Journal of Turgut Ozal Medical Center 2016;23(1):29-35
ORİJİNAL MAKALE/ORIGINAL ARTICLE DOI: 10.5455/jtomc.2015.2954

The Effect of Callisthenic Exercises on Pain Threshold, Pain Severity and Muscle Strength on Sedentary Women Diagnosed with Upper Extremity and Low Back Pain

Üst Ekstremite ve Bel Ağrı Tanısı Konulan Sedanter Kadınlarda Kalistenik Egzersizlerin Ağrı Eşiği, Ağrı Şiddeti ve Kas Kuvveti Üzerine Etkileri

Betül Akyol[1], Cengiz Arslan[2], Cemil Çolak[3]

[1]İnönü University, College of Physical Education and Sports, Department of Physical Education and Sports for the Disabled, Malatya, Turkey
[2]Fırat University, Faculty of Sport Sciences, Department of Coach Training in Sports, Elazığ, Turkey
[3]İnönü University, Faculty of Medicine, Department of Biostatistics and Medical Informatics, Malatya, Turkey

Abstract

Aim: This study on sedentary women diagnosed with upper extremity and low back pain is conducted to analyze the effects of calisthenic exercises on pain threshold, pain severity, and muscle strength.

Materials and Methods: Our study included 80 sedentary women, aged between 40-60, who were diagnosed with upper extremity and low back pain; these patients were admitted to the outpatient physical therapy clinic of a private hospital in Malatya. Patients were randomly assigned to two groups. 40 patients underwent conservative therapy (US, HP, tens) as the control group and 40 patients received conservative therapy and calisthenic exercises as the training group. Both groups were administered a pre-test and post-test model. Pain threshold, pain severity, muscle strength of the subjects were assessed before and after the treatment. The data were evaluated using IBM SPSS Statistics 22.0 package software, and the level of significance was taken as $p<0.05$.

Results: Based on the results of this study, patients who were treated with conservative treatment together with calisthenic exercises had significantly increased muscle strength, pain threshold values ($p <0.05$) while they also showed significantly decreased pain intensity values ($p <0.05$). It was observed that all muscle strength variables were significantly improved compared to the baseline values after treatment with calisthenic exercise added to conservative treatment. There were significant differences found in muscle strength and pain threshold values between the two groups ($p<0.05$).

Conclusion: In conclusion, we believe that conservative treatment administered with calisthenic exercises increases muscle strength and muscle pain threshold values.

Keywords: Sedentary Women; Low Back Pain; Pain Threshold; Callisthenic Exercises.

Özet

Amaç: Üst ekstremite ve bel ağrısı tanısı konulmuş sedanter kadınların katılımı ile gerçekleştirilen bu çalışma, kalistenik egzersizlerin ağrı eşiği, ağrı şiddeti, kas kuvveti üzerine etkilerini incelemek amacı ile yapılmıştır.

Gereç ve Yöntemler: Çalışma grubumuzu Malatya ilindeki özel bir hastanenin fizik tedavi polikliniğine başvuran, yaşları 40-60 arasında değişen, üst ekstremite ve bel ağrı tanısı konulan, sedanter 80 kadın oluşturmuştur. Denekler rastgele iki gruba ayrılmıştır. Kontrol grubunda 40 deneğe konservatif tedavi (ultrason (US), hotpack (HP), tens), eğitim grubunda 40 deneğe kalistenik egzersiz ve konservatif tedavi uygulanmıştır. Her iki gruba ön test- son test modeli uygulanmıştır. Tedavi öncesi ve uygulanan tedaviler sonrası deneklere ağrı eşiği, ağrı şiddeti, kas kuvveti testi yapılmıştır. Veriler IBM SPSS Statistics 22.0 paket programı ile değerlendirilmiş ve anlamlılık düzeyi $p<0.05$ olarak alınmıştır.

Bulgular: Yapılan çalışma sonunda, konservatif tedavi ile kalistenik egzersizlerin bir arada uygulandığı terapilerde kas kuvveti, ağrı eşik değerlerinde artış görüldüğü ($p<0.05$), ağrı şiddeti değerlerinde azalma görüldüğü ($p<0.05$) tespit edilmiştir. Konservatif tedaviye ek olarak uygulanan kalistenik egzersizlerle birlikte bütün kas kuvvet değerlerinde tedavi sonrasında tedavi öncesine göre artış gözlemlenmiştir. Kas kuvvet değerleri ile ağrı eşik değerleri arasında iki grup arasında anlamlı farklar bulunmuştur ($p<0.05$).

Sonuç: Sonuç olarak; konservatif tedavi ile birlikte uygulanan kalistenik egzersizlerin kas kuvvetini artırarak, ilgili kasın ağrı eşiği değeri üzerinde etkili olduğu düşüncesi gelişmiştir.

Anahtar Kelimeler: Sedanter Kadın; Bel Ağrısı; Ağrı Eşiği; Kalistenik Egzersiz.

Received/Başvuru: 23.07.2014
Accepted/Kabul: 28.08.2015

Correspondence/İletişim
Betül AKYOL
İnönü Üniversitesi BESYO Engelilerde Egzersiz Ve Spor Eğitimi Bölümü, MALATYA, TÜRKİYE
E-mail: betul.akyol@inonu.edu.tr

For citing/Atıf için
Akyol B, Arslan C, Colak C. The effect of callisthenic exercises on pain threshold, pain severity and muscle strength on sedentary women diagnosed with upper extremity and low back pain . J Turgut Ozal Med Cent 2016;23(1):29-35

DOI: 10.5455/jtomc.2015.2954

2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

INTRODUCTION

Chronic low back pain is very common in society and has already become a serious health problem that causes serious economic losses and even job loss. 65-80% of the world population is faced with low back pain during their lives (1).

Pain experienced by individuals affects sleep routine, family life, social life, efficiency in work life, and, in turn, reduces the quality of life. Controlling pain is important for providing relief to individuals, improving the quality of life, and reducing complications (2, 3). The most varied personal way of measuring physical pain is pain threshold level. In recent years, measurements of pain threshold help determine areas of pain and provides the ability to deliver the right treatment to patients (4, 5).

The International Association for the Study of Pain (IASP) has defined pain threshold in its terminological guide published in 1979 as the smallest stimuli intensity while pain tolerance is defined as the biggest stimulus an individual can bear (6).

Pressure pain threshold measurement provides insight into a person's sensitivity to pain and this can be useful for many clinical situations. For example, depending on underlying causes, it can be difficult to determine pain in the body caused by low force implementation apart from the sensitivity to pain. With pressure pain threshold and sensitivity level monitoring, underlying problems, pain levels, improvement speed and level can be followed. Since neuromuscular condition is generally associated with mechanical hyperalgesia, pressure algometry is used for diagnostic purposes in clinic practices (7, 8, 9).

Calisthenic exercises are aerobic and dynamic exercises. These are paced or low intensity exercises enabling the use of large muscle groups in the upper and lower extremities; as they can be modified, they are also handy and useful exercises. These exercises are performed rhythmically and in specific numbers. They can be adjusted according to the physical fitness level of the person. They are suitable for use in sedentary and elderly people. Calisthenic exercises consist of movements which increase the flexibility and strength of the body. At the same time, they increase both muscle endurance and cardiovascular fitness level. They allow the development of psychomotor skills such as coordination and balance as well. Calisthenic exercises are attractive due to their appropriate and functional nature in any environment and their applicability (7).

In this study, we aim to examine the effect of calisthenic exercises on pain threshold, pain severity and muscle strength in sedentary women diagnosed with upper extremity and back pain.

MATERIALS and METHODS

This study is approved by Inonu University Clinical Research Ethics Committee with the protocol number: 2013/56. To study the effect of calisthenic exercises on pain threshold in sedentary women diagnosed with upper extremity and back pain, we included in the study the patients who were admitted to the physical therapy clinic of a private hospital in Malatya, Turkey.

The study included a total of 80 sedentary women suffering from upper extremity and back pain between 40 and 60 years of age (48.20 ± 7.2 years; mean ± standard deviation). The patients who participated in the study were divided into two random groups. One of the groups (control group) were offered a combination of hot pack, ultrasound, conservative treatment (containing TENS) while the other group (study group) received conservative treatment along with calisthenic exercise training. We evaluated the patients before and after the treatment; the patients were also included in a physiotherapy programme at the start of treatment.

As part of the muscle test, we evaluated neck flexion, neck extension, elevation of the scapula, shoulder flexion, shoulder extension, shoulder abduction, back extensors, and anterior trunk flexors.

Muscle testing was conducted according to Dr.Robert W. Lovett's (10) manual muscle testing method. This test comprises the following categories:

Normal (5): muscle completes the range of motion with maximum resistance against gravity.
Good (4): muscle completes its normal range of motion with resistance less than maximum resistance against gravity.
Fair (3): muscle completes its normal range of motion against gravity.
Poor (2): muscle completes its normal range of motion in a position with gravity eliminated.
Trace (1): palpable contraction before disclosure of motion in the joint.
Total paralysis (0): No muscle contraction is felt.

Pain Intensity: Each patient was asked whether they had pain in the upper extremity and back and to mark the severity of pain on a 10cm scale. Then, these marks were measured with a ruler (11).

Pain Threshold: Pain threshold in the neck, cervical 3rd and 5th vertebrae spinous projections, trapezius muscle, deltoid muscle, lateral epicondyle area, 3rd metacarpal proximal of the dorsal aspect of the hand, and lumbar 3rd and 5th vertebrae spinous protrusions in the waist were determined with J-Tech digital algometer (J-Tech Medical Industries Algometer Commander). The applied force used for the calibration of the device was set to Newton (N). Each time the device is turned on, it automatically self-calibrates displaying zero. The measurement of the cervical regions were carried out with the 0.5 cm^2 probe tip; other regions were measured with the 1 cm^2 probe tip.

2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

Measurements were repeated three times at 5-second intervals and the average values were recorded. Each evaluation was applied first on the left side and then the right side in relaxation position. The patients were asked to say "Yes" each time they felt pain in each contact. Each time the patients said "Yes," the device was held back for 5 seconds to provide relief; the second and third measurements from the same spot were then carried out after the relaxation period (12, 13).

Pain threshold measurements were recorded twice for each patient, before and after the treatment for each region.

Treatment: Our research included 80 sedentary women with upper extremity and back pain in two groups. The control group patients only received conservative therapy (hot pack, ultrasound, TENS therapy) in the clinic. The conservative treatment (hot pack, ultrasound, TENS therapy) of the study group patients accompanied 3-days-a-week calisthenic workouts targeted at large muscle groups in the upper and lower extremities with a physiotherapist for 8 weeks. Conservative treatment consisted of 20 minutes of hot pack, 20 minutes of TENS, and 10 minutes of US for the first four weeks while the patients received a treatment of 20 minutes of hot pack and 20 minutes of TENS in the second 4 weeks. We applied conservative treatment to the study group before starting the exercise training programme.

The exercise programme applied to the study group was as follows:

1) Flexion of the shoulders in standing position
2) Shoulder abduction in standing position
3) Reciprocal trunk lateral flexion in standing position
4) Shoulder elevation in sitting position
5) Circular motion of the shoulder from front to back in sitting position
6) Scapular adduction in sitting position with hands on waist
7) Reaching forwards in long sitting position
8) Reciprocal straight leg raising in supine position
9) Reciprocal hip flexion and extension in supine position
10) Abduction in side lying position
11) Body extension in prone lying position (14).

The estimated difference between the study and control groups was 3.5; the estimated standard deviation of the training group was 4.2; the estimated standard deviation of the control group was 4.6; in case of Type I error (alpha) 0.05 and Type II error (beta) 0.20 (power = 0.80), it was calculated by power analysis that each group should at least have 34 individuals.

To improve the reliability of the results of the study, a total of 80 patients were included, including 40 patients in each group (MedCalc version 12.4.0.0 for Windows).

Data were summarized by mean ± standard deviation. The appropriateness of the data to the normal distribution was assessed by Kolmogorov-Smirnov test while the homogeneity control of variances was assessed by Levene test. To analyse the data, we used the t test for independent samples between the groups; to compare the groups, we also used the t-test for dependent samples. We used IBM SPSS Statistics 22.0 for Windows software package for analyses. $P<0.05$ was considered statistically significant.

RESULTS

Above, we present the mean age, weight, and height of the study and control groups. There is no statistically significant difference between the groups ($p>0.05$).

Table 1. Mean age, weight, and height of the study and control groups.

Variables	Study Group (n=40)	Control Group (n=40)	p*
Age (years)	48.52±7.90	47.47±6.90	0.53
Weight (kg)	71.36±12.33	69.06±13.30	0.42
Height (cm)	162.02±5.20	161.67±5.00	0.76

*: $p<0.05$ shows the significance level acoording to the t-test results of independent samples; the data are presented in mean±standard deviation.

Comparisons of pre- and post-treatment values of muscle strength of the study and control groups are given in Table 2. According to this and in terms of muscle strength values of the study group, there is a significant increase for all the muscle strength values after treatment compared to pre-treatment evaluation ($p<0.001$). Evaluating the data of the control group, we noticed significant improvement ($p<0.05$) in neck flexors and abdominal muscles while other muscle strength values did not show statistically significant values ($p>0.05$).

Table 3 presents the comparison between of pre- and post-treatment pain threshold values of the two groups. Studying the pain threshold values on the right and left sides, there is a notable increase in terms of pain threshold values ($p<0.001$) between the measurements before and after the treatment. In control group, except for the left hand pain threshold ($p>0.05$), all other pain threshold values ($p<0.001$) showed significant increase after treatment compared to pre-treatment values.

2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

Table 2. Comparison of muscle strength values of the groups before and after the treatment.

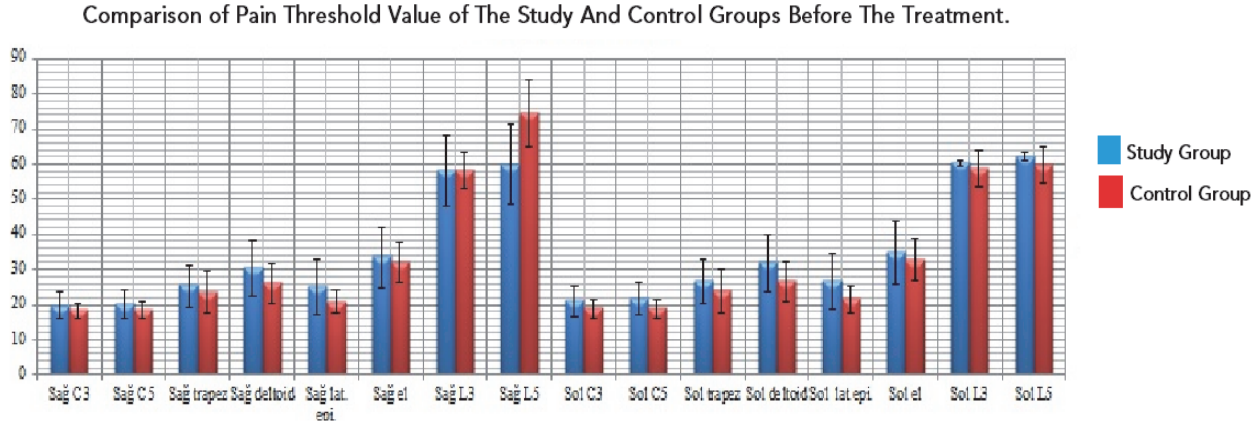
Variables	Study Group (n=40)			Control Group (n=40)		
	Before the treatment	After the treatment	p*	Before the treatment	After the treatment	p*
NF	3.47±0.55	4.10±0.49	<0.001*	3.60±0.49	3.80±0.40	0.008*
NE	3.22±0.42	3.80±0.40	<0.001*	3.32±0.47	3.40±0.49	0.453
SE right	3.95±0.63	4.52±0.59	<0.001*	3.70±0.56	3.77±0.47	0.257
SE left	3.67±0.72	4.35±0.57	<0.001*	3.60±0.59	3.65±0.53	0.317
ShF right	3.65±0.57	4.42±0.54	<0.001*	3.50±0.50	3.60±0.49	0.219
ShF left	3.52±0.59	4.15±0.53	<0.001*	3.40±0.49	3.47±0.50	0.250
ShE right	3.40±0.49	3.90±0.49	<0.001*	3.25±0.43	3.27±0.45	1.000
ShE left	3.32±0.47	3.67±0.52	<0.001*	3.20±0.40	3.25±0.43	0.500
ShA right	3.57±0.54	4.25±0.49	<0.001*	3.52±0.55	3.57±0.54	0.157
ShA left	3.45±0.55	4.02±0.53	<0.001*	3.42±0.54	3.42±0.54	1.000
BE	3.25±0.43	3.82±0.54	<0.001*	3.22±0.42	3.27±0.45	0.500
Abdominal	3.55±0.50	4.30±0.51	<0.001*	3.70±0.46	3.97±0.35	0.001*

*: p<0.05 shows the significance level acoording to the t-test results of dependent samples; NF: Neck flexion; NE: Neck extension; SE right: right scapular elevation; SE left: left scapular elevation; ShF right: right shoulder flexion; ShF left: left shoulder flexion; ShE right: right shoulder extension; ShE left: left shoulder extension; ShA right: right shoulder abduction; ShA left : left shoulder abduction; BE: back extension; the data are presented in mean±standard deviation.

Table 3. Comparisons of pain threshold values of the study and control groups before and after the treatment (Newton/ kg/ cm²)

Variable	Study Group (n=40)		p*	Control Group (n=40)		p*
	Before the treatment	After the treatment		Before the treatment	After the treatment	
Right C3	19.50±3.79	22.10±4.75	<0.001*	18.20±2.34	19.10±2.56	<0.001*
Right C5	20.00±4.28	22.70±5.10	<0.001*	18.30±2.30	19.00±2.48	<0.001*
Right trapezoid	25.20±5.87	27.60±6.73	<0.001*	23.40±5.95	24.00±6.08	<0.001*
Right deltoid	30.50±7.91	32.80±8.41	<0.001*	26.10±5.67	26.60±5.69	<0.001*
Right lat. epi.	25.00±7.72	27.00±8.48	<0.001*	20.80±3.30	21.40±3.56	<0.001*
Right hand	33.40±8.76	35.20±8.87	<0.001*	32.10±5.68	32.70±5.78	<0.001*
Right L3	58.20±9.98	62.20±1.08	<0.001*	58.10±4.99	58.80±4.89	<0.001*
Right L5	59.90±11.4	64.10±1.20	<0.001*	74.20±9.59	59.90±5.50	<0.001*
Left C3	21.00±4.30	23.50±5.11	<0.001*	18.90±2.75	19.80±2.86	<0.001*
Left C5	21.60±4.74	23.90±5.66	<0.001*	18.80±2.71	19.50±2.91	<0.001*
Left trapezoid	26.50±6.18	28.70±7.20	<0.001*	23.80±6.29	24.50±6.43	<0.001*
Left deltoid	31.80±8.28	34.00±8.93	<0.001*	26.70±5.76	27.30±5.81	<0.001*
Left lat.epi.	26.60±8.10	28.40±8.49	<0.001*	21.50±3.82	22.10±3.90	<0.001*
Left hand	34.80±9.12	36.50±9.52	<0.001*	32.60±5.95	33.00±5.92	0.13
Left L3	60.30±1.02	63.40±1.10	<0.001*	58.60±4.97	59.40±4.99	<0.001*
Left L5	62.00±1.15	65.30±1.23	<0.001*	59.90±5.12	60.60±5.32	<0.001*

*: p<0.05 shows the significance level acoording to the t-test results of dependent samples; Right C3: right cervical 3; Right C5: right cervical 5; Right lat. epi: right lateral epicondyle; Right L3: right lomber 3; Right L5: right lomber 5; Left C3: left cervical 3; Left C5: left cervical 5; Left lat. epi: left lateral epicondyle; Left L3: left lomber 3; Left L5: left lomber 5; the data are presented in mean±standard deviation.



2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

Figure 1. Comparison of pain threshold value of the study and control groups before the treatment.

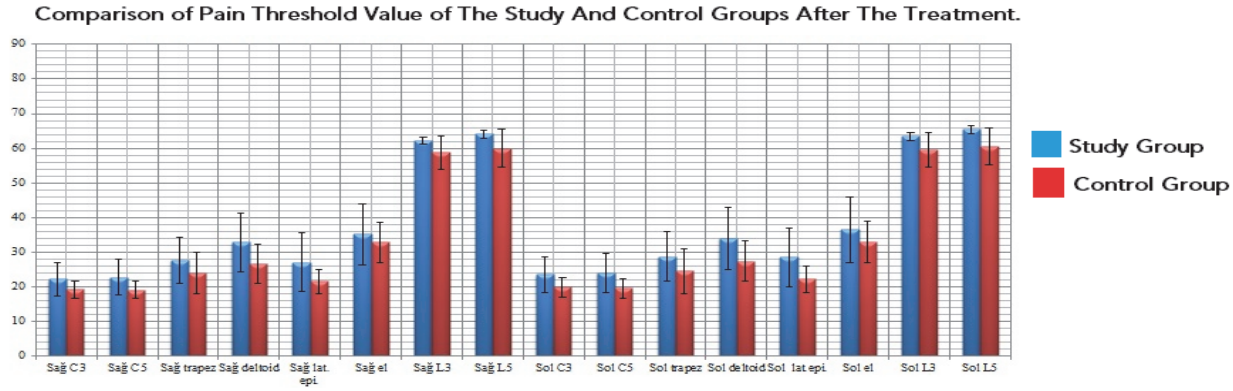


Figure 2. Comparison of pain threshold value of the study and control groups after the treatment.

Table 4 presents VAS measurements of both groups before and after the treatment. As seen in the table, the pre- and pos-treatment values of the study group reveal notable improvement in terms of VAS scores ($p<0.001$). In the control group, there was no statistically significant change in VAS scores after the treatment ($p\leq0.01$)

Table 4. Comparison of VAS scores of the groups before and after the treatment.

Variable	Study Group (n=40)		p*	Control Group (n=40)		p*
	Before the Treatment $\overline{X}$ ±SD	After the Treatment $\overline{X}$ ±SD		Before the Treatment $\overline{X}$ ±SD	After the Treatment $\overline{X}$ ±SD	
VAS (cm)	7.15±1.57	2.38±1.47	<0.001	7.71±1.33	4.46±1.65	<0.001

*: $p<0.05$ shows the significance level acoording to the t-test results of dependent samples; VAS: Visual Analog Scale; the data are presented in mean±standard deviation.

DISCUSSIONS

In this study, which aims to show the effect of calisthenic exercise - when it is applied together with conservative treatment - on threshold of pain, pain intensity and muscle strength, we adopted a pre-test and post-test model.

As a useful form of exercise, calisthenic exercises are aerobic and dynamic exercises and they can be modified for lower and upper extremities. Calisthenic exercises consist of movements which increase the flexibility and strength of the body. As a commonly used training model in rehabilitation and sports training, calisthenic exercises lead to stronger and more flexible bodies with high performance and lower injury rates if they are adopted in the early and late stages of training (15).

Examining the muscle strength values of our patients, we observed that all patients showed improvement in terms of muscle strength in all muscle groups after the calisthenic exercise training programme. Only neck flexors and abdominal muscle strength values were found to be significant in the control group.

Dividing 68 patients with an average age of 76 into two groups, Iwamoto et al. (16) have stated that a course of 3-days-a-week calisthenic exercise accompanied by balance-flexibility-walking exercises for five months have provided significant increase in terms of muscle strength and flexibility in their study group of 34 people. Keser et al. (17) have similarly divided 30 multiple sclerosis patients (mean age: 35 years) into two groups; their study group with multiple sclerosis patients were administered calisthenic exercises for 6 weeks (three days a week). Their study has shown that calisthenic exercises lead to decrease in VAS scores and increase muscle endurance. Our study also confirms the idea that calisthenic exercise programmes effectively increase muscle strength.

Therefore, regardless of the duration of exercises and different demographic characteristics of patients, our study confirms the significant increase in muscle strength due to calisthenic exercises reported in the literature.

Calisthenic exercises are used in many rehabilitation programmes, yet, there are only a few studies on the effect of these exercises on pain intensity and pain threshold. Analysing the pre-test and post-test values

2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

of VAS scores of patients who were trained with calisthenic exercises, there are significant differences in VAS scores between the groups. The VAS scores of the trained group were considerably lower than the VAS scores of the control group. This explains that calisthenic exercises have positive effect on pain intensity. Jespersen et al.'s study (18) on 22 women (mean age: 39 years) diagnosed with lateral epicondylitis shows that there is a strong correlation between VAS, assessed pain intensity, and pain threshold and pain tolerance.

Our study shows that sedentary women, who complained of pain and did calisthenic exercises 3-days-per-week for 8 weeks, had increased pain threshold and muscle strength values and reduced pain intensity. We also determined a relationship between decrease in pain intensity and pain threshold. Considering this relationship, pain threshold and pain severity should be considered together before and after the treatment.

Yürük and Gültekin's study (14) on patients with fibromyalgia syndrome, who received calisthenic exercise training, shows that pain threshold values were higher compared to the pre-treatment results after treatment. Jones et al's study (19) includes 24 individuals divided into two groups. They provide aerobic exercise training for 30-minute-a-day/3-days-a-week for 6 weeks. They report that they have observed positive change in the participants' pain threshold at the end of the training.

In our study, pain threshold values were lower in the preliminary tests than the final test results. There was significant difference between the two measurements. The age range and type of exercise in Yürük and Gültekin's research is similar to our study. The increase in pain threshold at the end of our work is also supported in the literature. In Jones et al's (19)'s study, physical exercise training programme was for 6 weeks while this was 8 weeks in our study; yet, our research has provided significant improvement in the pain threshold in this period. Jones et al's study is solely based on aerobic exercises whereas our study comprised calisthenic exercises with characteristics of aerobic exercises and this explains the development in a positive direction that we observed in our patients.

CONCLUSION

In conclusion, our study on sedentary women, who had pain and were treated with a combination of conservative treatment and 3-days-a-week calisthenic exercises for 2 months, has shown that calisthenic exercises increase pain threshold compared to application of conservative treatment alone. At this point, we hold the opinion that applying calisthenic exercises along with conservative treatment increases muscle strength and pain threshold while decreasing severity of pain, which in turn improve people's quality of life.

Patients usually avoid exercises for fear of increased symptoms such as pain and fatigue. However, as physical activity decreases, muscle strength and muscle endurance also diminish and muscles become more prone to traumas; at length, this situation creates a vicious cycle. Therefore, by offering less intense and applicable physical activities that would not aggravate symptoms of patients with pain, practitioners can contribute to the enhancement of the quality of life of patients.

Calisthenic exercises are not very common in treatment of sports injuries and rehabilitation, yet we believe that calisthenic exercises can be used both as an alternative treatment in rehabilitation and as an exercise method that improves muscle endurance and muscle strength.

REFERENCES

1. Türkoğlu M. Ağrının tanımlanması ve ölçümü. ın: yegül i, editör. ağrı ve tedavisi. Yapım Matbaacılık, İzmir, 1993.p.19-28.
2. Diamond AW, Coniam SW. The management of chronic pain, New York: Oxford University Press. 1997.
3. Wall PD, Melzack R. Textbook of pain. Edition. London: Chirchill Livingstone. 1994.
4. Yılmaz A, Ergin S. Ağrı: periferal ve santral sensitizasyon. Romatizma 2006;21:105-10.
5. Robert A. ve Duarte MD. Ağrı sınıflaması. In: S.Özyalçın, S. Dinçer editörler, Ağrının Sırları İstanbul: Nobel Tıp Kitabevleri; 2005.p.6-9.
6. Kayhan Z. Ağrı: Klinik Anestezi. 3. Baskı Logos yayıncılık; 2004.p.922-59.
7. Kınser AM, SandsWA, Stone MH. Reliability and validity of a pressure algometer. J Strength Cond Res 2009;23(1):312–4.
8. Ohrbach R, Gale EN. Pressure pain thresholds, clinical assessment, and differential diagnosis: reliability and validity in patients with myogenic pain. Pain 1989;39:157–69.
9. Kosek E, Ekholm J, Nordemar RA. Comparison of pressure pain thresholds in different tissues and body regions. long-term reliability of pressure algometry in healthy volunteers. Scand J Rehabil Med 1993;25:117–24.
10. Otman S, Demirel H, Sade A. Tedavi hareketlerinde temel değerlendirme prensipleri. Ankara: Sinem Ofset. 1998.
11. Nicolakis P, Erdogmus B, Kopf A, Djaber-Ansari A, Piehslinger E, Fialka-Moser V. Exercise therapy for craniomandibular disorders. Arch. Phys. Med. Rehabil 2000;81:1137-42.
12. Lydia V, Roberto C, Fil A. Thermal and mechanical pain thresholds in patients with fluctuating parkinson's disease. Parkinson Relat Disord 2012;18:953-57.
13. Özer D. Temporomandibular eklem disfonksiyon sendromunda rol oynayan etyolojik faktörlerin ve semptomların araştırılması (Yüksek lisans tezi). Ankara: Hacettepe Üniversitesi; 2004.

2016;23(1):29-35
DOI:10.5455/jtomc.2015.2954

14. Baştuğ Yürük Ö, Gültekin Z. Fibromiyalji sendromu olan kadınlarda iki farklı egzersiz programının karşılaştırılması. Fizyoter Rehabil 2008;19(1):15-23.
15. Ozer Kaya D, Duzgun İ, Baltaci G, Karacan S, Colakoglu F. Effects of calisthenics and pilates exercises on coordination and proprioception in adult women: a randomized controlled trial. J Sport Rehabil 2012;21:235-43.
16. Iwamoto J, Suzuki H, Tanaka K, Kumakubo T, Hirabayashi H, Miyazaki Y et al. Preventative effect of exercise against falls in the elderly: a randomized controlled trial. Osteoporos Int 2009;20:1233-40.
17. Keser I, Meric A, Kirdi N, Kurnec A, Karabudak R. Comparing routine neurorehabilitation programme with callisthenic exercises in multiple sclerosis. Neuro Rehabilitation 2011;29:91-8.
18. Jespersen A, Amris K, Graven-Nielsen T, Arendt-Nielsen L, Marie Bartels E, Torp-Pedersen S, et. al. Assessment of pressure-pain thresholds and central sensitization of pain in lateral epicondylalgia. Pain Medicine 2013;14:297-304.
19. Jones MD, Booth J, Taylor JL, Barry BK. Aerobic training ıncreases pain tolerance in healthy individuals. Med. Sci. Sports Exerc 2014;5:120-6.