THE EFFECTS OF CORE STABILIZATION EXERCISES ON PAIN AND FUNCTIONALITY IN PATIENTS WITH SHOULDER IMPINGEMENT SYNDROME

OMUZ SIKIŞMA SENDROMU OLAN HASTALARDA TEMEL STABİLİZASYON EGZERSİZLERİNİN AĞRI VE İŞLEVSELLİK ÜZERİNE ETKİLERİ

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Abstract

Aim: To investigate whether core stabilization exercises provides additional benefit when used with conventional shoulder exercises on pain and functionality in patients with shoulder impingement syndrome (SIS).

Materials and methods: Patients with SIS were randomly divided into two groups as follows; intervention group (n=38) and the control group (n=38). Patients in both groups participated in a conventional shoulder exercise program. The intervention group was additionally assigned to core stabilization exercises for 3 days/wk for a period of 6 wks. All patients were allowed to take only acetaminophen up to 3000 mg/day for the control of pain. Outcome measures including visual analog scale (VAS) (pain at rest, during activity and at night), shoulder range of motions (ROMs), shoulder disability questionnaire (SDQ) and The University of California-Los Angeles scale (UCLA) were evaluated before (baseline) and after the treatment (6th week).

Results: A total of 76 patients (21 M, 55 F, mean age; 53.7 ±10.3) were enrolled in this study. Demographic and baseline clinical characteristics of the groups were similar between the groups ($p > 0.05$). Within each group, significant improvements were observed in all clinical variables ($p < 0.001$). There was no significant differences in the changes in outcome scores (according to baseline values) between the groups ($p<0.05$).

Conclusion: We found a significant improvement in terms of pain, ROM and functionality in both groups. Core stabilization exercises do not provide additional benefit in patients with SIS.

Key words: Impingement syndrome, core stabilization, shoulder exercises.

Özet

Amaç: Temel stabilizasyon egzersizlerinin, omuz sıkışma sendromu (SIS) olan hastalarda geleneksel omuz egzersizleriyle birlikte kullanıldığında ağrı ve işlevsellik konusunda ek fayda sağlayıp sağlamadığını araştırmak.

Gereç ve yöntem: SIS'li hastalar rastgele iki gruba ayrıldı; müdahale grubu (n = 38) ve kontrol grubu (n = 38). Her iki gruptaki hastalar geleneksel bir omuz egzersiz programına katıldı. Müdahale grubu ayrıca 6 hafta süreyle 3 gün / hafta süreyle temel stabilizasyon egzersizlerine atandı. Ağrının kontrolü için tüm hastaların sadece 3000 mg / güne kadar asetaminofen almasına izin verildi. Görsel analog ölçek (VAS) (istirahatte, aktivite sırasında ve gece ağrı), omuz hareketleri aralığı (ROM'lar), omuz sakatlığı anketi (SDQ) ve Kaliforniya Üniversitesi-Los Angeles ölçeği (UCLA) dahil sonuç ölçümleri daha önce değerlendirildi (başlangıç) ve tedaviden sonra (6. hafta).

Bulgular: Çalışmaya toplam 76 hasta (21 E, 55 K, ortalama yaş; 53.7 ± 10.3) alındı. Grupların demografik ve başlangıç klinik özellikleri gruplar arasında benzerdi ($p > 0.05$). Her grup içinde, tüm klinik değişkenlerde önemli gelişmeler gözlendi ($p < 0.001$). Gruplar arasında sonuç skorlarındaki değişikliklerde (başlangıç değerlerine göre) anlamlı farklılık yoktu ($p < 0.05$).

Sonuç: Her iki grupta da ağrı, ROM ve işlevsellik açısından anlamlı iyileşme bulduk. Core stabilizasyon egzersizleri, SIS'li hastalarda ek fayda sağlamaz.

Anahtar kelimeler: Sıkışma sendromu, çekirdek stabilizasyonu, omuz egzersizleri.

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Introduction

Shoulder impingement syndrome (SIS) is the most common disorder of shoulder, accounting for 44-65% of all complaints of shoulder pain during a physician's visit [1]. It is a compression of subacromial tissues as a result of narrowing of the subacromial space. The reasons may include anatomical and mechanical factors, rotator cuff pathology, glenohumeral instability, restrictive processes of the glenohumeral joint, imbalance of the muscles, and postural abnormalities. It is affected shoulder sensory-motor control and maximal shoulder muscle strength [2]. Recent studies have demonstrated that motor control and strengthening exercises can improve on function in patients with SIS [3]. Additionally, the inhibition of normal neuromuscular reflex stabilization participates to repetitive injuries and the progressive reduction of the joint [4]. If there is no need attention to preventing adaptations in motor control in patients with SIS, they change central motor planning, compensatory motion patterns, which worse affect the quality of motion [5]. The conventional shoulder exercises might be inadequate to refrain from compensation because it cannot ensure a stable background for optimal motion control of a kinetic chain system [4]. Therefore, there is a need to functional kinetic chain system as core stabilization exercises. The "core" has been described as a box, with the abdominal and oblique muscles in the anterior and lateral, paraspinal and gluteal muscles in the posterior, the diaphragm as the roof, and the pelvic floor and hip girdle muscles as the bottom [6]. The core stabilization exercises serve as a muscular corset that works as a unit to stabilize the body and spine and perform as the center of the functional kinetic chain. Because it makes optimal energy production and transfer to distal segments, functional stability of the shoulder may be associated with core control [5]. Hence, core stabilization exercises should be improved to provide neuromuscular coordination and normal functioning of the muscles in the shoulder, thereby providing protection from coming injuries. Some studies show how core stabilization exercises improve neuromuscular coordination [6-8]. However, there is no study on the relationship between core stabilization exercises and SIS. Therefore, this study was aim to investigate the effectiveness of core stabilization exercises on pain and functionality in patients with SIS.

Materials And Methods

Patients with unilateral SIS were consequtively enrolled from the outpatient clinic of the Ankara Physical Medicine and Rehabilitation Training and Research Hospital between October 2013 to November 2014. The ethical committee approval was obtained for the study and all participants gave written informed consent prior to enrollment. Patients were eligible for study enrollment if they fulfilled the following criteria: determination of impingement symptom in the clinical examination (both positive Neer's impingement test and Hawkin's sign), and ability to complete follow-up data collection by questionnaire at six weeks [9,10]. All patients had an anteroposterior shoulder radiograph to rule out other causes of shoulder pain, such as osteoarthritis, osseous abnormalities, and calcium deposits. The calcific tendinitis, complete full-thickness or articular sided tear of the rotator cuff were rule out by ultrasonographically. We excluded patients with previous history of any rheumatic disease, fractures, infections, or tumors, shoulder trauma, surgery, corticosteroid injections or physical therapy for the symptomatic shoulder within the six months and other concomitant shoulder pathologies [10].

The study was designed as a prospective, single-blinded randomized controlled trial. The demographic data of the patients including age, gender, educational level, presence of chronic disease, dominant hand, affected side, body mass index (BMI), duration of shoulder pain were recorded. Patients were randomly (via sealed envelopes method) divided into two groups as follows; intervention group (n=40) and the control group (n=40). Patients in both groups participated in a conventional shoulder exercise program. The intervention group was additionally assigned to core stabilization exercises for 3 days/week for a period of 6 weeks. All patients were allowed to take only acetaminophen up to 3000 mg/day for the control of pain. The patients were instructed not to use non-steroidal anti-inflammatory drugs (NSAIDs) during the treatment period. To avoid bias, clinical examination (ZS), randomization (HS), exercises application (SSO) were performed by experienced physiatrist. Patients were evaluated before (baseline) and after the treatment (6^{th} week) by blinded physiatrist (SB).

Outcome Measures

Pain: Pain levels during sleep, rest and activity were assessed with a 100-mm visual analogue scale (VAS). [0 cm: Absence of pain to 100 mm: The worst pain experienced]. The reliability and validity of the VAS is well established [11]. We established that a 20-mm decrease on the VAS would be considered a significantly change in this study [12].

Range of motion (ROM): The ROM was measured by using the universal goniometer. To measure shoulder flexion and abduction, the examiner measured the ROM of the arms in the sagittal and coronal planes while the subject was asked to sit and extend the elbow joint. The starting position of the shoulder was 0° glenohumeral joint abduction, 90° elbow flexion, and neutral supination/pronation forearm position. The fulcrum of the goniometer or its axis was always placed over a stationary bony landmark, such as the acromion. The subject moved the affected extremity to the end of a pain-free active range of shoulder flexion and abduction. The flexion angle was formed by aligning the moving arm of the goniometer with the lateral epicondyle and the midline of the humerus, whereas a stationary arm remained in its starting position, aligned with the lateral midline of the thorax. The abduction angle was formed by aligning the moving arm of the goniometer with the medial epicondyle and midline of the humerus, and the stationary arm remained still, parallel to the sternum. These measurements have been shown to have good intrarater reliability and validity [13].

Functionality: For functional disability, the Shoulder Disability Questionnaire (SDQ) and the University of California-Los Angeles scale (UCLA) were used. SDQ is composed of 16 self-reported questions (0; no disability and 100; maximum disability) [14].

With the UCLA scale, pain, function, active flexion angle, flexion muscle strength and patient satisfaction were evaluated. Each element of pain and function were assessed with scores from 1 to 10. Active flexion angle, flexion muscle strength and patient satisfaction were evaluated on a scale of 1-5. In total, a score of 34-35 was assessed as perfect, 29-33 as good and below 29 as poor [15].

Exercise Applications

All patients came into clinic once two weeks for 6 weeks. The patients were supervised in the clinic in order to ensure that exercises were performed correctly. To ensure adherence, the patients kept an exercise log and phone calls were made to each patients at least once a week. The intensity of exercises was at the patient's tolerance level.

Shoulder Exercise Program

The components of a home-based standardized exercise program were range of motion (ROM) (daily), flexibility (daily) and strengthening exercises (3 times/ weekly). ROM was begining with pendulum exercises, progress to active assisted motion (with a cane), then to active motion (perform in front of a mirror or using the opposite hand on the trapezius to prevent hiking of the shoulder) as comfort dictates. Patient education was made for activity modification. Stretching exercises for flexibility were given performed by the patient in a corner of doorjamb, and posterior shoulder stretching using the crossed body adduction technique. Each stretch should be held for 30 seconds and repeated 5 times, with a 10-second rest between each stretch. When pain-free full ROM was obtained, strengthening exercises of the rotator cuff, scapular stabilizers, and deltoid muscles were given. Rotator cuff strengthening exercises included the following exercises with the theraband: internal rotation with the arm adducted to side, external rotation with the arm adducted to side. Scapula stabilizer strengthening involved chair press, push-up plus (prone using body weight or supine with hand weight), and upright rows using an elastic band. Combination strengthening while standing using elastic bands should include forward elevation and extension (for deltoid muscles). Each exercise should be performed as 3 sets of 10 repetitions, with increases in elastic resistance as strength improves. When pain-free full ROM was reached during activities and all exercises were completed, the activities progressively increased to prepare the patient for full functional return [2].

Core Stabilization Exercise Program

The core stabilization exercises approach utilized in this study is shown in Table 1 [16-18]. The exercise program consisted of 11 different types of exercises. The patients were required to carry out each exercise procedure until they reached their maximal range and their muscles were at their tightest and to then keep static stretching for 10 second. They were recommended to do 3 sets, 30 second to 3 minutes for static hold, 8-12 repeat for dynamic exercises in two times a week.

Statistical Analysis

All statistical calculations were performed by using SPSS 19.0 program (SPSS Inc., Chicago, Illinois). The Shapiro-Wilk test was utilized to assess the normal distribution of the

Table 1 | The core stabilization exercise program.

Type of exercise	Description
1. Trunk flexion	The patients lay face up, bent the knees and hips toward the chest using their hands.
2. Trunk extension	The patients lay face down and used both hands to push the body up but with the hips still touching the floor mat.
3. Trunk rotation	The patients lay face up, bent the right knee and hip and crossed them over to the left. Using the left hand the patient pushed the knee to the mat and tried to keep the right shoulder on the mat. The position was repeated in reverse.
4. Conventional long lying sit-up	The patients lay face up, perform spine and hip flexion with stretched knees and hips.
5. Conventional hook lying sit-up	The patients lay face up, perform spine and hip flexion with bended knees and hips.
6. Curl-up	The patients lay face up, with arms at sides, tilt pelvis to flatten back in supine position. The patients raise shoulders and head from floor.
7. Diagonal curl-up	The patients lay face up, arms fold across chest, tilt pelvis to flatten back. The patients lift head and shoulders from floor while rotation to one side.
8. Reverse curl-up	The patients lay face up, make posterior pelvic tilt (lift feet) with spine and hip flexion (legs stretched or bent) and fixed arms overhead. The patients tight abdominal muscles and raise head and shoulders off the floor.
9. Bridge	The patients lay face up, bent knees and raise hips off the floor until hips are aligned with knees and shoulders and tight abdominal muscles.
10. Bird dog	The patients lay face down, raise opposite arm and leg in quadruped position (reciprocally). Do not arch neck.
11. Pelvic floor muscle exercise	The patients perform contraction of the pelvic floor muscles for 6 s followed by rest for 6 s, resulting in 5 contraction cycles/min. The number of contraction cycles is increased over the 6-week period.

Table 2 | The comparison of baseline characteristics and clinical parameters of the groups.

	Control group (n=38) (%) Mean±SD	Intervention group (n= 38) (%) Mean±SD	P
Age (years)	51.8±9.2	55.6±11.2	0.117
Gender	29/9	26/12	0.304
F/M			
Educational level			
Illiterate	3 (7.9)	7 (18.4)	0.279
Primary school	19 (50)	20 (52.6)	
High school	16 (42.1)	11 (28.9)	
Comorbidities			
Absence/Presence	20/18	16/22	0.358
Dominant hand			
Right/Left	37/1	36/2	0.556
Affected side			
Right/Left	22/16	20/18	0.873
BMI (kg/m²)	28.5±4.2	28.5±2.7	0.455
Duration of pain (months)	6.7±9.8	10.4±1.28	0.164
VAS			
Rest	4.7±2.0	3.9±2.2	0.083
Activity	6.7±1.4	6.8±1.4	0.694
Night	5.4±2.4	5.4±2.0	0.999
ROM (o)			
Flexion	146.6±3.0	140.2±3.6	0.429
Abduction	146.0±3.9	137.4±3.7	0.278
Internal rotation	64.2±6.1	65.0±2.1	0.887
External rotation	64.4±2.5	66.0±2.1	0.771
SDQ	72.6±1.7	72.7±1.4	0.988
UCLA	16.5±4.3	14.6±3.9	0.069

n: Number of patients per group, %: Percantage of patients per group, (p<0.05) is considered as statistically significant, **BMI:** Body mass index, **VAS:** Visuel analog scale, **ROM:** Range of motion, **SDQ:** Shoulder disability questionnaire, **UCLA:** The University of California-Los Angeles Scale.

variables. The chi-square test was used to compare the distribution of categorical variables. The paired t-test was used to evaluate baseline and 6th week results within the groups. The student t test was used to comparison of treatment changes between groups. Significance level was set at $p < 0.05$.

Results

A total of 86 patients were screened routine outpatient with SIS. Of these, 80 patients met the inclusion criteria and agreed to participate. These patients were randomly allocated into control (n = 40) or intervention (n = 40) groups. Two patients in each group was lost during follow-up and 76 (55 women, 21 men) patients completed the study (Figure 1).

The comparison of the demographic and baseline clinical characteristics is shown in Table 2. At baseline, there was no significant difference between the two groups in terms of characteristics and clinical parameters ($p<0.05$). The comparison of baseline and post treatment (6th weeks) results for clinical parameters within each groups is demonstrated in Table 3. According to, within each group, significant improvements were observed in all clinical variables ($p< 0.05$).

According to baseline values, the changes in outcome scores (Δ) with treatment are shown in Table 4. There was no significant differences in Δ changes between the groups ($p<0.05$).

Discussion

We researched whether core stabilization exercises provides additional benefit when used with conventional shoulder exercises in patients with SIS. It is found a significant improvement in terms of pain, ROM, functionality in both groups. But core stabilization exercises combined with a conventional shoulder exercise program do not seem to have an additional positive effect on clinical parameters. This is the first study, to our knowledge, exploring the holistic effect of core stabilization exercises on SIS.

The conservative treatment is preferable and first choice in SIS [9]. The aim of treatment is to decrease pain, regain ROM, restore normal shoulder mechanics, and relieve functionality [2]. Exercise therapy is more effective than no treatment in reducing pain and improving function of the shoulder [9]. The effectiveness of conventional shoulder exercises in SIS was reported in a systematic review and meta-analysis [2,10]. Exercises focused on rotator cuff and scapular stabilizers of low intensity and high frequency, combining eccentric training with stabilization training of the scapula and focusing on relaxation and proper posture [9]. Recent studies effective interventions include therapeutic exercises focusing on strengthening the rotator cuff and scapular stabilizing muscles, stretching to decrease capsular tightness, scapular taping techniques, and patient education of proper posture [19]. In another study, a specific, progressive exercise

Table 3 | The comparison of baseline and post treatment (6th weeks) results for clinical parameters within groups.

	Control group (n=38) Mean±SD	Intervention group (n= 38) Mean±SD
VAS		
Rest		
Baseline	4.7±2.0	3.9±2.2
6th weeks	1.5±0.5	1.1±1.6
p	**0.010**	**0.0001**
Activity		
Baseline	6.7±1.4	6.8±1.4
6th weeks	2.6±1.7	3.0±1.6
p	**0.001**	**0.001**
Night		
Baseline	5.4±2.4	5.4±2.0
6th weeks	1.8±1.8	1.8±1.7
p	**0.001**	**0.003**
ROM		
Flexion		
Baseline	146.5±3.0	140.2±3.6
6th weeks	169.2±1.7	170.2±1.3
p	**0.0001**	**0.0001**
Abduction		
Baseline	146.0±3.9	137.3±3.7
6th weeks	170.7±1.4	168.6±1.5
p	**0.0001**	**0.0001**
Internal rotation		
Baseline	64.2±6.1	65.0±2.1
6th weeks	87.3±4.4	86.3±6.3
p	**0.008**	**0.001**
External rotation		
Baseline	64.4±2.5	66.0±2.1
6th weeks	88.7±3.4	86.8±6.1
p	**0.006**	**0.013**
SDQ		
Baseline	72.6±1.7	72.7±1.4
6th weeks	25.5±2.4	26.5±2.7
p	**0.024**	**0.0001**
UCLA		
Baseline	16.5±4.3	14.6±3.9
6th weeks	29.7±3.1	29.6±3.0
p	**0.008**	**0.015**

n: Number of patients per group, **%:** Percantage of patients per group. ($p<0.05$) is considered as statistically significant. **VAS:** Visuel analog scale, **ROM:** Range of motion, **SDQ:** Shoulder disability questionnaire, **UCLA:** The University of California-Los Angeles Scale.

program focusing on training the rotator cuff and scapular stabilizers was found effective in improving function, decreasing pain, and reducing the need of surgery for patients with chronic SIS [20]. In accordance with the literature, our study showed similar results. Significant improvements were found in pain, ROM and functionality in both groups.

Core stabilization provides a steady base for transfer of load along the kinetic chain from the extremities. Core stability is a key factor of primary movement patterns. The mechanisms of core stabilization were explained passive, active, and neural control subsystems [6]. The passive subsystem consists of the static tissues, which is to stabilize in ROM as tensile forces increase and mechanical resistance to movement is produced, as well as to transfer position and load information to the neutral control subsystem via mechanoreceptors. The active subsystem consists of the core muscles and makes dynamic stabilization to the spine and proximal appendicular skeleton, as well as motion information to the neural control subsystem. The neural control subsystem is the center for incoming and outgoing signals that finally manufacture and sustain core stability. Core stabilization exercises can improve the function of one of more of these subsystems.

Behm et al. demonstrated core muscles with axial and appendicular attachments that transfer force and momentum between the extremities and core along the kinetic chain [21]. Another study reported core muscles recruitment patterns during any extremity movements in patients with low back pain compared with healthy controls. Core muscles were recruited before any extremity motion, indicating that core muscles provide proximal stability for distal mobility [22]. Ayhan et al. showed that increased trunk muscle strength in the stabilization group might also have contributed to proximal stability [5]. Overall, these studies concluded that weakness in core stabilization might be related to upper and lower extremity function. Additionally, some studies reported core dysfunction might be more of a neuromuscular control problem than a strength problem [6,22]. Peripheral musculoskeletal dysfunctions can be associated with cortical reorganisation and movement retraining using the principles of motor

Table 4 | The comparison of treatment changes (Δ) of the clinical parameters according to baseline values (mean ± SD).

	Control group (n=38) (%) Mean±SD	Intervention group (n= 38) (%) Mean±SD	P
ΔVAS			
Rest	3.2±2.0	2.8±1.7	0.363
Activity	4.0±1.7	3.7±1.3	0.440
Night	3.6±2.1	3.5±2.0	0.956
Δ ROM			
Flexion	22.6±2.4	30.0±3.1	0.246
Abduction	24.7±2.5	31.3±2.9	0.308
Internal rotation	24.2±2.4	20.8±1.	0.502
External rotation	24.2±2.4	20.8±1.9	0.502
ΔSDQ	47.0±2.3	46.0±1.7	0.848
ΔUCLA	13.2±4.1	15.02±4.4	0.069

n: Number of patients per group, Δ; The changes of parameters (6th week vs. baseline), ($p<0.05$) is considered as statistically significant, **VAS:** Visuel analog scale, **ROM:** Range of motion, **SDQ:** Shoulder disability questionnaire, **UCLA:** The University of California-Los Angeles Scale.

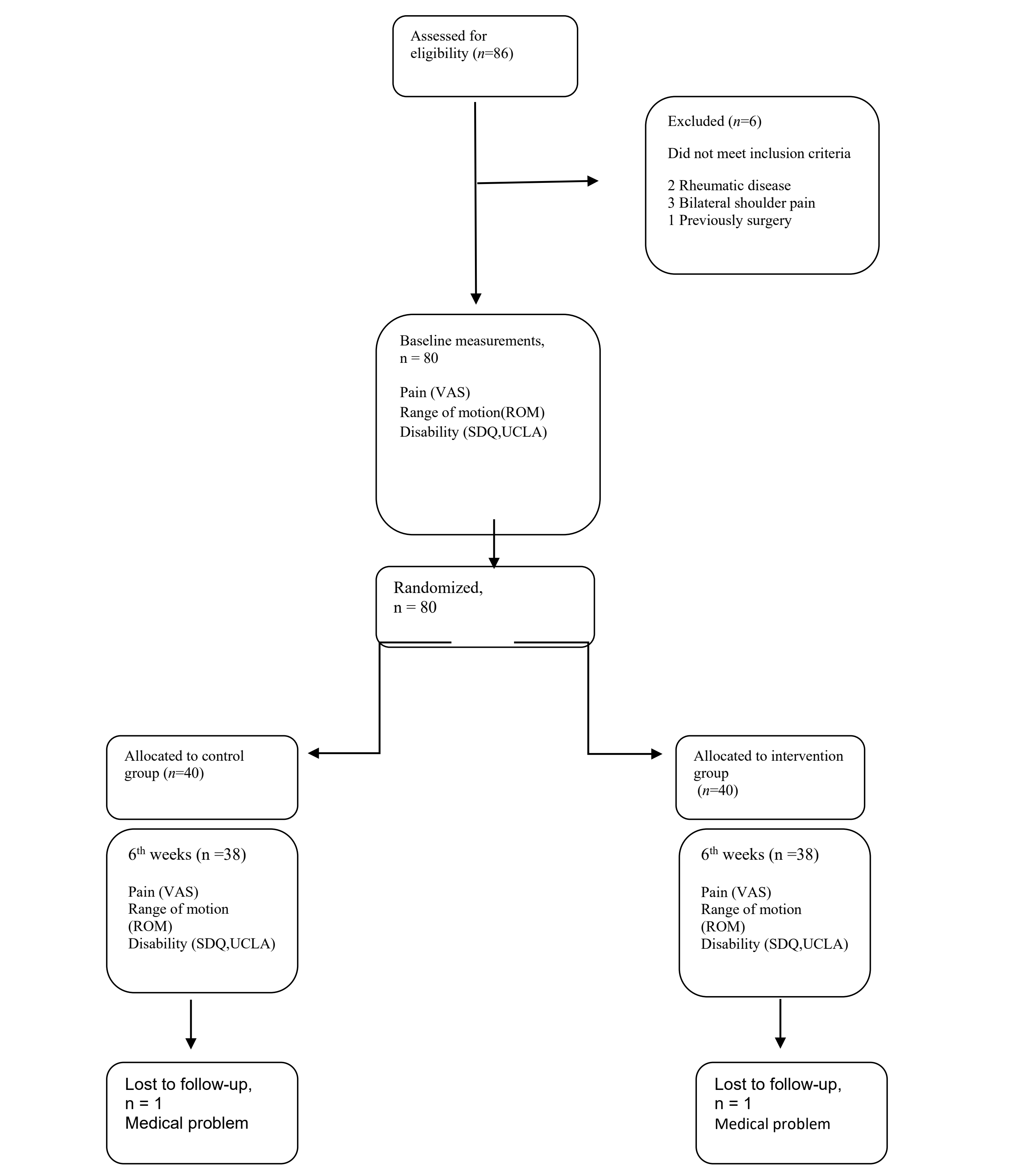

Figure 1 | Flow diagram of patients throughout the course of the study.

learning can change motor control in athletes [23,24]. So, the core stabilization is described as the basis of the kinetic chain responsible for facilitating the transfer of torque and momentum between the extremities. Our study 's result does not supply in these literatures. Through this research, the core stabilization exercises were found not to be additional effective in clinical parameters of patients with SIS. As a result, the training core stabilization still remains a challenge for clinicians**.** We expect that core stabilization exercises are implemented according to the theoretical framework that dysfunction in core muscles are related to SIS. Further studies with larger sample sizes would be better to investigate the effects of core stabilization exercises in patients with SIS.

Limitation

The limitations of this study were that they lacked a control group that did not receive treatment and follow up testing to assess the long-term effects. But forming such a control group was not found to be ethically correct. Also, there is no direct comparison of core stabilization exercises and conventional shoulder exercises. Additionally, there was no suitable comparable study in the literature to use in the calculation of the sample size at the time the authors conducted the study; thus, we could not calculate sample size of this study.

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Kaynaklar

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