Group*	Immobilization Group*
Immediate postoperative period	Pendulum exercises and elbow, wrist, and hand AROM	Elbow, wrist, and hand AROM
1-6 wk	Therapist-supervised PROM of shoulder	Shoulder immobilized
6-12 wk	Initiated AAROM and AROM of shoulder	Therapist-supervised PROM of shoulder
3-4 mo	Initiated cuff, deltoid, and scapular stabilizer strengthening	Initiate AAROM and AROM of shoulder
> 4 mo	Full activities between 4 and 6 mos on basis of individual progress	Initiate cuff, deltoid, and scapular stabilizer strengthening; full activities between 5 and 6 mo on basis of individual progress
*AROM = active range of motion, PROM = passive range of motion, and AAROM = active-assisted range of motion		

Study Results

At baseline, there were no significant differences in patient age, tear size, or measures of preoperative function found between groups. Outcomes data were available for 103 (83%) of 124 subjects at six months, 105 (85%) of 124 subjects at twelve months, and 103 (83%) of 124 subjects at twenty-four months.³ A final follow-up category was created which included the last measured outcomes of a subject at a minimum of twelve months. This was done because some patients did not

return for either the twelve or twenty-four-month time point. If a subject had both twelve and twenty-four-month data, the latter were used in the final follow-up category. At the time of final follow-up, outcomes data were available for 114 (92%) of 124.³

All measured outcomes, except active external rotation, were significantly improved compared to baseline measures in both rehabilitation groups (See Table 4). The traditional rehabilitation group, compared with the immobilization group, had significantly better active elevation and external rotation at three months postoperatively. There were no significant differences in functional scores, active motion, and shoulder strength between rehabilitation groups at later time points. Functional outcomes plateaued at six or twelve months except for the relative constant score, which improved up to twenty-four months following surgery. Of the 116 shoulders with ultrasound assessment, 107 (92%) had an intact repair.³ There was no difference in healing rates between the traditional repair group compared with the immobilization group ($p = 0.46$).³

Time Point	VAS Pain Score	ASES Score	Relative Constant Score	SST Score	Elevation (deg)	External Rotation (deg)	External Rotation and Abduction	Abduction Strength (lb)	External Rotation Strength (lb)
Baseline	5.61	45.0	54.5	5.06	139.6	61.1	76.3	3.94	9.13
3 mo					129.8+	43.7+			
6 mo	1.27+	82.5+	74.5+	9.19+	154.1+	62.6+	80.6	5.74+	14.11
12 mo	1.01	88.5+	79.4+	10.17+	160.1	65.5	86.4+	5.41	15.85
24 mo	0.61	92.4	83.9+	10.80	163.7	64.2	88.5	6.41	16.02

*VAS = visual analog scale, ASES = American Shoulder and Elbow Surgeons, and SST = Simple Shoulder Test.
 + The difference between the designated value and the value and the previous time point was significant ($p < 0.05$)

Study 2

Prospective Randomized Study of Arthroscopic Rotator Cuff Repair Using an Early Versus Delayed Postoperative Physical Therapy Protocol. Cuff et al.

Study Objective: To evaluate patient outcomes and rotator cuff healing after arthroscopic rotator cuff repair using a postoperative physical therapy protocol with early passive motion compared with a delayed protocol that limited early passive motion.

Study Design

This was a randomized controlled trial with 1-year follow-up. The study enrolled 68 patients (mean age, 63 years; 56% men) who had a full-thickness crescent-shaped tear of the supraspinatus that was repaired arthroscopically using a trans-osseous equivalent suture-bridge technique. Subacromial decompression was performed in conjunction with the rotator cuff repair. In the early rehabilitation

group, 33 patients (18 men, 15 women) were randomized to passive elevation and rotation that began at postoperative day 2 (See Table 5). In the delayed rehabilitation group, 35 patients (20 men, 15 women) began the same protocol at 6 weeks. All patients were instructed to wear a shoulder immobilizer for 6 weeks from the surgical date. On the days outpatient therapy was not performed, patients were instructed to do gentle circular pendulum exercises on their own (See Table 5). All patients were required to complete questionnaires to determine their ASES and SST scores. Patient-reported satisfaction was recorded at 1 year after the operation. Range of motion for patients was digitally recorded at their preoperative appointment and at the 6-month and 1-year visits. Each patient underwent high-resolution ultrasound imaging after postoperative month 9 (range, 9-14 months; average, 12.2 months) to evaluate rotator cuff healing.⁴

Interval	Early ROM Group	Delayed ROM Group
Weeks 0-3	<ul style="list-style-type: none"> ● Shoulder Immobilizer worn ● Passive forward elevation 0°-120°, 3x weekly with PT* ● Passive external rotation 0°-30°, 3x weekly with PT ● Pendulum exercises, 3x daily for 5 min per session ● Active elbow, wrist, and hand ROM 	<ul style="list-style-type: none"> ● Shoulder immobilizer worn ● Pendulum exercises, 3x daily for 4 min per session ● Active elbow, wrist, and hand ROM
Weeks 4-6	<ul style="list-style-type: none"> ● Shoulder immobilizer worn ● Passive forward elevation to tolerance, 3x weekly with PT ● Passive external rotation 0°-45°, 3x weekly with PT ● Pendulum exercises, 3x daily for 5 min per session ● Active elbow, wrist, and hand ROM 	<ul style="list-style-type: none"> ● Shoulder immobilizer worn ● Pendulum exercises, 3x daily for 5 min per session ● Active elbow, wrist, and hand ROM
Weeks 6-10	<ul style="list-style-type: none"> ● Shoulder immobilizer discontinued ● Active assisted ROM, 3x weekly with PT 	<ul style="list-style-type: none"> ● Shoulder immobilizer discontinued ● Passive forward elevation to 120°, 3x weekly ● Passive external rotation to 30°, 3x weekly ● At week 7, progress to passive forward elevation to tolerance and 45° external rotation ● At week 7, begin active assisted ROM 3x weekly with PT
Weeks 10-12	<ul style="list-style-type: none"> ● Active assisted ROM 3x weekly with PT ● Active ROM to tolerance 	<ul style="list-style-type: none"> ● Active assisted ROM 3x weekly with PT ● Active ROM to tolerance

Weeks 12-on	• Begin rotator cuff strengthening	• Begin rotator cuff strengthening
*PT = physical therapy		

Study Results

Both rehabilitation groups showed similar improvements in preoperative to postoperative ASES scores and SST scores. At 6 months, the early range of motion group demonstrated a greater average forward elevation compared to the delayed range of motion group ($P < .0001$). At 1-year postoperative assessment, no statistically significant differences were found in patient satisfaction, rotator cuff healing, or range of motion between the early and delayed groups (See Table 6).

Table 6. Comparison of Mean Preoperative and Postoperative Patient Data From Both Rehabilitation Groups Over Time						
	ASES Score	SST Score	Forward Elevation (deg)	External Rotation (deg)	Full Internal Rotation (%)	Rotator Cuff Healing (%)
Preoperative	42.5	5.3	159	43		
12-month	92.0	11.1	173.5	45.5	92.5	88
P Value	0.0049	.883*	0.063*	0.668*	0.99*	0.47*
*Not significant						

Study 3

Is early passive motion exercise necessary after arthroscopic rotator cuff repair? Kim et al.

Study Objective: To elucidate whether early passive motion exercise affects functional outcome and tendon healing after arthroscopic rotator cuff repair.

Study Design: This was a randomized controlled trial that followed 105 consecutive patients (44 men, 61 women) who underwent arthroscopic repair for small- to medium-sized (< 3 cm) full-thickness rotator cuff tears. Patients with large to massive tears, labral lesions or any previous shoulder surgery or stiffness preoperatively were excluded from this study. All selected 105 patients were instructed to wear an abduction brace for approximately 4-5 weeks after surgery until they could begin active-assisted shoulder exercises. Two groups were randomly divided and followed during the 4-5 weeks of abduction brace-wearing immediately following surgery (See table 7). Group 1, “Early passive motion (EM)” group, composed of 56 patients (26 men and 30 women with mean age of 60.06 +/- 9.04) who conducted early passive motion exercises 3-4 times a day during the abduction brace-wearing period. Group 2, “Delayed motion (DM)” group, composed of 49 patients (18 men and 31 women with mean age of 60.00 +/- 10.42) who were not allowed passive motions during the same period. Range of motion (ROM) and

visual analog scale (VAS) for pain were measured at 3, 6, and 12 months postoperatively, and functional evaluations were done at 6 and 12 months postoperatively using Constant score, Simple Shoulder Test (SST) score and American Shoulder and Elbow Surgeons (ASES) score. Ultrasound, CT arthrography, or MRI was used to evaluate postoperative RC healing as well.¹

Table 7. Demographic data of patients included in the study			
		Early Motion Group (Group 1)	Delayed Motion Group (Group 2)
Number of patients		56	49
Age, mean (range)		60.06 (30 - 75)	60.00 (27 - 82)
Sex, Male/Female		26/30	18/31
Dominant arm, Right/Left		37/19	32/17
Comorbidities	<i>Diabetes</i>	8	7
	<i>Hypertension</i>	16	15
	<i>Thyroid disease</i>	1	1
Smoking		13	11
Tear size in anteroposterior dimension, mean +/- SD (mm)		18.9 +/- 12.6	16.3 +/- 6.5
Medial retraction, mean +/- SD (mm)		18.3 +/- 13.2	17.8 +/- 12.9
Repair technique	<i>Single row</i>	9	8
	<i>Double row</i>	1	1
	<i>Suture bridge</i>	46	40

Study Results: All 105 patients completed minimum of 1-year follow-up evaluation. For all the evaluation criteria, including three ROM tests and three functional tests, data collected from 6-month and 1-year postoperative follow-ups were used to make comparisons (See Table 8). It was found that there were no statistically significant differences between the two groups for all three ROM tests, as well as all three functional tests. Imaging done at a minimum of 1 year after surgery to evaluate healing of the repaired RC revealed that healing was seen in 49 out of 56 patients (88%) in group 1 and in 40 out of 49 patients (82%) in group 2.¹

Table 8. Comparison of outcomes from the two groups: early passive motion versus delayed motion				
Range of Motion				
	Time	Early Passive Motion (95% C.I.)	Delayed Motion (95% C.I.)	P Value
Forward Flexion (in degrees)	Preoperative	144.70 (135.79-153.61)	144.84 (135.94-153.74)	.982
	Postoperative 3 months	144.86 (140.08-149.64)	140.00 (133.26-146.74)	.319
	Postoperative 6 months	150.57 (141.66-159.48)	147.14 (141.04-153.24)	.392
	Postoperative 12 months	159.75 (151.46-168.04)	153.67 (146.93-160.41)	.206
External Rotation with the arm at the side (in degrees)	Preoperative	67.27 (59.94-74.60)	69.84 (62.49-77.19)	.633
	Postoperative 3 months	71.22 (63.46-78.98)	66.33 (59.20-73.46)	.349
	Postoperative 6 months	77.21 (71.82-82.60)	72.86 (64.32-81.40)	.393
	Postoperative 12 months	78.50 (71.58-85.42)	81.33 (70.83-91.83)	.623
Internal Rotation at the back (vertebral level numbered serially, i.e. 12 for 12th T vertebra, 13 for 1st L vertebra)	Preoperative	T 9.7 (T 8.6-T 10.8)	T 9.2 (T 8.1-T 10.3)	.552
	Postoperative 3 months	T 7.6 (T 6.4-T 8.8)	T 8.4 (T 7.3-T 9.5)	.256
	Postoperative 6 months	T 9.0 (T 8.2-T 9.8)	T 10.1 (T 9.0-T 11.2)	.104
	Postoperative 12 months	T 10.0 (T 9.2-T 10.9)	T 9.9 (T 8.4-T 11.4)	.854
Functional Test				
	Time	Early Passive Motion (95% C.I.)	Delayed Motion (95% C.I.)	P Value
Constant Score	Preoperative	53.73 (49.77-57.69)	49.93 (45.87-53.99)	.186
	Postoperative 3 months	63.23 (60.24-66.22)	63.33 (59.70-66.96)	.966
	Postoperative 6 months	66.11 (63.26-68.96)	64.52 (60.87-68.17)	.991
	Postoperative 12 months	69.81 (67.81-71.81)	69.83 (65.97-73.69)	.854
Simple Shoulder Test (SST) Score	Preoperative	4.06 (3.06 – 5.06)	3.52 (2.58 – 4.46)	.424
	Postoperative 3 months	6.34 (5.35-7.33)	6.05 (4.92-7.18)	.738
	Postoperative 6 months	7.81 (6.96-8.66)	6.70 (5.68-7.72)	.120
	Postoperative 12 months	9.00 (7.54-10.46)	9.00 (7.65-10.35)	.631
American Shoulder and Elbows	Preoperative	48.38 (42.99-53.77)	46.27 (41.15-51.39)	.566

Surgeons (ASES) Score	Postoperative 3 months	65.19 (59.95-70.43)	64.68 (58.60-70.76)	.896
	Postoperative 6 months	67.08 (61.71-72.45)	69.89 (64.12-75.66)	.561
	Postoperative 12 months	73.29 (58.25-88.33)	82.90 (74.99-90.81)	.216

CRITIQUES AND LIMITATIONS OF STUDIES

In the study by Keener et al., subject attrition was an issue. There were 85% remaining subjects at 12 months follow-up and 83% remaining subjects at 24 months. Due to the lack of follow-up, they created a final follow-up classification in which either the 12 or 24-month data were used. Therefore, their final follow-up rate of 92% subjects is misleading since it was derived from a combination of data. Additionally, the at-home pendulum exercises were unsupervised so it cannot be known if the subjects were compliant or not. Overall, there was no clinically meaningful difference found between study groups, which could be due to the small sample size. Lastly, patient satisfaction was not evaluated in this study.

The Cuff et al. study lacked statistical power needed to definitively detect a statistically significant difference in healing rates between the two cohorts. Therefore, leading to type II error, which would be failing to show statistical significance in the study population due to an inadequate number of study subjects. Like the Keener et al study, the at-home pendulum exercises were unsupervised so, again, it is unknown whether or not the patients were compliant. Additionally, patient compliance with movement restrictions in the postoperative period also was not able to be documented. If the patients were non-compliant with either the pendulum exercises or the movement restrictions, this could have affected their motion or healing rate.

Lastly in the study by Kim et al., follow-up period and study method were major limitations. First, study was performed at two different sites: Arthroscopic repairs were performed by two different surgeons, and evaluation were done by two different researchers at two different locations. Inter-observer discrepancies and different skill sets brought on by two different surgeons could not be overlooked. Second, the authors felt that 1 year was a relatively short period of time for postoperative follow-up, leaving a question of possibility of a different outcome if patients were followed longer. Lastly, stratified randomization was not performed. Stratified randomization is a two-stage procedure used in clinical research. Patients who enter the research are first grouped into strata according to clinical features that may influence the outcome risk. Then, patients within each stratum are randomly assigned to different treatment groups.⁶ If this study used both stratification and randomization to assign patients, treatment outcome may have been different.

DISCUSSION

Rotator cuff repair is one of the most common shoulder surgeries conducted in the U.S. each year. However, successful postoperative healing and restoration of the tendon function still varies greatly ranging from 20% up to 90% of all repair cases. While the outcome of RC repair depends on multiple factors, including patient history and skill set of surgeons, the most challenging question that is still plagues orthopedists is which rehabilitation protocol should be employed to promote the best prognosis of post-surgical patients.

While there is evidence-based literature available on standard rehabilitation protocols for ankle and knee repairs, there is none yet in place for shoulder repairs. Therefore, orthopedic surgeons typically rely on their clinical judgment to determine which rehabilitation protocol should be followed after an arthroscopic RC repair. Therefore, we chose three of the most recent and best evidence-based studies we could find in order to see if different clinical outcomes are produced when early versus delayed motion exercises are compared.

The results of the study are significant to our patient case since he is a collegiate swimmer post-RC repair whose main concern is the healing and functional restoration of his injured shoulder in order to get back to his swimming career. Each study compared the outcome with both subjective data (patient survey conducted via SST and ASES scoring system), as well as objective data from physical exam that measured degree of range of motion of the affected shoulder joint, and ultrasound results that evaluated healing status of the affected tendon.

Keener et al. conducted a randomized control trial and followed 124 patients under the age of 65 who underwent arthroscopic repair of full-thickness RC tear over a 30-month period. 65 subjects were randomly assigned to the early rehabilitation group while 59 subjects were assigned to the immobilization group. Patients were evaluated at 6, 12 and 24 months postoperatively with assessment of the surgical outcome using visual analog pain scale score, American Shoulder and Elbow Surgeons (ASES) score (See Appendix 2), Simple Shoulder Test (SST), relative constant score, and strength measurements. Tendon integrity was also assessed with ultrasound at 12 months following the operation. The result was found to have no statistically significant difference between the early versus delayed rehabilitation group. Both groups had similar outcomes in terms of functional scores, pain scores and healing rate as seen on ultrasound in comparison to the preoperative conditions.

However, it must be mentioned that there were only 85% and 83% of subjects evaluated at 12- and 24- month follow-up period, respectively. Subject attrition was an issue and their final follow-up of 92% of subjects was derived from a combination of data and not based on a true number.

Cuff et al. followed 68 patients who underwent arthroscopic repair of full-thickness crescent-shaped RC tear for 1-year period. In the early rehabilitation group, 33 patients were randomly assigned to the early rehabilitation group that immediately began passive motion exercises following the operation, while the other 35 patients were enrolled in the delayed rehabilitation group that began rehabilitation protocol at 6 weeks following the surgery. Patients were evaluated via patient questionnaires using SST and ASES scores, range of motion of the shoulder, as well as high resolution ultrasound imaging at 9 months following the surgery to evaluate the RC healing. This study by Cuff et al. also showed similar improvements in both groups, especially at 1-year post-surgery where there was no statistically significant difference seen in the clinical outcome of both groups across the evaluation criteria. One limitation in study, however, was in lack of statistical power needed to detect a difference of statistical significance in healing rates between 2 groups.

In both studies by Keener et al. and Cuff et al., it must be mentioned that pendulum exercises conducted at home were not monitored, so patient compliance may be an issue which may potentially affect the clinical outcome.

Study conducted by Kim et al. included 105 patients who underwent arthroscopic repair for full-thickness RC tear. All patients were randomized into early versus delayed rehabilitation groups and followed for a total of 12 months postoperatively. The “early passive motion” (EM) group consisted of

56 patients while the “delayed motion” (DM) group comprised of 49 patients. Functional evaluations using SST, ASES and constant score, range of motion and visual analog scale (VAS) for pain were measured at 3-, 6- and 12-month follow-up evaluations, and imaging studies, either ultrasound or MRI, were used to evaluate the RC healing. This study also found no significant differences in the outcome of RC repair for both early and delayed rehabilitation groups. Imaging done to evaluate healing of RC were also comparable with healing rate of 88% in the early rehabilitation group and 82% in delayed rehabilitation group. The limitation to this study was that surgical intervention and evaluation of patients were done at two different hospital sites, which may have generated inter-observer discrepancies and possibly different outcomes caused by difference in the level of skill set found in two surgeons. Also, the researchers felt that 1-year follow-up period was not adequate enough, and speculation still remained regarding whether a longer period of postoperative follow-up would have yielded a different conclusion of the study.

CONCLUSION

Early and delayed rehabilitation protocols after arthroscopic rotator cuff repair are both reasonable options. Both protocols are associated with similar functional scores, range of motion, muscle strength and function, and tendon healing. Although no statistical difference was found between the two groups, it should not be assumed that immobilization does not lead to risk of shoulder stiffness or that early motion does not impair tendon healing. Further studies are needed to draw these conclusions.

Recommendations for future studies are: increase sample size and close monitoring of patients’ home exercises in attempt to prevent non-compliance and enforce strict adherence to the assigned rehabilitation protocol.

CLINICAL RECOMMENDATIONS

JC is a young college athlete who underwent arthroscopic rotator cuff repair and needs to be able to swim at his full capacity next year. Based on our analysis, rehabilitation protocol, passive motion exercises versus immobilization up to 3 months post-operatively, is equally safe and effective after surgical rotator cuff repair. Ultimately, the final decision will be left up to the patient and what works best with his lifestyle and schedule.

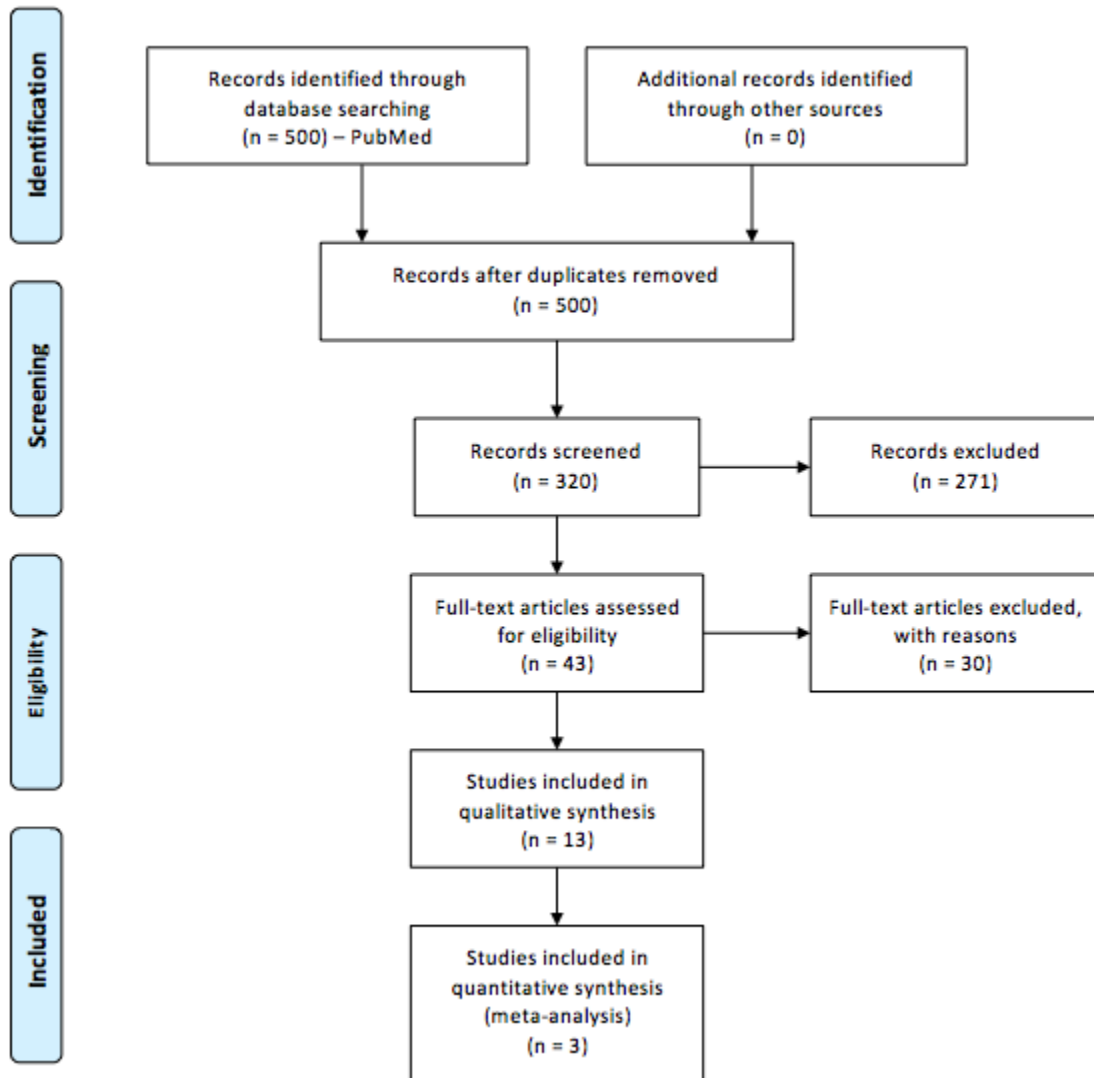
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Appendix 1 PRISMA



Appendix 2. The American Shoulder & Elbow Society (ASES) Rating Scale				
Are you having pain in your shoulder?	Yes		No	
Do you have shoulder pain at night?	Yes		No	
Do you take pain medications such as Tylenol, Advil, aspirin, etc.?	Yes		No	
Do you take strong pain medications such as tramadol, codeine, morphine, etc.?	Yes		No	
How many pills do you take on an average day?				
How bad is your pain on a 1 - 10 scale (10 being the worst)?				
Circle the number that indicates your ability to do the following activities.				
0 - unable to do; 1 - very difficult to do; 2 - somewhat difficult; 3 - not difficult				
Put on a coat	0	1	2	3
Wash your back or do up bra	0	1	2	3
Comb hair	0	1	2	3
Lift 10 lbs. above your shoulder	0	1	2	3
Do your usual work	0	1	2	3
Do your usual sport/leisure	0	1	2	3
Sleep on the affected side	0	1	2	3
Manage toileting	0	1	2	3
Reach a high shelf	0	1	2	3
Throw a ball overhand	0	1	2	3

Appendix 3. Simple Shoulder Test (SST)

Comfort

- Is your shoulder comfortable with your arm at rest by your side?
- Does your shoulder allow you to sleep comfortably?

Range

- Can you reach the small of your back to tuck in your shirt with your hand?
- Can you place your hand behind your head with your elbow straight out to the side?
- Can you wash the back of your opposite shoulder with the affected extremity?

Strength

- Can you place a coin on a shelf at the level of your shoulder without bending your elbow?
- Can you lift 1 lb (a full pint container) to the level of your shoulder without bending your elbow?
- Can you lift 8 lbs (a full gallon container) to the level of your shoulder without bending your elbow?

Other

- Can you carry 20 lbs at your side with the affected extremity?
- Do you think you can toss a softball underhand 10 yd with the affected extremity?
- Would your shoulder allow you to work full time at your regular job?
- Do you think you can toss a softball overhand 20 yd with the affected extremity?

Appendix 4. Levels of Evidence

<i>Level</i>	<i>Type of Evidence</i>
1	Large randomized controlled trials with clear cut results
2	Small randomized controlled trials with unclear results
3	Cohort and case-control studies
4	Historical cohort or case-control studies
5	Case series, studies with no controls

Adapted from Sackett DL. Rules of evidence and clinical recommendations on the use of antithrombotic agents. Chest 1989;95:2S-4S