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The effect of mulligan mobilization on pain and life quality of patients with Rotator cuff syndrome: A randomized controlled trial

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Abstract.
BACKGROUND: Mulligan mobilization techniques cause pain and affect the function in patients with Rotator cuff syndrome.
OBJECTIVE: The aim of the study was to investigate the effect of Mulligan mobilization on pain and quality of life in individuals with Rotator cuff syndrome.
METHODS: This study was conducted on 30 patients with Rotator cuff syndrome. The patients were randomized into Mulligan and control group. All the patients participating in this study were treated with conventional physiotherapy. Additionally, the Mobilization with movement (MWM) technique was used in the Mulligan group. Visual Analog Scale (VAS), Disabilities of the Arm, Shoulder, and Hand (DASH), goniometer for the normal range of motion (ROM) and Short Form-36 (SF-36) questionnaires were used for assessment.
RESULTS: Statistically significant improvement was found in the post-treatment VAS, DASH, SF-36, and ROM values significantly improved in both groups ($p < 0.05$). However, the Mulligan group showed much better results when compared to the control group in ROM, VAS, DASH ($p < 0.05$). In the SF-36 questionnaire, significant results were obtained for both groups, except the social function parameter. For the SF-36 parameters, both groups performed equally.
CONCLUSIONS: Mulligan mobilization was more effective than general treatment methods for pain as well as normal joint motion, DASH scoring and some parameters of SF-36 compared with general treatment methods.

Keywords: Rotator cuff syndrome, Mulligan mobilization, pain, quality of life

1. Background

The rotator cuff is generally formed by the compression between the humerus and the coracoacromial arc of the long head of the subacromial bursa and biceps tendon in the subacromial space. It is the most common cause of shoulder pain [1]. Rotator cuff syndrome can be caused by acromion-related, coracoid-attached, bursa-related, rotator cuff-bound, or overall shoulder misuse [2]. Exposure of rotator cuff muscles to a variety of factors such as traction, compression, contusion, subacromial abrasion, inflammation, injection, and age-related degeneration affect tendonitis and proteoglycan content in tissues. Patients with SIS are examined by means of medical history and physical assessment. The patients' symptoms, such as pain, limited mobility, and decreased strength, may lead to a diagnosis of SIS. However, these assessments should be reinforced with tests for more clear and precise diagnoses [3]. Although there are several ways to treat Rotator cuff syndrome, the main objective is to reduce

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pain and improve function. There are many treatment options that focus on improving the ROM. Conservative treatment methods are among the first-line treatment options, i.e. non-steroid pain relievers, steroid injections and physiotherapy modalities [4,5]. The most common exercise and joint mobilization methods are preferred in physiotherapy applications [6–8]. One of the methods used for joint mobilization is Mulligan mobilization. The Mulligan concept is a mobilization technique of the joint in a weight-bearing position involving continuous gliding and continuous active movement [9]. The Mulligan mobilization technique involves several techniques such as natural apophyseal shift (NAGS), continuous natural apophyseal shift (SNAGS) and motion with mobilization (MWM) techniques. In MWM, the direction of application of force is selected according to the forces generated in the joints. Then, the most appropriate and effective force will improve the ROM [10]. The most influential factors for that decision are the shape of articular surfaces in the joint, alignment of cartilage tissue, ligament and capsule fibrils, direction of muscles and tendons. The main objective of this technique is to correct the biomechanical impairment of the intended joint. During the normal motion, the compression forces are minimized to control the motion. Any changes that may occur in the joint affect the proprioceptive recycling mechanism. Thus it is aimed to correct this mechanism by Mulligan mobilization. Therefore, the main purpose of this study was to examine the effects of Mulligan mobilization techniques on pain, ROM and quality of life.

2. Methods

A randomized, single blind controlled clinical trial was developed, consisting of two treatment groups.

2.1. Study design

The study population was comprised of 30 patients diagnosed with Rotator cuff syndrome. Randomization was done by putting a closed box of 15 pieces of paper with number 1 and 15 pieces of paper with number 2 (30 in total). A random paper was drawn for the participants included in the study. Participants with paper number 1 were placed in the Mulligan group, participants with paper number 2 were placed in the control group. The trial was approved by the Istanbul Medipol University Ethical Committee (no. 261). The participants were informed about the study and had to provide written informed consent.

Inclusion criteria:

- Between the age of 30 and 70
- Partial rupture and suffering from Rotator cuff syndrome
- No shoulder surgery

Exclusion criteria:

- Any orthopedic injury and cardiac problems preventing the use of assessment methods
- A recent myocardial infarction or major shoulder trauma

Initially, forty voluntary patients who met the criteria for the study were recruited and randomly divided into two groups (Fig. 1). During the trial, four patients from the control group and seven patients from the Mulligan group were unable to complete the study due to various reasons. Therefore, the study was completed with a total of 30 participants equally divided in the control group and the Mulligan group.

2.2. Outcome measures

Sex, age, time from onset of injury, dominant or nondominant affected side, type of injury (tendinitis, tendinosis or partial tear), VAS score, ROM assessments, DASH score and SF-36 score were recorded before and after assessment.

2.2.1. Pain

The VAS is a simple and frequent measurement of the severity of pain [8]. Patients are generally requested to mark the severity of their pain on a 100 mm vertical line. The lowest limit is the minimum amount of pain and the uppermost limit is the maximum amount of pain [8].

2.2.2. Range of motion

Universal goniometer is used to measure the joint position and joint ROM [11]. Measurements were based on Kendall and American Association of Orthopedic Surgeons [11]. In this study, the ROM of the shoulder flexion, extension, abduction, internal rotation, and external rotation were measured with a goniometer.

2.2.3. Functionality

DASH, which was introduced by the American Academy of Orthopedic Surgeons and other organizations, is a measurement of physical limitations and

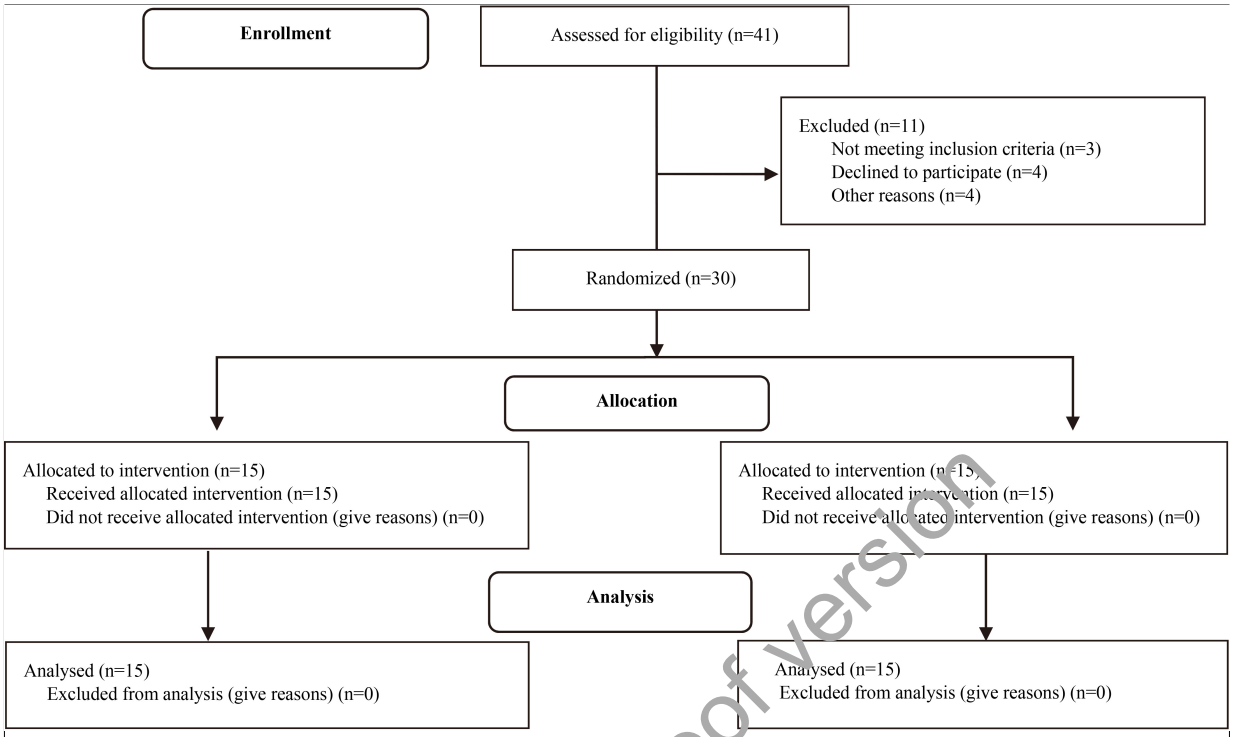

Fig. 1. Patients selection.

function in upper extremity problems [12]. The DASH survey has three sub-parameters. The first part contains 30 questions; 21 questions measure the difficulty of the patient's daily life functions, 5 questions measure the symptoms and 4 other questions usually measure social function, work, sleep and patient's self-confidence [12].

2.2.4. Quality of life

Daily living activities were assessed using the Short Form 36 (SF-36). This is an evaluation scale consisting of 36 items that investigate 8 dimensions of health [13]. Eight sections including physical and mental state; physical function, social function, movement limitations (depending on physical and emotional reasons), mental health, vitality (energy), pain and health. Each scale contains between 2 and 10 items and the scoring is between 0% and 100%. The 0% demonstrates the extreme disability level and 100% demonstrates that the patient experiences no problems [14].

2.3. Intervention

All participants were divided into two groups based on the treatment method. Both groups were treated for 6 weeks.

2.3.1. Control group

In this group, traditional physiotherapy applications were applied, such as stretching exercises, cold pack, ultrasound Transcutaneous Electrical Nerve Stimulation (TENS), finger staircase, Codman and wand exercises.

2.3.2. Exercise program

After the participants were assessed, they were taken to the 6-week exercise program specifically once a day for 5 days a week. Initially, wand exercises were applied in this programme followed by Codman exercises, finger stairs, shoulder handwheel and shoulder capsule stretching exercises. Flexion, abduction, extension, external and internal rotation stretching in the direction of the shoulder were applied. Stretching exercises were applied with 5 repetitions in each direction and hold 20 seconds and capsular stretching exercises were added. Also, strengthening exercises were continued with theraband depending on the circumstances of the participants. Shoulder flexion, abduction, extension, external and internal rotation strengthening exercises with theraband were used with 3 sets of 10 repetitions. Resting time between two sets was one minute for each exercise.

Ultrasound of 1.5 MHz in 6 minutes and TENS of 100 Hz in 20 minutes were applied in both groups.

2.3.3. Mulligan group

In addition to the traditional physiotherapy applications, active accessory mobilizations of the humeral head using the MWM technique were carried out in flexion, abduction, external and internal rotation directions. For this technique, participants were seated on a stretcher, and the physical therapist was standing opposite of the upper extremity that would be treated. The internal hand of the physical therapist stabilized participants' shoulder girdle and, with the thenar eminence of the other hand, performed a glide of the humeral head (this direction is the most suitable for treating such shoulder limitations). Participants were asked to flex the affected shoulder until the pain started while the physical therapist sustained the gliding force to the humeral head. The physical therapist tried to maintain the glide at right angles to the plane of movement throughout the entire range while participants were requested to perform an active movement. Participants were instructed that MWM, including shoulder movement, must be pain-free and should be immediately stopped if any pain was experienced during the treatment.

The MWM technique lasted around 20 minutes, in 3 sequences of 10 repetitions with a rest interval of 30 seconds between each sequence.

2.4. Statistical analysis

Statistical analysis of the data was performed using the Statistical Package for the Social Sciences (SPSS) 16.0 program. Numerically measured data are expressed as percentage, mean, standard deviation and standard error average. The normal distribution of the data was determined by One Sample Kolmogorov Smirnov test (Chart 2). The study used Wilcoxon for the efficacy of the pre-treatment and post-treatment program independent groups and Mann Whitney-U test for the efficacy of the program, as p values ($p = 0.05$) of the study were greater than 0.05 (normal distribution). The results of the pre-treatment and post-treatment program were considered significant if p values were smaller than 0.05 but insignificant if they were greater.

3. Results

Participants were similar with respect to demographic and clinical characteristics. An overview of the distribution included variables is provided in Table 1. No differences were found between the groups. When compared with values of VAS, ROM, DASH, and SF-36 before treatment, there are no statistically significant differences in VAS and DASH between the Mulligan and control group ($p < 0.05$) but there were statistically significant differences in some parameters of ROM and SF-36 (Table 2). However, pre-treatment ROM measurements of the shoulder in Mulligan group is lower than the control group. Table 3 shows the pre- and post-treatment results of VAS, ROM, DASH and SF-36 scores within the same groups and difference analysis between groups. Both groups were found to have statistically significant differences in VAS, the ROM of the shoulder, DASH and SF-36 results in pre- and post treatment ($p < 0.05$). When the treatment efficacy was compared between the two groups, VAS rest and activity scores, ROM of shoulder and DASH scores in Mulligan group were found to better than the control group ($p < 0.05$). In addition, in terms of SF-36 change values, no statistically significant difference was found between the groups except for the social function parameter. Parameters of SF-36 except social

Table 1
Comparison of demographic characteristics of groups

	Mulligan group	Control group
Sex (M/F)	8/7	10/5
Age	51.73 ± 6.64	50.26 ± 4.28
Affected shoulder n (%)		
Right	7 (46)	8 (53)
Left	8 (53)	7 (46)

Table 2
Comparison of pre-treatment values between the 2 groups

	Mulligan group mean ± SD	Control group mean ± SD	p-value
VAS resting	5.93 ± 2.86	4.86 ± 2.66	0.33
VAS activity	8.60 ± 1.40	8.60 ± 0.91	0.68
Shoul. flex. ROM	104.33 ± 21.61	125.00 ± 25.28	0.02
Shoul. ekst. ROM	18.33 ± 6.96	32.00 ± 7.97	0.00
Shoul. abd. ROM	97.00 ± 17.20	113.33 ± 22.01	0.04
Shoul. ER. ROM	25.00 ± 10.52	49.33 ± 23.51	0.00
Shoul. IR. ROM	46.00 ± 13.65	56.33 ± 23.25	0.21
DASH	53.92 ± 11.56	53.19 ± 15.09	0.54
SF-36-PF	67.66 ± 13.34	53.00 ± 20.33	0.04
SF-36-RP	26.66 ± 29.07	21.66 ± 31.14	0.42
SF-36-BP	30.13 ± 20.19	30.13 ± 17.58	0.95
SF-36-GH	62.53 ± 14.34	60.86 ± 16.70	0.57
SF-36-VT	62.80 ± 13.32	47.40 ± 21.72	0.02
SF-36-SF	60.53 ± 23.65	66.46 ± 25.87	0.48
SF-36-RE	53.06 ± 37.35	37.40 ± 21.11	0.21
SF-36-MH	76.53 ± 9.66	66.20 ± 16.59	0.04

SD: Standart Deviation; VAS: Visual Analog Scale; ROM: Range of Motion; DASH: The Disabilities of the Arm, Shoulder and Hand Index; SF-36: Short Form (36); PF: Physical Function; RP: Role-Physical; BP: Bodily Pain; GH: General Health; VT: Vitality; SF: Social Function: RE: Role-Emotional; MH: Mental Health.

Table 3
Comparison of changes in outcome measures within and between 2 groups

Variable	Mulligan group			Control group			Groups I–II		
	Pre-tre	Post-tre	p	Pre-tre	Post-tre	p	Mulligan. group Diff. Mean (SD)	Cont. group Diff. Mean (SD)	p
VAS resting	5.93 ± 2.86	0.73 ± 1.16	0.00	4.86 ± 2.66	1.80 ± 1.82	0.00	5.20 ± 2.03	3.06 ± 1.36	0.00
VAS activity	8.60 ± 1.40	2.46 ± 1.72	0.00	8.60 ± 0.91	5.60 ± 1.12	0.00	6.14 ± 0.32	3 ± 0.30	0.00
Shoul. flex. ROM	104.33 ± 21.61	174.33 ± 6.22	0.00	125.00 ± 25.28	157.33 ± 18.69	0.00	70 ± 18.61	32.33 ± 13.74	0.00
Shoul. ekst. ROM	18.33 ± 6.98	41.33 ± 3.99	0.00	32.00 ± 7.97	40.66 ± 3.71	0.00	23 ± 7.97	8.66 ± 6.11	0.00
Shoul. abd. ROM	97.00 ± 17.80	171.67 ± 6.98	0.00	113.33 ± 22.01	144.67 ± 20.91	0.00	74.66 ± 14.20	31.33 ± 11.56	0.00
Shoul. ER. ROM	25.00 ± 10.52	83.00 ± 7.27	0.00	49.33 ± 23.51	71.00 ± 17.64	0.00	58.00 ± 10.48	21.66 ± 13.45	0.00
Shoul. IR. ROM	46.00 ± 13.65	86.33 ± 6.67	0.00	56.33 ± 23.25	71.66 ± 15.43	0.00	40.33 ± 14.69	15.33 ± 15.29	0.00
DASH	50.92 ± 11.56	17.87 ± 11.53	0.00	53.19 ± 15.09	33.23 ± 13.77	0.00	33.05 ± 13.14	19.36 ± 14.95	0.01
SF-36-PF	67.66 ± 13.34	83.00 ± 12.36	0.00	53.00 ± 20.33	74.66 ± 20.91	0.00	15.34 ± 12.31	21.66 ± 18.96	0.28
SF-36-RP	26.66 ± 29.07	70.00 ± 31.62	0.00	21.66 ± 31.14	48.33 ± 34.67	0.00	43.34 ± 34.67	26.67 ± 25.81	0.14
SF-36-BP	30.13 ± 20.19	50.66 ± 21.70	0.00	30.13 ± 17.58	55.86 ± 16.48	0.00	20.53 ± 17.40	25.73 ± 18.41	0.43
SF-36-GH	62.53 ± 14.34	68.73 ± 17.97	0.16	60.86 ± 16.70	63.53 ± 13.57	0.44	6.20 ± 16.90	2.67 ± 11.49	0.50
SF-36-VT	62.80 ± 13.32	72.33 ± 16.46	0.01	47.40 ± 21.72	56.00 ± 22.21	0.05	9.53 ± 13.02	8.60 ± 15.79	0.86
SF-36/-SF	60.53 ± 23.65	87.33 ± 14.17	0.00	66.46 ± 25.87	72.33 ± 22.38	0.07	26.80 ± 24.51	5.87 ± 12.40	0.00
SF-36-RE	53.06 ± 37.35	68.33 ± 15.39	0.41	37.40 ± 21.11	42.00 ± 38.69	0.36	15.27 ± 41.51	4.60 ± 39.45	0.47
SF-36-MH	76.53 ± 9.66	80.00 ± 11.80	0.14	66.20 ± 16.59	70.93 ± 12.32	0.26	3.47 ± 8.92	4.73 ± 15.73	0.78

SD: Standart Deviation; VAS: Pre-tre: Pre Treatment; Post-tre: Post Treatment; p-diff value: difference value; Visual Analog Scale; ROM: Range of Motion; DASH: The Disabilities of the Arm, Shoulder and Hand Index; SF-36: Short Form (36); PF: Physical Function; RP: Role-Physical; BP:Bodily Pain; GH: Generel Health; VT: Vitality; SF: Social Function: RE: Role Emotional; MH: Mental Health.

function were changed in the same way in both groups (Table 3).

4. Discussion

The subacromial bursa and rotator cuff muscles are compressed between the acromion and the proximal humerus [15]. If the subacromial surface area decreases, degeneration and rupture occur in soft tissue. The pathology of the injury begins with bursitis and tendonitis inflammation and covers a wide area of fibrosis in bursal and partial or complete rotator cuff rupture [15]. Individuals with Rotator cuff syndrome who had only partial rupture were included in our study.

Ginn and Cohen found statistically that there was a reduction in pain intensity in the study of conservative methods (such as exercise therapy, passive joint mobilization, corticosteroid injection, electrotherapy) in patients with shoulder pain [16]. Kochar and Dogra also found that the efficacy of US treatment with Mulligan mobilization was more effective on the severity of the pain in a study which examined 66 patients with lateral epicondylitis [17]. Another study was performed on 30 patients with adhesive capsulitis, where 15 patient were treated with Mulligan mobilization and 15 patients were only supervised under a controlled exercise program. When the results were examined, there was a decrease in pain level in both groups. In the Mulligan mobilization group, the pain score decreased more [18]. Neelapala et al. studied 31 patients with shoulder pain and divided them in two groups. The first group followed a traditional exercise program and the second group used the MWM technique. At the end of 3 sessions, the Mulligan group had a further decrease in VAS value [19].

Ajit and Shika studied 15 people with the shoulder impingement syndrome. In the study, the effect of Mulligan mobilization (MWM) technique on acromiohumeral distance, pain level, and DASH were examined. As a result, there was a statistically significant decrease in VAS and DASH scores and a significant increase in acromiohumeral distance [20]. Our study showed similar results to this literature. In our study, there was a significant decrease in VAS scores in both groups. In the Mulligan mobilization group, VAS activity scores were much lower than those of the control group. In a study by Teys et al. on shoulder pain, 24 patients were divided into a group of Mulligan mobilization, a group of Sham, as well as a control group. When the results were examined, the Mulligan group increased by 16 degrees in the shoulder joint movement and by 4 degrees in the Sham group. In the control group, no increase in the ROM was observed [21]. Kachingwe et al. have performed four different treatment groups in a study of 33 patients with shoulder impingement. The first group followed exercises, the second group followed glenohumeral mobi-

lization and exercises, the third group followed Mulligan mobilization and exercises, and the fourth group only received patient education. When the treatment was completed, the ROM of the shoulder joint was increased in the glenohumeral (GH) mobilization group and the Mulligan mobilization group, but not in the other groups. The increase in the Mulligan group was more significant than the GH mobilization group [22]. In another study, 40 patients with adhesive capsulitis were examined. While the first group was performing traditional physiotherapy applications, the MWM technique was followed by the second group. In both groups, the internal rotator muscles of the participants were stretched. As a result, the internal rotation of the Mulligan group increased more in the ROM [23]. In our study, both the Mulligan and control groups showed an increase in the ROM of the active shoulder joint. The increase in shoulder EHA in the Mulligan mobilization group was greater than in the control group.

In the study conducted by Delgado-Gil et al. on patients with the shoulder impingement, the first group was applied for Mulligan mobilization and the second group was Sham mobilization for 2 weeks as 2 days per week. There was a statistically significant increase in painless shoulder flexion, maximum shoulder flexion and external rotation in the Mulligan group; where there was no change in shoulder extension, abduction and internal rotation [24]. In our study, Mulligan mobilization showed a statistically significant increase in all ROM of the shoulder. We could attribute an increase in the total ROM to a greater frequency of Mulligan mobilization in our results.

Guimarães et al. looked at the immediate effect of Mulligan mobilization on 27 patients with shoulder impingement syndrome. In that study, Mulligan mobilization for the first 4 sessions and Sham technique for the last 4 sessions were applied in a group. As opposed to the first group, another group used the Sham technique in the first 4 sessions, then used Mulligan mobilization in the last 4 sessions. At the end of the exercises, there was a significant increase in shoulder external rotation and abduction ROM in both groups [25]. Minerva et al. also performed another study on 60 patients with adhesive capsulitis. Maitland mobilization technique was applied to one group and MWM technique was applied to the other groups. In addition, both groups followed the exercise program. When the results were examined, there was a further decrease in pain level in the MWM technique group. When the literature is examined, there are many studies to increase the shoulder joint ROM of Mulligan mobilization [26]. Our study also proved that Mulligan mobilization improved shoulder joint motion.

In both groups, the conventional physiotherapy methods were applied: i.e. stretching exercises, cold pack, ultrasonics, TENS, wand, Codman exercises, shoulder posterior capsule stretching and strengthening exercises. In our results, although the classical physiotherapy treatment plan had positive effects on pain, ROM, DASH and SF-36 scores, more significant results were obtained when classical physiotherapy was combined with Mulligan mobilization. Perhaps if we had only applied the Mulligan mobilization technique, our results could not have been improved that much. In a systematic review to support this, studies investigating the effects of physiotherapy applications on patients with shoulder impingement were compiled. It has been shown that physiotherapy practices provided similar healing with electrophysiologic agents, shoulder ROM exercises, and upper extremity strengthening exercises when compared with shoulder surgery [27].

In another systematic review, TENS demonstrated a pain relief effect on rotator cuff tendinopathic patients. When used in conjunction with the US, both pain relief and joint ROM increased. Thus, we also used it together in our study to benefit from the synergetic effects of both US and TENS [28]. In another study in individuals with shoulder Rotator cuff syndrome, a group stretching and strengthening exercises were performed; manual therapy was also applied to the shoulder and neck region along with the other group exercise, and functional DASH score was evaluated. When the results were examined, it was seen that there was a similar decrease in DASH score in both groups [29]. In our study, both Mulligan and control groups were also statistically and significantly reduced.

Lombardi et al. studied 60 patients with subacromial impingement who underwent resistance training for shoulder muscles twice a week for 2 months. SF-36 questionnaire scores after treatment were reported to be significantly higher in the Mulligan group than in the control group [30]. When our results were examined, significant changes were observed in both groups, and the social function and vitality parameters of the Mulligan group were found to be statistically higher than those of the control group.

5. Conclusion

The distribution of age affected parties and genders of the participants in the study were similar in the Mul-

ligan and control groups. VAS, ROM, DASH and SF-36 scores before and after treatment were statistically evaluated. In conclusion, our study showed that Mulligan mobilization was much more effective than traditional treatment methods for pain, the ROM, DASH scoring and some parameters of SF-36.

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Conflict of interest

None to report.

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