

Water-Based versus Land-Based Exercise Program for the Management of Shoulder Impingement Syndrome

Omuz Subakromiyal Sıkışma Sendromunun Tedavisinde Su İçi Egzersizler ile Kara Egzersizlerinin Karşılaştırılması

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Summary

Objective: In this study, we aimed to compare the clinical effect of land-based and water-based exercise programs in patients with subacromial impingement syndrome.

Materials and Methods: Seventy shoulders were randomized to water-based (n=35) or land-based (n=35) exercise program. The intervention in the water-based exercise group consisted of hot pack, transcutaneous electrical nerve stimulation (TENS), ultrasound (US) and exercise in the water; and in the land-based exercise group, consisted of hot pack, TENS, US and land-based exercises. The measurement was performed after the treatment and 3 months after the beginning of the treatment. We used visual analog scale (VAS) for pain assessment and shoulder function was measured with the Shoulder Pain and Disability Index and the Western Ontario Rotator Cuff Index.

Results: Patient demographics and baseline values were similar for both groups. The pain reduction in both groups was statistically significant at the first follow-up. A significant reduction in pain at second follow-up was observed in the water-based exercise group compared with the land-based exercise group. We found statistically significant recuperation in both groups for functional index and more recuperation in the water-based exercise group at the second follow-up.

Conclusion: A greater improvement in pain and functional capacity was achieved with combination of physical therapy and water-based exercise program in patients with subacromial impingement syndrome. *Türk J Phys Med Rehab 2012;58:79-84.*

Key Words: Exercise therapy, aquatic rehabilitation, shoulder pain

Özet

Amaç: Bu çalışmamızda omuz subakromiyal sıkışma sendromlu hastalarda kara egzersizleri ile su içi egzersizlerin etkinliğini karşılaştırmayı amaçladık.

Gereç ve Yöntem: Çalışmaya her iki grupta 35 olmak üzere, toplam 70 omuz alındı. Hastalar 2 gruba randomize edildi. Kara egzersiz grubuna (n=35) sıcak paket + transkütanöz elektiriksel sinir stimülasyonu (TENS) + ultrason (US) + kara egzersizleri, su içi egzersiz grubuna (n=35) sıcak paket + TENS + US + su içi egzersiz tedavileri uygulandı. Hastalar tedaviden hemen sonra ve 3. ayda değerlendirildi. Değerlendirme ölçümlerinde ağrı için görsel analog skala, fonksiyonel durum için ise Shoulder Pain and Disability Index ve Western Ontario Rotator Cuff İndeksleri kullanıldı.

Bulgular: Çalışmaya alınan hastaların her iki grupta da tedavi öncesinde demografik ölçümleri benzerdi. Hastaların tedaviden hemen sonraki ilk kontrolünde ağrı şiddetinde istatistiksel olarak anlamlı azalma her iki grupta da gözlemlendi. 3. aydaki ikinci kontrolde ise su içi egzersiz grubunda ağrı şiddetindeki azalmanın daha fazla olduğu kaydedildi. Her iki grupta da ilk kontrolde omuzun fonksiyonel durumunu değerlendirmeye yönelik skalalarda istatistiksel olarak anlamlı düzelleme kaydedildi, ikinci kontrolde bu düzelmelerin su içi egzersiz grubunda daha fazla olduğu gözlemlendi.

Sonuç: Omuz subakromiyal sıkışma sendromlu hastalarda, fizik tedavi ajanları ile su içi egzersiz programının kombinasyonu; ağrı ve fonksiyonel kapasitenin düzelmesinde kara egzersiz kombinasyonundan daha fazla iyileşme göstermiştir. *Türk Fiz Tıp Rehab Derg 2012;58:79-84.*

Anahtar Kelimeler: Egzersiz tedavisi, akutik rehabilitasyon, omuz ağrısı

Introduction

Shoulder impingement syndrome (SIS) is a common cause of shoulder pain. SIS has various causes, such as mechanical factors and glenohumeral instability. The coracoacromial arch consists of the acromion, coracoacromial ligament, and coracoid process. During elevations of the shoulder joint, the supraspinatus tendon can become compressed between the head of the humerus and the coracoacromial arch (1). Rather than a single traumatic event, overuse of the shoulder leading to repeated microtraumas is in question. Pain and limited range of motion (ROM) are the main symptoms of SIS (2). Non-steroidal anti-inflammatory drugs, corticosteroid injections into the subacromial space, various physical therapy modalities, and surgical intervention are the treatment options for SIS (3).

In addition to all treatment options for SIS, physical exercise is recommended as an adjunctive therapy; the efficiency of physical exercise has been demonstrated in a number of studies. ROM, stretching and strengthening exercises are performed both to provide treatment and to avoid recurrence (3-5). The main areas that need strengthening are the depressors of the humeral head (subscapularis, infraspinatus, and teres minor), the scapular balancing muscles (upper and lower fibers of the trapezius, serratus anterior, and the rhomboids), and the main muscles responsible for humeral position (deltoid, pectoralis major, and latissimus dorsi) (6).

Exercises can be carried out in physical therapy units under supervision or at home as an exercise program. Another method of exercise is water-based exercises. The viscosity of water provides an opportunity to perform resistance exercises. Moreover, due to the buoyancy of water, exercises can be carried out without overloading the joints and can be less painful and much easier, which leads to increased patient compliance with exercise (7). In the present study, the effectiveness of water- and land-based exercises in patients with SIS was compared.

Materials and Methods

Of the patients presenting to our outpatient clinic with shoulder pain complaints between April 2007 and April 2008, 57 patients were diagnosed with SIS and were included in the current study; 70 shoulders were examined.

Ethics Committee approval was obtained prior to the study. The participants were informed about the study, and those who agreed to participate were given details about the study and signed informed consent forms were obtained. The study was performed in accordance with the provisions of the World Health Organization (WHO), the Declaration of Helsinki, Good Clinical Practices and Good Laboratory Practices of the World Psychiatric Association.

In the patients presenting with shoulder pain, history, routine biochemical tests, and shoulder anteroposterior radiographs were obtained in order to establish a differential diagnosis. Additionally, outlet and axillary radiographs, and magnetic resonance imaging (MRI) were also requested when necessary. We performed detailed physical and neurologic examinations. Patients with non-shoulder-related pathologies that could lead to shoulder pain, infections and malignancies, shoulder instability, calcified tendinitis, and calcified bursitis detected with conventional radiography, a history of cervical, shoulder, or back surgery, corticosteroid injections or physical therapy due to a similar complaint involving the shoulder in the last

6 months, cervical radiculopathies, total rotator cuff tears, fractures or dislocations as a result of severe acute trauma, dementia or other psychiatric illnesses, or adhesive capsulitis were excluded from the study.

We used specific tests, such as Neer's, Hawkins', painful arc, supraspinatus, drop-arm, Yergason's, and Speed tests. We performed a subacromial impingement injection test by injecting 10 mL of a local anesthetic into the subacromial space in patients with positive impingement test results. The patients with a 50% improvement in pain in active and passive ROM were diagnosed with SIS. An injection test was regarded to be the reference test (8).

We examined 70 shoulders in 57 patients. Of the patients, 28 were randomized into the land-based exercise group (LG) and 29 were randomized into the water-based exercise group (WG). Surface heat (heat pack), transcutaneous electrical nerve stimulation (TENS), deep heat (ultrasound [US]), and land exercises were performed on the shoulders of the patients in the LG (n=35), while surface heat (heat pack), TENS, deep heat (US), and water exercises were administered to shoulders of the patients in the WG (n=35).

Surface Heat

Heat packs filled with silica gel were heated at 75°C in a unit and then we administered towel-wrapped heat packs to the patients in both groups for 20 minutes.

Transcutaneous Electrical Nerve Stimulation

We performed TENS therapy using a Sonopuls 492 machines. A total of 4 carbon-silicon composite electrodes (2x2 cm in size) were placed over the region of the shoulder pain. The current frequency was set at 60 Hz, the current time was set at 60 microseconds, and the amplitude was calculated to avoid discomfort and to remain under the motor threshold. The therapy was performed in both groups for 20 minutes with the conventional method.

Ultrasound

We performed US therapy using a Sonopuls 492 machines. Ultrasound Gel Therascanc was applied during the examination. Both groups were administered a dose of 1.5 Watt/cm² at a frequency of 1 MHz for 8 minutes in a mode of continuous and circular motion to the anterior, lateral, and posterior parts of the involved shoulder 5 times a week, for a total of 20 sessions.

Exercises

Land-Based Exercise Group

The patients underwent an exercise program immediately after the physical therapy under the supervision of a physiotherapist. For the first 10 days, ROM and stretching exercises, and for the following 10 days strengthening exercises were performed. After completion of the therapy, the patients continued a home exercise program twice daily. The adherence of the patients to the exercises was checked during follow-up.

Water-Based Exercise Group

The patients underwent a program consisting of ROM and stretching exercises for the first 10 days, which was followed by 10 days of strengthening exercises in water by using dumbbells.

We performed water-based exercises immediately after the physical therapy for 20 days with the assistance of a physiotherapist and hydrotherapist. Water-based exercises took place in a therapy pool maintained at 28-30°C, which was 8 m in width, 12 m in length, and 1.4 m at its deepest point. After 20 sessions of therapy,

the patients continued the same home exercise program as the LG patients to be performed twice daily. Therefore, the only difference between the two groups was the water-based exercises, which were carried out during the therapy period.

We evaluated the patients at baseline (before treatment), after the treatment (first follow-up), and 3 months after the beginning of the treatment (second follow-up). We performed pain severity, ROM (actively and passively measured by a goniometer), specific tests, the Shoulder Pain and Disability Index (SPADI), and the Western Ontario Rotator Cuff Index (WORC) measurements for the evaluations.

Statistical Analysis

Statistical analyses were performed using a SPSS 12.0 program. Along with descriptive statistical methods (mean, median, standard deviation, and minimum and maximum), we used the Student's t-test to compare the groups for normally distributed quantitative variables. The Mann-Whitney U-test was used for comparing the variables between the two groups. The Wilcoxon test was used to evaluate pre- and post-treatment values within the groups. Repeated measurements more than twice were analyzed by the Friedman test within groups. The level of statistical significance was set at $p < 0.05$.

Results

The mean age of the 57 patients who were enrolled in the study (21 men and 36 women) was 57.2 ± 10.0 years. The mean age of the 28 patients (7 men and 21 women) in the LG was 58.3 ± 8.6 years, while the mean age was 56.2 ± 11.3 years for the 29 patients (14 men and 15 women) in the WG. There was no significant difference in terms of mean age and men/women (M/W) ratios between the groups ($p = 0.432$ and $p = 0.069$, respectively). The mean duration of pain in the LG was 8.9 ± 7.5 months, while the mean duration of pain was 10.0 ± 13.2 months in the WG, with no significant difference between the two groups ($p = 0.554$) (Table 1). There was a significant difference between the two groups at baseline measurement of the SPADI disability subscale ($p = 0.046$).

The mean pain severity at baseline for the LG and WG, which was evaluated by using a visual analogue scale (VAS), was 7.1 ± 1.2 and 7.3 ± 1.1 , respectively, and the difference was not significant ($p = 0.579$). However, statistically significant improvements were detected in the analysis of repeated measurements of pain between the groups ($p < 0.0001$). While the first control evaluation revealed no statistically significant differences between the groups ($p = 0.062$), the second control showed that the decrease in VAS scores in the WG were significantly higher than the LG ($p < 0.001$) (Table 2 and Figure 1).

The total evaluation of the pain subscale of the SPADI scores demonstrated that there was an improvement in both groups at the first follow-up, and the improvement observed in the WG was significantly better at the second follow-up ($p = 0.004$). Similarly, the total evaluation of the scores of SPADI disability subscale revealed that there was improvement in both groups at the first follow-up, and the improvement observed in the WG at the second follow-up was significantly better ($p < 0.001$). The total score evaluation of the

SPADI, by calculating the mean value of the scores of the disability and pain subscales, demonstrated improvement in both groups at the first follow-up and significantly better improvement in the WG at the second follow-up ($p = 0.002$). Improvements in pain and disability subscales and total SPADI scores were significant in both groups ($p < 0.001$) (Table 3).

Table 1. Demographic features of patients.

	LG	WG	P
Age, years (mean±SD)	58.3±8.6	56.2±11.3	0.432
Gender (M/F)	7/21	14/15	0.069
Duration of pain (months)	8.9±7.5	10.0±13.2	0.554

SD: Standart deviation
 M/F: Male/Female
 LG: Land-based exercise group
 WG: Water-based exercise group.

Table 2. VAS scores in both groups.

	LG	WG	P
Pre-treatment	7.1±1.2	7.3±1.1	0.579
First control	3.7±1.4	3.2 ±1.4	0.062
Second control	4.1±1.7*	2.8 ±1.5*	<0.001

*Significant improvement in repeated measures of pain ($p < 0.0001$)
 LG: Land-based exercise group
 WG: Water-based exercise group.

Table 3. Comparison of Shoulder Pain and Disability Index (SPADI) score.

		LG	WG	P
SPADI (pain)	Pre-treatment	33.4±4.6	32.7±4.7	0.433
	First control	14.1±7.8	12.5±8.0	0.391
	Second control	14.6±8.1*	9.3±6.2 *	0.004
SPADI (disability)	Pre-treatment	56.6±10.0	52.1±10.9	0.046
	First control	26.2±13.3	20.9±17.2	0.078
	Second control	27.2±12.4*	14.7±12.1*	<0.001
SPADI (total)	Pre-treatment	45.0±7.3	42.4±7.8	0.239
	First control	20.1±10.5	16.7±12.6	0.234
	Second control	20.9±10.2*	12.0±9.1*	0.002

*Significant improvement in repeated measures of pain ($p < 0.0001$)
 LG: Land-based exercise group
 WG: Water-based exercise group.

Table 4. Comparison of the Western Ontario Rotator Cuff Index (WORC) score.

	LG	WG	P
Pre-treatment	1348,4±185.9	1353,2±240.3	0.553
First control	739.7±332.9	599.7±417.5	0.064
Second control	733.1±331.6*	475.0 ±269.9*	<0.001

*Significant improvement in repeated measures of pain ($p < 0.0001$)
 LG: Land-based exercise group
 WG: Water-based exercise group

Statistical analysis of the Western Ontario Rotator Cuff Index (WORC) demonstrated improvements in both groups at the first follow-up and significantly better improvement in the WG at the second follow-up ($p < 0.001$). Improvements in WORC scores were significant in both groups ($p < 0.001$) (Table 4 and Figure 2).

Discussion

SIS is one of the most common causes of shoulder pain. Conservative therapy for this syndrome is based on initiating early rehabilitation as soon as possible to ensure proper soft tissue healing. Prompt therapy shortens the period of restriction and accelerates the return to normal activity. For this purpose, the scapulathoracic rhythm is corrected and the balance between the glenohumeral and scapulathoracic forces is reinstated (9). Physical therapy modalities and therapeutic exercises are of importance both for providing pain relief and maintaining ROM and functional structure (10).

The mean age of the 28 patients (7 men and 21 women) in the LG was 58.3 ± 8.6 years, while it was 56.2 ± 11.3 years for 29 patients (14 men and 15 women) in the WG. The mean age was 46 years in a study carried out by Bureau et al. (11) describing dynamic sonography in SIS management. In a study by Calis et al. (12) investigating the diagnostic value of clinical diagnostic tests in SIS, the mean age of the patients with SIS was reported to be 52.58 ± 14.8 years. The mean age was 53.69 ± 8.02 years in a study

performed by Arıkan et al. (13) comparing the effectiveness of US and microwave diathermy in shoulder periarthritis. An evaluation of studies demonstrates that shoulder pain and SIS can be observed in various age groups. However, the general view is that increased degenerative alterations occur in the shoulders by aging, bringing along SIS formation (14).

Sex distribution of the patients in the present study was 36.8% men and 63.2% women. Similar to the present study, women ratios are also higher in the literature, particularly in studies carried out in Turkey. The M/W ratio was 40/60 in a study conducted by Calis et al. (12). Esenyel et al. (15) reported an M/W ratio of 39.6/60.4. In a study by Ozgul et al. (16) M/W ratio was 29.2/70.8. Although higher incidence of SIS has been reported in women, higher or equal percentages of men were also reported. Higher men ratios have been reported in studies carried out in other countries. In a study by Morrison et al. (17), the M/W ratio was reported to be 62.7/37.3. Bengtsson et al. (18) reported a M/W ratio of 62/38. Higher women ratios in studies carried out in Turkey, as well as in the present study, can be attributed to the fact that women constitute a higher percentage of patients presenting to physical medicine and rehabilitation outpatient clinics.

The patients in the present study were asked to express the severity of their shoulder pain by a VAS; pain was significantly lower for both the LG and WG at the first follow-up and for the WG at the second follow-up evaluation. Tascioglu et al. (19) investigated in their study the effectiveness of low-dose laser therapy in patients diagnosed with SIS due to partial supraspinatus tendon rupture. The patients in the 1st group were administered a physical therapy program, including heat pack, US, TENS, and exercise, while the patients in the 2nd group were administered low-dose laser therapy consisting of 15 sessions in addition to physical therapy modalities; and a significant decrease was observed in pain scales in both groups at the end of the study (19). In a study by Baltacı et al. (20), one of the groups was administered classic physiotherapy, another group was administered manipulative therapy in combination with classic physiotherapy, and the last group was administered manual therapy alone. At the end of the therapy period, the VAS scores for pain levels at rest, night, and activity were observed to have dropped in all the three groups (20). In the present study, the pain scores were also decreased in both groups. Moreover, it was determined that the improvement at the second follow-up evaluation was significantly better in the WG. We considered, as water provides an ideal environment, exercises can be performed less painfully, and patient motivation is higher in the initial stages of the therapy, which results in better adherence to therapy, leading to more effective and better results in terms of healing and pain relief.

The SPADI was developed by Roach et al. in 1991. SPADI has a total of 3 subscales (total, pain, and disability). Cloke et al. (21) investigated the correlation of the SPADI with the Oxford Shoulder Score (OSS), and the Short Form 36 (SF-36) used in evaluating the functional status in SIS and reported that the SPADI correlated quite well with OSS while they correlated weakly with SF-36. Furthermore, they indicated that survey forms, such as SF-36, used to evaluate general health, are less sensitive and specific to measure the changes occurring during follow-up of patients with shoulder pain, and they recommended the use of the SPADI and OSS for patients with SIS (21). Therefore, a method such as SF-36, used to evaluate general daily life activity, was not used in the present study.

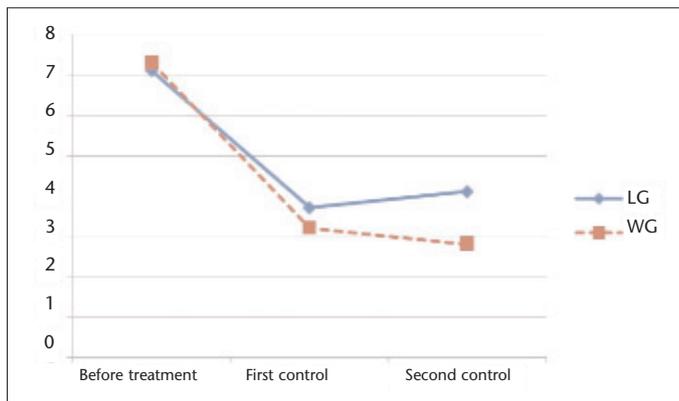


Figure 1. Comparison of visual analogue scale (VAS) score between land-based exercise group (LG) and water-based exercise group (WG).

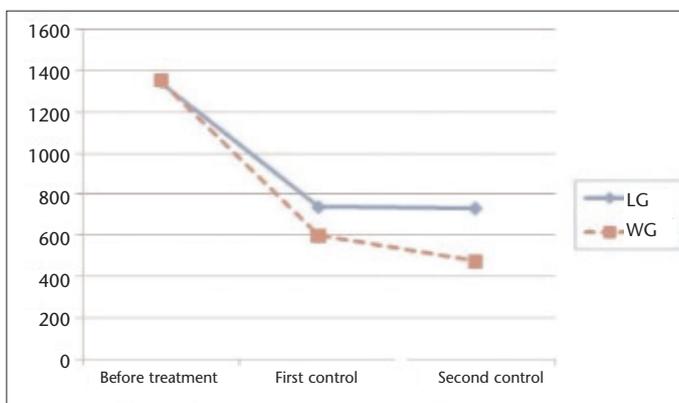


Figure 2. Comparison of Western Ontario Rotator Cuff Index (WORC) score between land-based exercise group (LG) and water-based exercise group (WG).

Furthermore, in the present study, we used the the Western Ontario Rotator Cuff (WORC) index, another shoulder-specific questionnaire developed by Kirkley et al. (22). The questionnaire consists of 21 questions analyzing the physical symptoms, sports and free time activities, professional life, social functions, and emotional status. In 2006, El et al. (23) conducted a validity study on the Turkish version of the WORC index and reported that it could be used in clinical trials in patients with rotator cuff disorders.

A study comparing the Rotator Cuff-Quality of Life (RC-QOL) with WORC index as well as with other scales indicated that both forms were quite sensitive in determining alterations in patients with rotator cuff lesions (24). Holtby et al. (25) compared the Constant-Murley Form, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), and WORC Index Form for evaluating patients with shoulder pain and they reported a strong correlation between them. In the present study, we also used the WORC index as it was demonstrated to be one of the effective shoulder-specific questionnaires in assessing the changes in the severity of the disease and as its validation study had been carried out for the Turkish language. Thus, it was considered that negative aspects related to the use of the SPADI of which the validity study of the Turkish version has not been carried out yet, have been partially reduced.

There are no recent studies on water-based exercises for shoulder pathologies in the literature. In the present study, we carried out a program for the WG consisting of ROM and stretching exercises for the first 10 days, followed by 10 days of strength-building exercises in water with dumbbells making use of the viscosity of water, which provides resistance. Although few studies exist in the literature investigating the effectiveness of water-based exercises in shoulder pathologies (7,26), there are many studies related with preserving general well-being and other musculoskeletal system pathologies (27-32).

Another point stated in the previous studies was the fact that water-based exercises were less painful for the muscles compared with land-based exercises and patients felt less tired afterwards (33,34). A constraint of the present study was the fact that no assessments were performed to determine if there was muscular pain and fatigue immediately after exercise. Another positive effect of the water-based exercises is increased flexibility and easier achievement of pain-free ROM. This effect, provided by water, was apparent in the present study as well and a greater increase was achieved in ROM in the WG. When the previous studies were evaluated, it was noted that patients were administered rather long exercise programs about 3 times a week, lasting 2-8 months (27,33-35). Considering the reimbursement provided by social security organizations, exercise therapy in the present study lasted for a total of 20 sessions, performed 5 times a week for 1 month. This is a shorter period than those of the studies conducted in the other countries. A water-based exercise lasting longer is likely to achieve better results.

One of the weaknesses of our study was the presence of a significant difference between the two groups at baseline measurement of the SPADI disability subscale ($p=0.046$). This situation may be a result of randomization. Our results may have influenced this situation.

Another point is that the patients who underwent water-based exercise program could have been interviewed concerning treatment satisfaction, and if they had undergone a program with land-based exercises for any reason, they could have been asked to

complete a questionnaire comparing the two programs. Their experience with water-based exercises could have been noted in their own words. If a questionnaire had been conducted in this manner, it would be considered that there would have been a significant difference between the LG and WG. The therapy methods compared in the present study were not administered as monotherapy, but in combination with a standard program administered to each of the two groups in exactly the same way. Therefore, possible synergic effects of the investigated therapeutic agents may have had an impact on the present results and it may be proposed that they are not isolated effects of water- and land-based therapies alone. Further clinical studies should be carried out by administering different therapy agents or drugs alone in order to evaluate the effect of water-based exercises on clinical improvement; it is maintained that longer follow-up periods have to be established.

Another important aspect is the cost-benefit ratio. Previous studies have demonstrated that the results obtained in return for the price paid have been satisfactory in programs with water-based exercises (35,36). In the present study, water-based exercises led to a minor increase in therapy costs as some negative factors were involved, such as transportation to the location that the therapy was administered, swimming costumes and other accessories, and an increase in time allocated for the therapy.

In conclusion, water- and land-based exercises combined with physical therapy were established to have a favorable effect on pain, ROM, and daily activities in the treatment of SIS. Furthermore, the WG was shown to have a great improvement in pain and functional capacity. We considered that combination of physical therapy and water-based exercise is an effective approach in SIS management. However, further studies are required to support the present results.

Conflict of Interest:

Authors reported no conflicts of interest.

References

1. Akman Ş, Küçükkaya M. Subakromiyal sıkışma Sendromu: Patogenez, klinik ve muayene yöntemleri. *Acta Orthop Traumatol Turc* 2003;37 Suppl 1:27-34.
2. Botanlioğlu H, Kesmezacar H, Erginer R, Babacan M. Omuz sıkışma sendromunun konservatif tedavisi. *Gülhane Tıp Dergisi* 2006;48:208-14.
3. Michener LA, Walsworth MK, Burnet EN. Effectiveness of rehabilitation for patients with subacromial impingement syndrome. *J Hand Ther* 2004;17:152-64.
4. Lombardi I Jr, Magri AG, Fleury AM, Da Silva AC, Natour J. Progressive resistance training in patients with shoulder impingement syndrome: A randomized controlled trial. *Arthritis Rheum* 2008;59:615-22.
5. Walther M, Werner A, Stahlschmidt T, Woelfel R, Gohlke F. The subacromial impingement syndrome of the shoulder treated by conventional physiotherapy, self-training, and a shoulder brace: Results of a prospective, randomized study. *J Shoulder Elbow Surg* 2004;13:417-23.
6. Çakmak A. Subakromiyal sıkışma sendromunda konservatif tedavi. *Acta Orthop Traumatol Turc* 2003;37:112-8.
7. Thein JM, Brody LT. Aquatic-based rehabilitation and training for the shoulder. *J Athl Train* 2000;35:382-9.
8. Tangtrakulwanich B, Kapkird A. Analyses of possible risk factors for subacromial impingement syndrome. *World J Orthop*. 2012;18:35-9.
9. Churchill RS, Fehring EV, Dubinsky TJ, Matsen FA 3rd. Rotator cuff ultrasonography: diagnostic capabilities. *J Am Acad Orthop Surg* 2004;12:6-11.

10. Celik D, Sirmen B, Demirhan M. The relationship of muscle strength and pain in subacromial impingement syndrome. *Acta Orthop Traumatol Turc* 2011;45:79-84.
11. Bureau NJ, Beauchamp M, Cardinal E, Brassard P. Dynamic sonography evaluation of shoulder impingement syndrome. *AJR Am J Roentgenol* 2006;187:216-20.
12. Çalis M, Akgün K, Birtane M, Karacan I, Çalis H, Tüzün F. Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. *Ann Rheum Dis* 2000;59:44-7.
13. Arıkan V, Kaçar C, Gilgil E, Urhan S, Tuncer T, Bütün B, Akyokuş A. Ultrason ve mikrodalga diaterminin omuz periartiritindeki etkinliklerinin karşılaştırılması. *Romatizma* 2004;19:105-10.
14. Bonsell S, Pearsall AW 4th, Heitman RJ, Helms CA, Major NM, Speer KP. The relationship of age, gender, and degenerative changes observed on radiographs of the shoulder in asymptomatic individuals. *J Bone Joint Surg Br* 2000;82:1135-9.
15. Esenyel CZ, Esenyel M, Yeşiltepe R, et al. Subakromiyal sıkışma sendromunda steroid enjeksiyonunun doğru şekilde uygulanması ile omuz ağrısı ve fonksiyonu arasındaki ilişki. *Acta Orthop Traumatol Turc* 2003;37:41-5.
16. Özgül A, Taşkınatan MA, Bal A, Kalyon TA. Omuz ağrılı hastalarda ultrasonografi ve magnetik rezonans görüntüleme. *Romatizma* 2004;19:117-22.
17. Morrison DS, Frogameni AD, Woodworth P. Non-operative treatment of subacromial impingement syndrome. *J Bone Joint Surg Am* 1997;79:732-7.
18. Bengtsson M, Lunsjö K, Hermodsson Y, Anders Nordqvist A, Abu-Zidan FM. High patient satisfaction after arthroscopic subacromial decompression for shoulder impingement. *Acta Orthop* 2006;77:138-42.
19. Taşcıoğlu F, Dalkıran İ, Öner C. Parsiyel supraspinatus tendon rüptürü olan subakromiyal sıkışma sendromlu hastalarda düşük doz lazer tedavisinin etkinliği. *Türk Fizik Tıp ve Rehab Derg* 2003;49:18-22.
20. Baltacı G, Beşler A, Bayrakçıtunay V, Ergun N. Omuz sıkışma sendromunun konservatif tedavisinde manipülatif yöntemlerin etkisi. *Joint Dis Rel Surg* 2002;13:27-33.
21. Cloke DJ, Lynn SE, Watson H, Steen IN, Purdy S, Williams JR. A comparison of functional, patient-based scores in subacromial impingement. *J Shoulder Elbow Surg* 2005;14:380-4.
22. Kirkley A, Alvarez C, Griffin S. The development and evaluation of a disease-specific quality-of-life questionnaire for disorders of the rotator cuff: The Western Ontario Rotator Cuff Index. *Clin J Sport Med* 2003;13:84-92.
23. El Ö, Bircan Ç, Gülbahar S, Demiral Y, Şahin E, Baydar M, et al. The reliability and validity of the Turkish version of the Western Ontario Rotator Cuff Index. *Rheumatol Int* 2006;26:1101-8.
24. Razmjou H, Bean A, Van OV, MacDermid JC, Holtby R. Cross-sectional and longitudinal construct validity of two rotator cuff disease-specific outcome measures. *BMC Musculoskelet Disord* 2006;13:7-26.
25. Holtby R, Razmjou H. Measurement properties of the Western Ontario Rotator Cuff Outcome Measure: A preliminary report. *J Shoulder Elbow Surg* 2005;14:506-10.
26. Kelly BT, Lori A, Roskin LA, Kirkendall DT, Speer KP. Shoulder muscle activation during aquatic and dry land exercises in nonimpaired subjects. *J Orthop Sports Phys Ther* 2000;30:204-10.
27. Gusi N, Tomas-Carus P, Häkkinen A, Häkkinen K, Ortega-Alonso A. Exercise in waist-high warm water decreases pain and improves health-related quality of life and strength in the lower extremities in women with fibromyalgia. *Arthritis Rheum* 2006;55:66-73.
28. Granath AB, Hellgren MS, Gunnarsson RK. Water aerobics reduces sick leave due to low back pain during pregnancy. *J Obstet Gynecol Neonatal Nurs* 2006;35:465-71.
29. Foley A, Halbert J, Hewitt T, Crotty M. Does hydrotherapy improve strength and physical function in patients with osteoarthritis-a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening programme. *Ann Rheum Dis* 2003;62:1162-7.
30. Devereux K, Robertson D, Briffa NK. Effects of a water-based program on women 65 years and over: a randomised controlled trial. *Aust J Physiother* 2005;51:102-8.
31. Takeshima N, Rogers ME, Watanabe E, Brechue WF, Okada A, Yamada T, et al. Water-based exercise improves health-related aspects of fitness in older women. *Med Sci Sports Exerc* 2002;34:544-51.
32. Parker KM, Smith SA. Aquatic-Aerobic Exercise as a Means of Stress Reduction during Pregnancy. *J Perinat Educ* 2003;12:6-17.
33. Robinson LE, Devor ST, Merrick MA, Buckworth J. The effects of land vs. aquatic plyometrics on power, torque, velocity, and muscle soreness in women. *J Strength Cond Res* 2004;18:84-91.
34. Jentoft ES, Kvalvik AG, Mengshoel AM. Effects of pool-based and land-based aerobic exercise on women with fibromyalgia/chronic widespread muscle pain. *Arthritis Rheum* 2001;45:42-7.
35. Gusi N, Tomas-Carus P. Cost-utility of an 8-month aquatic training for women with fibromyalgia: a randomized controlled trial. *Arthritis Res Ther* 2008;10:R24. Epub 2008 Feb 22
36. Van Tubergen A, Boonen A, Landewé R, Rutten-Van Mölken M, Van Der Heijde D, Hidding A, et al. Cost effectiveness of combined spa-exercise therapy in ankylosing spondylitis: a randomized controlled trial. *Arthritis Rheum* 2002;47:459-67.