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ORIGINAL STUDY

Passive mobilization after arthroscopic rotator cuff repair is not detrimental in the early postoperative period

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This prospective randomized study compares the clinical results of immediate passive mobilization versus delayed mobilization in the rehabilitation of rotator cuff repair during the early postoperative period.

The mobilization group (79 patients) received immediate daily passive mobilization. The immobilization group (51 patients) was immobilized for 4 weeks until physiotherapy was started. Passive range of motion was noted preoperatively, at 6 weeks and 4 months. Strength was measured preoperatively and at 4 months. Constant-Murley, Simple Shoulder Test, SPADI and UCLA scores were noted at baseline and at 4 months. Ultrasonography was performed at 6 weeks to exclude early failures of repair.

We noted no significant difference between the two groups regarding range of motion at 6 weeks and range of motion, strength and functional outcome scores at 4 months. Ultrasound didn't show a difference in healing at 6 w in either of both groups.

Both rehabilitation protocols seem applicable as well as safe in the early post-operative phase.

Level of evidence : Level 1, randomized prospective trial.

Keywords : arthroscopy ; rehabilitation ; shoulder ; rotator cuff repair.

INTRODUCTION

Patients undergoing rotator cuff repair (RCR) are eligible to be treated with different postoperative rehabilitation protocols (*2,4,7,8,10,13,20*). Rotator cuff repairs are usually fitted in an abduction pillow for 4 to 6 weeks. In this period, immediate daily passive mobilization physical therapy might reduce the risks of early postoperative stiffness but could impair the structural integrity of the rotator cuff repair site in the early healing phase (*10*). Alternatively, temporary strict immobilization in the pillow without any physical therapy or passive exercise should limit the risks of early failure of the footprint repair but may enhance the risk of postoperative stiffness (*7,13*). In this prospective randomized trial a

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comparison is made between the early outcomes and risks in both groups. We hypothesized that there might be a delay of recuperation of range of motion and power in the immobilization (IM) group at 4 months, as well as a higher rate of impaired healing on US at 6 weeks in the early mobilization (MO) group.

MATERIAL AND METHODS

Inclusion and exclusion criteria

Between February 2008 and May 2011 594 patients were eligible for an arthroscopic RCR. From those a cohort was withdrawn after consent, applying in- and exclusion criteria and with approval of the ethical board. Inclusion criteria were completely repairable tears from small to large proportions, repaired by either single or double row technique. An acromioplasty was performed at all times. The size of tears and fixation techniques were equally distributed throughout both groups. Informed consent was given for randomization to either of both. Exclusion criteria were isolated subscapularis repairs, massive tears or tears involving margin convergence techniques, incompletely repaired tears, repair of partial thickness tears, revision cases, concomitant glenohumeral osteoarthritis and preoperative adhesive capsulitis. A total of 130 consecutive patients who met the inclusion criteria and fully completed the 4 months follow up period are presented.

Rehabilitation protocol

All patients received a postoperative abduction (30°) pillow brace for 4 weeks day and night and 2 more weeks only at night. It was allowed to remove the pillow for hygienic purposes and 3 times a day to do some pendulum exercises (maximum 10 minutes, diameter 20 cm) for both groups. The MO group started physical therapy at day 1 under guidance of their own physical therapist following a standardized scheme with daily controlled passive mobilization exercises (5 days a week) consisting of abduction, forward flexion and external / internal rotation as tolerated and scapulothoracic mobilization exercises. Specific capsular glenohumeral exercises and active-assisted shoulder exercises were started at week 5 progressively. At week 8, muscle strengthening was allowed progressively. The IM group was continuously immobilized in the brace for 4 weeks except for the pendulum exercises. Gradual passive mobilization was started from week 5 on a self-administered basis and after 6 weeks a similar protocol was used as group MO under guidance of their physical therapist.

Evaluation

Two independent physical therapists specialized in shoulder rehabilitation performed blinded assessments of passive range of motion, muscle force and functional outcome measures at baseline, 6 weeks and 4 months post operatively. Preoperatively, a Simple Shoulder Test (SST), Shoulder Pain And Disability Index (SPADI), Constant-Murray score (CM) and University of California at Los Angeles (UCLA) score were obtained. Normalised Constant-Murray scores were obtained to adjust for gender- and age-matched function of the shoulder *(6)*. Passive range of motion was noted for forward elevation, abduction in the plane of the scapula, external rotation with the arm at the side and internal rotation. At six weeks, passive range of motion was again noted and an experienced musculoskeletal radiologist performed an ultrasound (US) examination to rule out early failure of the cuff repair site. The examination was performed at 6 weeks after the initial period of different rehabilitation – immobilization vs. immediate mobilization – ended for both groups . We assumed that possible detrimental effects of early mobilization would be detectable at this stage. The high-resolution US evaluation was performed using a General Electric system Logic E9 and a variable high-frequency linear array transducer (6-15 MHz). The US imaging was performed with the patient seated and the shoulder extended, the elbow flexed, and the hand on the iliac wing. The transducer was oriented parallel to the supraspinatus tendon to visualize the fibers in the longitudinal plane and rotated 90° to evaluate the tendon in the transverse plane. If the rotator cuff could not be visualized because of tearing and retraction under the acromion, or if a focal defect was evident, this was classified as a recurrent tear. If no tear was visualized, the transducer was used to compress the deltoid against the rotator cuff tendon to ensure the tendon did not separate, which would indicate a non-retracted recurrent tear. Four months postoperatively SST, SPADI, CM and UCLA scores were repeated, passive range of motion assessed and patient satisfaction noted as “satisfied” or “not satisfied”. The range of motion measurements were subject of a standardized measurement protocol with a goniometer. Force measurements were performed by a “MicroFET2” hand-held dynamometer (N) (Force Evaluating and Testing-system, Hoggan Health Industries Inc.).

Statistical analysis

All statistical analyses were performed using the SPSS software package (version 19.0, SPSS Inc., Chicago, Illinois), and a P value less than .05 was taken as the level of statistical significance. Baseline characteristics were measured for both groups. P values were calculated with Fisher exact test for gender and with Mann-Whitney U test for age. An independent t-test was used to evaluate differences between the 2 groups for passive range of motion, strength and functional scores (Constant Murley, Normalized Constant Murley, Simple Shoulder Test, Shoulder Pain and Disability Index and UCLA Shoulder rating scale). Pre- and postoperative significance for the functional outcome scores was determined with a paired t-test. The Fisher exact test was used to compare US results and subjective satisfaction measurements.

RESULTS

130 patients completed the full evaluation. The MO group consists of 79 patients with a mean age of 64,6 y and 38/41 male-female ratio. The IM group consists of 51 patients with a mean age of 65,1 y with a 21/30 male-female ratio. There were no significant differences between the 2 groups for demographics (Table I), neither for passive range of motion preoperatively as well as postoperatively at 6 weeks and 4 months (Table II). At 6 weeks the average anteflexion was 108° in the IM group versus 109° in the MO group (P = .65). Abduction was 97° in the IM group versus 100° in the MO group (P = .16). External rotation with the arm at the side was 27° (IM) versus 30° (MO) (P = .36), with also minor differences in external rotation with the arm abducted. Internal rotation at 6 weeks valued 43° in the IM group and 45° in the MO group (P = .44). At the final evaluation at 4 months the average anteflexion was 141° for the IM group and 139° for the MO group (P = .49). These values returned to their preoperative values, 142° for the IM group and 140° for the MO group. The average abduction at 4 months was 130° for the IM group and 128° for the MO group (P = .65), comparable with their preoperative values, 128° for the IM and 130° for the MO group. External rotation in adduction resulted in an average of 46° for both groups after 4 months (P = .97) and 64° at 90° abduction for both groups (P = .87). The average internal rotation in 90° shoulder abduction after 4 months was 64° for the IM group and 62° for the MO group (P = .55). Force measurements didn't differ significanty at 4 months for anteflexion, abduction, external rotation or internal rotation (Table III). No significant differences were found between the 2 groups regarding the functional outcome scores, including Constant Murley and Normalized Constant Murley, SST, SPADI and UCLA (Table IV) scores at 4 months postoperatively. All tests significantly improved after arthroscopic rotator cuff repair (P < 0,05). The US examination of the rotator cuff at 6 weeks postoperatively revealed an intact repair in 96% in the IM group. Two patients had a questionable ultrasound image with a small defect without retraction in the transverse plane. In the MO group, all patients had an US evaluation without signs of repair failure 6 weeks after the arthroscopic RCR. At 4 months a satisfaction score of 86% was obtained in the IM group and 92% was satisfied in MO group without significant difference between both groups (P = .37). No significant complications were noted, except for the cases with postoperative stiffness, delaying complete recovery of mobility.

Table I. — Baseline Clinical Characteristics

	Baseline Clinical Characteristics	
	IM	MO
No. off patients, n	51	79
Gender (Male)	41	48
Age, n (SD)	65.1 (9.7)	64.6 (10.0)

IM, Immobilization Group ; MO, Mobilization Group.

DISCUSSION

Rehabilitation after RCR is balancing between protection of the repaired cuff to enhance footprint healing and timely mobilization of the shoulder to avoid stiffness and to restore normal shoulder kinematics. Rehabilitation protocols after arthroscopic cuff repair are usually either progressive or conservative. Most patients are fitted in an abduction pillow for 4 to 6 weeks. In this time period, progressive surgeons start immediate daily passive

Table II. — Range of Motion (Degrees)

	Range of Motion (Degrees)		
	IM	MO	P-value
Anteflexion			
Pre (SD)	142.39 (25.87)	140.03 (23.41)	0.59
6 wk (SD)	107.82 (15.56)	109.22 (18.06)	0.65
4 m (SD)	141.33 (17.73)	139.22 (16.75)	0.49
Abduction			
Pre (SD)	127.76 (26.41)	129.57 (27.34)	0.71
6 wk (SD)	96.74 (13.25)	100.15 (15.08)	0.16
4 m (SD)	129.57 (18.74)	127.96 (20.19)	0.65
External Rotation (0° Abduction)			
Pre (SD)	56.80 (23.95)	53.99 (23.25)	0.50
6 wk (SD)	27.43 (12.05)	29.89 (16.36)	0.36
4 m (SD)	46.27 (14.67)	46.18 (17.34)	0.97
External Rotation (90° Abduction)			
Pre (SD)	74.63 (19.24)	72.78 (19.49)	0.60
6 wk (SD)	31.90 (14.05)	30.29 (17.06)	0.58
4 m (SD)	63.53 (16.60)	64.24 (17.38)	0.87
Internal Rotation (90° Abduction)			
Pre (SD)	49.10 (22.32)	51.11 (23.99)	0.63
6 wk (SD)	42.59 (17.60)	44.92 (15.93)	0.44
4 m (SD)	64.49 (21.34)	62.47 (16.83)	0.55

IM, Immobilization Group ; MO, Mobilization Group ; SD, Standard Deviation ; Pre, Preoperative ; 6 wk, 6 Weeks ; 4 m, 4 Months.

mobilization physiotherapy. This might reduce the risks of early postoperative stiffness but could impair the structural integrity of the RCR site (*10*). Conservative surgeons rely on temporary strict immobilization in the pillow without any physiotherapy or passive exercises in this period, in order to limit the risks of early failure of the footprint repair (*13*). However, this might increase early postoperative stiffness.

In a rat model Thomopoulos *et al* (*18*) found that postoperative immobilization resulted in superior tendon to bone healing properties. Sarver *et al* (*17*) demonstrated that the increase in joint stiffness after immobilizing an injured and repaired rat shoulder was transient and, therefore, doesn't outweigh the long-term benefits of immobilization on improved tendon to bone healing.

In 2009 Peltz *et al* (*14,15*) unexpectedly found a decrease in passive joint mobility in a passive mobilization group versus continuous immobilization after RCR in rats. Differences in range of motion and joint stiffness remained even after four weeks of remobilization. They speculated that an excessive scar formation around the insertion site was accountable due to micro tearing during repetitive mobilizations. So, in their rat model, Soslowsky and colleague's (*3,14,15,17,18*) seem to have demonstrated that an early post operative mobilization protocol appears to have detrimental effects on the repair site and on the post operative range of motion leading to higher risks of post operative stiffness.

Several human studies have been performed in recent years that mainly compare the clinical differences between different rehabilitation protocols after RCR. Lastayo *et al* (*10*) randomly assigned 31 patients after rotator cuff repair into two groups during the first four weeks : continuous passive motion or manual passive motion exercises. After-

Table III. — Strength (N)

	Strength (N)		
	IM	MO	P-value
Anteflexion			
Pre (SD)	60.84 (31.82)	68.62 (84.43)	0.53
4 m (SD)	74.96 (42.27)	74.04 (29.77)	0.88
Abduction			
Pre (SD)	105.16 (47.78)	97.75 (48.55)	0.39
4 m (SD)	91.22 (41.27)	97.61 (36.18)	0.35
External Rotation			
Pre (SD)	63.76 (25.76)	62.30 (29.39)	0.77
4 m (SD)	66.06 (25.13)	70.71 (25.51)	0.31
Internal Rotation			
Pre (SD)	98.78 (45.89)	109.75 (42.78)	0.17
4 m (SD)	112.53 (44.85)	122.80 (37.09)	0.16

IM, Immobilization Group ; MO, Mobilization Group ; SD, Standard Deviation ; Pre, Preoperative ; 4 m, 4 Months.

wards all patients received a similar program. No significant difference could be noted between the two groups. In a similar paper by Hayes *et al* (*4*) no differences were demonstrated in passive range of motion, muscle force and functional outcomes in 58 patients after RCR either allocated to rehabilitation via individualized physiotherapy or a standardized home exercise regime.

Other studies aim to identify predisposing factors for postoperative stiffness in order to tailor an adapted postoperative regimen to the specific patient needs (*5,8,9,13,19,20*). A retrospective study by Trenerry *et al* (*19*) shows that restriction of preoperative hand behind back motion is the best predictive factor for the development of shoulder stiffness after RCR. If shoulder stiffness did occur, it resolved after 76 weeks. Koo *et al* (*8,9*) showed the risk of postoperative stiffness after RCR to be 4.9% and recommend a conservative rehabilitation protocol for tears greater than 5 cm or a combination of two tendons. Patients with a higher risk of postoperative stiffness (coexisting calcific tendinitis, adhesive capsulitis, PASTA-type tear, concomitant labral repair and single tendon repair) are eligible for a more accelerated rehabilitation program (*5*). Although stiffness is the most common complication following RCR, it is easily treatable and much easier to overcome than recurrent cuff tears caused by to aggressive postoperative rehabilitation (*8*). Van der Meijden *et al* (*20*) described a rehabilitation protocol that is either conservative or moderate based on the currently available literature and guided by the surgical findings : the protective protocol is reserved for tears greater than 5 cm or involving more than 2 tendons, poor tissue quality or repairs with greater tension.

Two recent studies have a similar set up as our paper. Kim *et al* (*7*) subdivided 105 patients in two groups with a similar active versus passive rehabilitation protocol as our study, showing no advantage in immediate passive mobilization for either early gain of range of motion or clinical outcome. Cuff *et al* (*2*) came to a similar conclusion. They enrolled 33 patients in an early passive mobilization protocol and 35 in the delayed range of motion group who only started physical therapy at 6 weeks. The authors demonstrated no significant advantage for early passive range of motion after arthroscopic rotator cuff repair.

In this study we didn't find any significant delay in passive range of motion at 6 weeks or 4 months for the group with initial immobilization as was also previously shown by Kim and Cuff. Force measurements were also performed and we didn't note a

Table IV. — Functional Outcome Scores

Functional Outcome Scores												
	Constant Murley				*Simple Shoulder Test*			*Shoulder Pain And Disability Index*			*UCLA Score*	
	Pre	N Pre	4 m	N 4 m	Pre	%	4 m	Pre	%	4 m	Pre	4 m
IM (SD)	69.55 (19.01)	80.80 (21.08)	75.16 (15.26)	90.36 (18.37)	6.29 (2.92)	52.47 (24.36)	9.02 (2.52)	62.51 (24.67)	48.08 (19.03)	18.90 (18.73)	18.65 (5.13)	26.51 (5.79)
MO (SD)	67.54 (19.25)	77.61 (21.59)	75.98 (12.47)	85.92 (15.72)	6.73 (2.77)	55.39 (23.08)	9.44 (2.19)	59.06 (24.92)	45.46 (19.22)	21.01 (20.95)	18.00 (5.14)	26.90 (5.41)
P-value	0.56	0.41	0.74	0.14	0.38	0.49	0.31	0.44	0.45	0.56	0.48	0.70

IM, Immobilization Group ; MO, Mobilization Group ; SD, Standard Deviation ; Pre, Preoperative Value ; N, Normalised Constant Murley ; 4 m, 4 Months.

difference 4 months post operatively between both groups. US healing at 6 weeks revealed a small defect without retraction in only 2 patients of the immobilization group although without repercussion in further follow up. Some gap formation with incomplete healing at 6 weeks could account for this image. Conversely, early mobilization did not seem to have a negative effect on tendon healing in any of our patients, thereby refuting our hypothesis. Although all clinical outcome scores had a significant improvement after rotator cuff repair no significant difference could be noted between the two groups after their repair. Force measurements showed that neither a progressive nor conservative approach after arthroscopic rotator cuff repair is of influence post operatively. The limitations of our study are that the compliance of the patients and physiotherapists to adhere strictly to the prescribed protocol may always be disputed in this type of study. Also the relatively short follow-up of 4 months and the use of US evaluation at 6 weeks may be subject to debate. The purpose of the study was to compare the relative risks of early tendon to bone failure at 6 weeks versus the risks of postoperative stiffness, as well as the difference in early function at 6 weeks and 4 months, when supervised rehabilitation usually ends in our department for uncompromised cases. Further improvement of functional scores over 1 year though is to be expected (*1*). The value of US can be disputed versus MRI, although US is widely used in evaluation of rotator cuff repair (*11,12,16*) and MRI at 6 weeks could not be systematically granted for. Regarding the timing of the US evaluation, we believe that the effect on repair site integrity between the 2 different protocols should be evaluated at the moment where both protocols ceased to be a different risk for the structural integrity at the repair site. Although there are certainly arguments for a later evaluation, our aim was to look at the influence of a different rehabilitation protocol in RCR in an early postoperative phase. We believe that possible differences found in US evaluations later in time cannot be clearly attributed to a difference in rehabilitation protocol. The strengths of this paper are the prospective randomized design and the multiple outcome scores all-pointing in the same direction.

CONCLUSION

In this paper we presented our results of 2 different rehabilitation protocols in the early postoperative phase of RCR. We didn't note a significant difference in subjective and clinical results between both groups at 6 weeks and 4 months. Early failure of cuff healing at 6 weeks could not be demonstrated in the early mobilization group as well as postoperative stiffness wasn't significantly increased in the delayed rehabilitation group. Early passive mobilization protocols as well as delayed mobilization protocols seem applicable and safe.

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