[Physical Therapy]

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A Comparison of Rehabilitation Methods After Arthroscopic Rotator Cuff Repair: A Systematic Review

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Context: Despite the significant attention directed toward optimizing arthroscopic rotator cuff repair, there has been less focus on rehabilitation after rotator cuff repair surgery.

Objective: To determine the effect of different rehabilitation protocols on clinical outcomes by comparing early versus late mobilization approaches and continuous passive mobilization (CPM) versus manual therapy after arthroscopic rotator cuff repair.

Data Sources: PubMed was searched for relevant articles using the keywords *rotator cuff, rotator, cuff, tears, lacerations*, and *rehabilitation* to identify articles published from January 1980 to March 2014.

Study Selection: Inclusion criteria consisted of articles of level 1 or 2 evidence, written in the English language, and with reported outcomes for early versus late mobilization or rehabilitation with CPM versus manual therapy after primary arthroscopic rotator cuff repair. Exclusion criteria consisted of articles of level 3, 4, or 5 evidence, non-English language, and those with significantly different demographic variables between study groups. Included studies were evaluated with the Consolidated Standards of Reporting Trials criteria.

Study Design: Systematic review.

Level of Evidence: Level 2.

Data Extraction: Level of evidence, study type, number of patients enrolled, number of patients at final follow-up, length of follow-up, age, sex, rotator cuff tear size, surgical technique, and concomitant operative procedures were extracted from included articles. Postoperative data included clinical outcome scores, visual analog score for pain, shoulder range of motion, strength, and rotator cuff retear rates.

Results: A total of 7 studies met all criteria and were included in the final analysis. Five studies compared early and late mobilization. Two studies compared CPM and manual therapy.

Conclusion: In general, current data do not definitively demonstrate a significant difference between postoperative rotator cuff rehabilitation protocols that stress different timing of mobilization and use of CPM.

Keywords: arthroscopic; rotator cuff; rehabilitation; mobilization timing; continuous passive mobilization; manual therapy

The ultimate goals of rotator cuff tear management are to relieve pain and restore shoulder function. Rehabilitation after surgical management is crucial to realize these goals and improve patient functional outcome, range of motion, and strength.[9,14] Although rehabilitation protocols may differ widely among surgeons, there exist 2 central parameters that can differentiate protocols: timing of mobilization and continuous passive mobilization (CPM).

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Table 1. Patient demographics and rotator cuff tear classification

Study	Level of Evidence	Study Type	Patients Enrolled, n	Patients at Final Follow-up, n	Mean Follow-up, mo	Average Age, y	Men	Women	Small Tear (<1 cm)	Medium Tear (1-3 cm)	Large Tear (3-5 cm)
Arndt et al[1]	1	Early vs late mobilization	100	92	16	55	34	58	NR	NR	NR
Cuff and Pupello[3]	1	Early vs late mobilization	68	68	12	63	38	30	NR	NR	NR
Düzgün et al[4]	1	Early vs late mobilization	29	29	6	56	3	26	NR	12	17
Garofalo et al[6]	1	CPM vs manual therapy	100	100	12	60	47	53	NR[a]	NR[a]	NR[a]
Keener et al[7]	1	Early vs late mobilization	145	114	24	55	73[b]	51[b]	NR	NR	NR
Kim et al[8]	1	Early vs late mobilization	117	105	12	60	44	61	NR[c]	NR[c]	NR
Lee et al[9]	1	CPM vs manual therapy	85	64	25	55	41	23	0	41	23

CPM, continuous passive mobilization; NR, not reported.
[a]All had C2-C3[18] rotator cuff tears (C2, <2 cm; C3, 3-4 cm).
[b]Reflects patients who underwent surgery.
[c]All were small- or medium-sized tears.

Currently, there is no consensus regarding the optimal timing of mobilization after arthroscopic rotator cuff repair. Some advocate early mobilization to prevent postoperative stiffness and subsequent decreased range of motion and function.[16] Others advocate a delay in mobilization to avoid compromise of tendon healing and integrity. Tendon integrity remains a valid concern as the retear rate after arthroscopic rotator cuff repair has been reported to be as high as 94% for massive cuff tears.[2,5,11] However, a variety of factors such as patient age and initial tear size are risk factors for recurrent tears.[12,15]

Additionally, debate exists regarding the use of CPM in rehabilitation protocols after arthroscopic rotator cuff repair. CPM may allow cautious early mobilization, an increase in collagen tissue healing with proper fiber orientation, and better functional outcomes after total knee arthroplasty.[10,13] However, there is a lack of consensus regarding its effect on functional outcomes in arthroscopic rotator cuff repair. Furthermore, it is unknown whether CPM offers benefit over manual therapy.

Given the central role of rehabilitation, the authors conducted a qualitative systematic review to investigate the optimal timing of therapy and the use of CPM in rehabilitation after rotator cuff repair. The primary purpose was to review all level 1 and 2 studies that evaluated the clinical outcomes of early versus late mobilization and CPM versus manual therapy after arthroscopic rotator cuff repair to compare the efficacies of these approaches. The authors hypothesized that clinical outcomes between patients that undergo early versus late mobilization and between patients that undergo CPM versus manual therapy are not statistically different.

METHODS

Studies were included that met the following criteria: level 1 or 2 evidence, written in English, compared outcomes between patients undergoing early versus late mobilization or compared outcomes between patients undergoing rehabilitation with CPM versus manual therapy after primary arthroscopic rotator cuff repair, and detailed the rehabilitation protocol. Studies were excluded if they: had level 3, 4, or 5 evidence, were non-English articles, or maintained a significant difference between study groups in terms of demographic variables.

Literature Search

PubMed was used to find relevant articles, published between January 1980 and March 2014, on rehabilitation after arthroscopic rotator cuff repair using the keywords *rotator cuff, rotator, cuff, tears, lacerations*, and *rehabilitation*. General search terms were used to prevent the inadvertent neglect of potential studies. The references of all included studies were

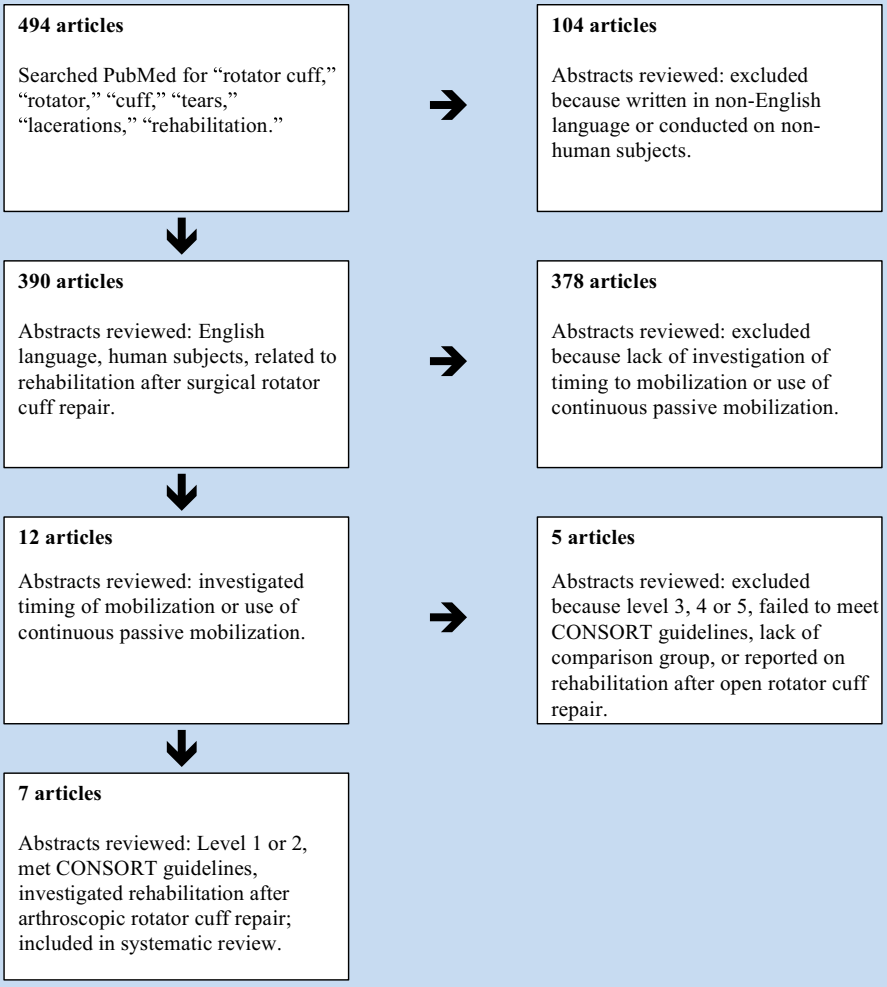

Figure 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram.

carefully reviewed for studies not identified by our literature search. Two independent reviewers reviewed the abstract of every article to determine the methods and subsequently reviewed all articles that met the aforementioned inclusion and exclusion criteria. The Consolidated Standards of Reporting Trials (CONSORT) 2010 checklist was used by both independent reviewers for quality appraisal of each randomized controlled study eligible for final inclusion.[17]

Data Extraction

Level of evidence, study type, number of patients enrolled, number of patients at final follow-up, length of follow-up, age, sex, rotator cuff tear size, surgical technique, and concomitant operative procedures were extracted from included articles. Postoperative data included clinical outcome scores, visual analog score for pain, shoulder range of motion, strength, and rotator cuff retear rates (Table 1).

RESULTS

Literature Search

The literature search is detailed in Figure 1.

Patient Demographics

Patient demographics are available in Table 1. None of the studies investigating the use of CPM reported the effective

Table 2. Surgical procedures, concomitant procedures, and retear rate

Study	Arthroscopic Technique	Concomitant Procedures	Retear Rate, %	Modality Used to Determine Retear
Arndt et al[1]	Single-row fixation (59%), double-row fixation (41%)	Long head of biceps tenotomy (65%), long head of biceps tenodesis (11%), acromioplasty (91%), AC joint ostephyte removal (5%), complete AC resection (15%)	20	Arthro–computed tomography
Cuff and Pupello[3]	Transosseous equivalent suture bridge (100%)	Subacromial decompression (100%)	12	Ultrasound
Düzgün et al[4]	1 anchor (76%), 2 anchors (24%); Side-to-side technique: 1 (38%), 2 (14%), 3 (3%)	NR	NR	NR
Garofalo et al[6]	Double-loaded titanium suture anchor (100%)	NR	NR	NR
Keener et al[7]	Modified double-row transosseus technique (100%)	Subacromial decompression (100%), acromioplasty (100%)	16	Ultrasound
Kim et al[8]	Single-row fixation (16%), double-row fixation (2%), suture bridge (82%)	Subacromial decompression (100%), acromioplasty (100%)	NR	NR
Lee et al[9]	Single-row fixation (100%); 1 or 2 anchors (64%), 3 or 4 anchors (36%)	Subacromial decompression (100%)	16	Magnetic resonance imaging

AC joint, acromioclavicular joint; NR, not reported.

follow-up for each study group individually.[6,9] Five studies included a study of homogeneity to ensure that comparison groups were not significantly different in terms of baseline characteristics.[1,4,7-9] One study[6] matched for age and sex and another study[3] did not specify whether a study of homogeneity was performed, but showed similar comparison group baseline characteristics in tabular format without mentioning statistical significance.

Rotator Cuff Tear Classification

Tear sizes were classified as small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (>5 cm). Full- and partial-thickness tears were included in the studies (Table 1).

Surgical Technique and Concomitant Procedures

All included studies involved all-arthroscopic rotator cuff repair, although the exact method varied (Table 2).

Rehabilitation Protocol

Tables 3 and 4 outline the rehabilitation protocols used in the included studies.

Functional Scores

All studies investigating early versus late mobilization reported functional outcome scores (Table 5). Only 1 of 2 studies evaluating CPM versus manual therapy reported functional scores (Table 6).

Table 3. Rehabilitation protocols in studies comparing early versus late mobilization

	Early Group	Late Group
Arndt et al[1]	3-5 physical therapy sessions per week starting on day after operation (stressing pendulum exercise, manual passive ROM, and CPM)	Sling immobilization for 6 weeks postoperatively
	Identical progressive active ROM rehabilitation protocol started at 6 weeks postoperatively	
Cuff and Pupello[3]	3 physical therapy sessions per week starting on postoperative day 2 (stressing pendulum exercise and graduated passive ROM) for 6 weeks	Sling immobilization for 6 weeks postoperatively, but pendulum exercises (3 times daily for 5 min/session) during this time period
	Active assisted ROM at weeks 6-10 Active ROM to tolerance at weeks 10-12 Rotator cuff muscle strengthening at week 12	Passive ROM at week 6; then started same protocol that "Early Group" started at week 6
Düzgün et al[4]	Identical protocols consisting of progressive increases in active ROM and exercise intensity	
	Reached final stage (active ROM against resistance and rotator cuff muscle strengthening) at week 7	Reached final stage at week 18
Keener et al[7]	Initial 6 weeks of passive ROM, progressive active ROM in subsequent 6 weeks, and rotator cuff strengthening 3-4 months postoperatively	
	Protocol started at first postoperative visit (10-14 days)	Protocol started 6 weeks postoperatively
Kim et al[8]	Passive shoulder ROM initiated on postoperative day 1	Shoulders immobilized for 4 or 5 weeks postoperatively (based on tear size)
	At 4-5 weeks postoperatively, identical progressive increases in active ROM and rotator cuff muscle strengthening at 9-12 weeks postoperatively	

CPM, continuous passive mobilization; ROM, range of motion.

Table 4. Rehabilitation protocols in studies comparing manual therapy versus CPM

	Manual Therapy Group	CPM Group
Garofalo et al[6]	Shoulders immobilized 4 weeks in both groups	
	Progressive pendulum and passive ROM exercises for the next 4 weeks	CPM regimen in addition to progressive pendulum and passive ROM exercises for the next 4 weeks
	Starting at 8 weeks postoperatively, both groups stress identical increases in passive and active ROM	
Lee et al[9]	Starting on day of surgery, pendulum and progressive passive ROM ×6 weeks	Starting on day of surgery, CPM machine with stretching limited to 90° ×3 weeks Progressive increases in passive ROM for next 3 weeks
	In both groups, active ROM started at 6 weeks postoperatively	

CPM, continuous passive mobilization; ROM, range of motion.

Table 5. Early versus late mobilization: functional and pain scores

Study	Mean Follow-up, mo	Constant Score			ASES Score			VAS Pain Score at Rest		
		Early	Late	*P* Value	Early	Late	*P* Value	Early	Late	*P* Value
Arndt et al[1]	16	77.6 ± 12.4	69.7 ± 18.0	0.045	NR	NR	NR	NR	NR	NR
Cuff and Pupello[3]	12	NR	NR	NR	91.1	92.8	<0.0049[a]	NR	NR	NR
Düzgün et al[4]	6	NR	NR	NR	NR	NR	NR	—[b]	—[b]	NR
Keener et al[7]	24	83.2 ± 11.5	84.3 ± 10.8	0.5	91.0 ± 15.3	93.3 ± 10.6	0.75	0.9 ± 1.7	0.6 ± 1.1	0.26
Kim et al[8]	12	69.81	69.83	0.854	73.29	82.90	0.216	2.8	1.8	0.34

ASES, American Shoulder and Elbow Surgeons score; NR, not reported; VAS, visual analog scale.
[a]Preoperative ASES scores were significantly different between groups.
[b]No numerical data reported; data reported in graphical format.

Table 6. CPM versus manual therapy: functional and pain scores

Study	Mean Follow-up, mo	UCLA Score			VAS Pain Score at Rest		
		CPM	Manual	*P* Value	CPM	Manual	*P* Value
Garofalo et al[6]	12	NR	NR	NR	0.2 ± 0.1	0.2 ± 0.2	>0.05
Lee et al[9]	12	31.8	32.3	0.341	0.15	0.23	0.382

CPM, continuous passive mobilization; NR, not reported; UCLA, University of California Los Angeles; VAS, visual analog scale.

Table 7. Early versus late mobilization: range of motion (in degrees unless noted otherwise)

Study	Mean Follow-up, mo	Forward Flexion			External Rotation			External Rotation With Abduction to 90°			Internal Rotation		
		Early	Late	*P* Value	Early	Late	*P* Value	Early	Late	*P* Value	Early	Late	*P* Value
Arndt et al[1]	16	172.4 ± 13.0	163.3 ± 25.1	0.094	58.7 ± 12.9	49.1 ± 18.0	0.011	NR	NR	NR	NR	NR	NR
Cuff and Pupello[3]	12	174	NR	0.063	46	45	0.668	NR	NR	NR	94[a]	91[a]	0.99
Düzgün et al[4]	6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Keener et al[7]	24	164 ± 13.4	163 ± 15.8	0.85	62.0 ± 16.4	66.2 ± 14.0	0.15	90.0 ± 10.3	87.7 ± 11.9	0.27	NR	NR	NR
Kim et al[8]	12	159.75	153.67	0.206	78.50	81.33	0.623	NR	NR	NR	T 10.0	T 9.9	0.854

NR, not reported.
[a]Percentage of patients achieving full internal rotation.

Pain

Pain data are summarized in Tables 5 and 6 for early versus late mobilization and CPM versus manual therapy, respectively.

Range of Motion

Range of motion data are summarized in Tables 7 and 8 for early versus late mobilization and CPM versus manual therapy, respectively.

Table 8a. CPM versus manual therapy: range of motion (in degrees)

Study	Mean Follow-up, mo	Forward Flexion			External Rotation		
		CPM	Manual	*P* Value	CPM	Manual	*P* Value
Garofalo et al[6]	12	165.2 ± 8	158 ± 10.1	>0.05	86 ± 4	85 ± 4.2	>0.05
Lee et al[9]	12	153.0 ± 12.2	155.3 ± 13.0	0.729	48.1 ± 13.9	53.0 ± 11.6	0.078

CPM, continuous passive mobilization.

Table 8b. CPM versus manual therapy: range of motion (in degrees)

Study	External Rotation at 90° of Abduction			Internal Rotation at 90° of Abduction			Abduction		
	CPM	Manual	*P* Value	CPM	Manual Therapy	*P* Value	CPM	Manual Therapy	*P* Value
Garofalo et al[6]	NR	NR	NR	NR	NR	NR	90 ± 2.5	88 ± 1.8	>0.5
Lee et al[9]	77.7 ± 11.6	76.3 ± 12.1	0.778	54.9 ± 21.5	65.7 ± 13.3	0.057	161.8 ± 27.3	167.8 ± 12.8	0.884

CPM, continuous passive mobilization, NR, not reported.

Table 9. Early versus late mobilization: tendon retear rate (%)

Study	Mean Follow-up, mo	Early	Late	*P* Value
Arndt et al[1]	16	23.3	15.4	0.269
Cuff and Pupello[3]	12	15	9	0.47
Düzgün et al[4]	6	NR	NR	NR
Keener et al[7]	24	10	6	0.46
Kim et al[8]	12	NR	NR	NR

NR, not reported.

Strength

Strength data are summarized in Tables 7 and 8 for early versus late mobilization and CPM versus manual therapy, respectively.

Tendon Retear Rate

For studies comparing early and late mobilization, 2 studies used ultrasound[3,7] and 1 study used arthro–computed tomography[1] to evaluate tendon retear rates. All 3 studies found a higher tendon retear rate in the early mobilization group relative to the late mobilization group, but none of the differences were statistically significant (Table 9).

Lee et al,[9] using magnetic resonance imaging, found a statistically nonsignificant higher tendon retear rate in the manual therapy group relative to the CPM group at final 24-month follow-up (Table 10).

DISCUSSION

Published data do not definitively demonstrate a significant clinical difference between patients who undergo early versus late mobilization and between patients who undergo CPM versus manual therapy.

Although all 5 studies that investigated early versus late mobilization reported functional scores, there was considerable study heterogeneity. In general, there exists a possible benefit from early mobilization at early follow-up, but results are equivocal at later follow-up.

Table 10. CPM versus manual therapy: strength (in kg unless noted otherwise)

Study	Mean Follow-up, mo	Forward Flexion			External Rotation			Internal Rotation			Tendon Retear Rate		
		CPM	Manual	*P* value	CPM	Manual	*P* value	CPM	Manual	*P* value	CPM	Manual Therapy	*P* value
Garofalo et al[6]	12	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lee et al[9]	12	7.33	7.76	0.227	7.62	7.94	0.542	8.44	8.90	0.450	8.8%	23.3%	0.106

CPM, continuous passive mobilization; NR, not reported.

Regarding pain, the literature generally shows no significant difference between early and late rehabilitation in terms of pain as measured by visual analog scale (VAS) pain scores. Only 1 study found a lower VAS pain score in the early mobilization group at 5- and 16-week follow-up, but not at final 6-month follow-up.[4]

Similarly, the literature generally does not demonstrate a significant difference between early and delayed mobilization in terms of range of motion. Three studies found significantly greater forward flexion and external rotation range of motion in the early mobilization group relative to the late mobilization group, but only at early follow-up (6 months or less).[1,3,7] Only 1 study reported consistently better external range of motion at each follow-up for the early mobilization group.[1] Similar to the functional outcome score results, range of motion results showed a possible improved outcome at early follow-up with early mobilization and equivocal results at later follow-up.

Only 1 article comparing early versus late mobilization reported strength as an outcome and did not find a significant difference.[7]

The authors consistently found a statistically nonsignificant trend of higher retear rates among patients undergoing early mobilization relative to those undergoing late mobilization. The higher rate of rotator cuff retears among patients undergoing early mobilization may still be clinically significant, especially as these studies were not powered to detect a significant difference between study groups in terms of retear rates. However, the true clinical significance of postoperative rotator cuff retears is unclear. Studies have implicated male sex, older age, and larger initial tear size as risk factors for recurrent rotator cuff tears.[12,15]

The paucity of studies comparing CPM versus manual therapy precludes the ability to draw any meaningful conclusion regarding the efficacy of CPM. The literature shows superior results in terms of functional scores, at early 3-month follow-up only, for the manual therapy group relative to the CPM group.[9] However, patients undergoing CPM had lower pain levels at early 2.5-month follow-up only,[6] and a nonsignificant higher retear rate was observed in the manual therapy group.[9] The clinical significance of these differences at early follow-up only is unclear.

The strengths of this systematic review include the adherence to strict inclusion and exclusion criteria, the analysis of level 1 studies only, and the high number of patients (572) included in the final analysis. In addition, the authors used 2 independent reviewers and the CONSORT 2010 checklist[17] to ensure the inclusion of high-quality data.

There are several limitations to this study. First, there was heterogeneity among the included studies in terms of patient demographics, tear characteristics, rehabilitation program protocols, outcome assessment tools, and imaging modalities used to determine retear rates. This heterogeneity among individual study designs precludes data analysis through meta-analysis. The final analysis only included 7 studies identified through a single database, which may not be generalizable to current clinical practice.

CONCLUSION

Based on the current literature, timing of mobilization and the use of CPM after arthroscopic rotator cuff repair do not significantly affect clinical outcomes at early to midterm follow-up.

Clinical Recommendations

SORT: Strength of Recommendation Taxonomy
A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
Clinicians should exercise their best clinical judgment based on patient-specific factors such as patient age and initial size of tear when deciding between different rehabilitation strategies.	B

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