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THE EFFECT OF TRUNK STABILITY TRAINING ON UPPER EXTREMITY ENDURANCE, STABILITY AND SHOULDER JOINT PROPRIOCEPTION IN POSTMENOPAUSAL WOMEN

ORIGINAL ARTICLE

ABSTRACT

Purpose: The incidence of shoulder pathologies is increasing in postmenopausal women. In this period, there is a need for protective approaches to be applied to prevent shoulder injuries. The aim of this study is to investigate the effects of clinical pilates exercises on upper extremity stability, endurance, function and shoulder joint proprioception in postmenopausal women.

Methods: 30 postmenopausal women between the ages of 40-60 were included in this study. Participants were given clinical pilates training for 6 weeks, 3 days a week, 60 minutes by a physiotherapist. Before and after pilates training, dynamic stability of the shoulder was evaluated with Closed Kinetic Chain Upper Extremity Stability Test (CKCUES Test) and Upper Quarter Y Balance Test (UQYBT). Upper extremity muscle endurance was evaluated with the modified push up test. Laser Pointer-Assisted Angle Reproduction Test (LP-ART) was used to evaluate shoulder joint position sense.

Results: A statistically significant difference was found in CKCUES Test (p=0.000, r=0.594), UQYBT (p=0.000, r=0.537), modified push up (p=0.000, r=0.594), LP-ART abduction (p=0.000, r= 0.491) and LP-ART flexion (p=0.000, r=0.484) at end of the training compared to the pre-training. The exercise program was found to be highly effective on all parameters.

Conclusion: It was concluded that clinical pilates training applied in postmenopausal women increased the dynamic stability of the shoulder, endurance and position sense. Trunk stabilization exercises may be beneficial as a preventive approach in the prevention of shoulder pathologies in postmenopausal women.

Keywords: Postmenopause, Proprioception, Shoulder Joint

POSTMENOPOZAL KADINLARDA GÖVDE STABİLİTE EĞİTİMİNİN ÜST EKSTREMİTE ENDURANSI, STABİLİTESİ VE OMUZ EKLEM PROPRİOSEPSİYONUNA ETKİSİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Postmenopozal dönemdeki kadınlarda omuz patolojilerinin görülme sıklığı artmaktadır. Bu dönemde omuz yaralanmalarını önleme amacıyla uygulanacak koruyucu yaklaşımlara ihtiyaç duyulmaktadır. Bu çalışma, postmenopozal dönemdeki kadınlarda klinik pilates egzersizlerinin omuz eklem propriosepsiyonu ile üst ekstremite stabilitesi ve enduransı üzerindeki etkileri araştırmak amacı ile tasarlanmıştır.

Yöntem: Çalışmaya 40-60 yaşları arasında değişmekte olan postmenopozal dönemdeki 30 gönüllü kadın dâhil edildi. Bireylere fizyoterapist eşliğinde haftada 3 gün, 6 hafta süreyle klinik pilates eğitimi verildi. Egzersiz programı öncesi ve sonrasında omuz eklem pozisyon hissi Lazer İmleç Yardımlı Açı Tekrarlama Testi (Lİ-ATT) ile, omzun dinamik stabilitesi Üst Ekstremite Y Denge Testi (ÜEYDT) ve kapalı kinetik zincir üst ekstremite stabilite testi (KKZÜEST) ile, üst ekstremite kas enduransı ise modifiye push up testi ile değerlendirildi.

Sonuçlar: Eğitim sonunda KKZÜEST (p=0,000, r=0,594), ÜEYDT (p=0,000, r=0,537), modifiye push up (p=0,000, r=0,594), Lİ-ATT abduksiyon (p=0,000, r=0,491) ve Lİ-ATT fleksiyon (p=0,000, r=0,484) ölçümleri üzerinde eğitim öncesine göre istatistiksel düzeyde anlamlı farklılık elde edildi ve egzersiz programı tüm parametreler üzerinde yüksek etkili bulundu.

Tartışma: Postmenopozal kadınlarda uygulanan klinik pilates eğitiminin omuz propriosepsiyonu, dinamik stabilitesi ve enduransını artırdığı sonucuna varıldı. Postmenopozal dönemdeki kadınlarda omuz patolojilerinin önlenmesinde koruyucu yaklaşım olarak gövde stabilizasyon egzersizleri yarar sağlayabilir.

Anahtar Kelimeler: Omuz Eklemi, Postmenopoz, Propriyosepsiyon

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INTRODUCTION

Postmenopause is defined as the period after menopause and begins after 12 months of amenorrhea (1). The incidence of shoulder injuries increases in the postmenopausal period (2,3). In a prevalence study investigating postmenopausal symptoms, it was reported that shoulder stiffness was the most common symptom in the postmenopausal period with a rate of 75.4% (2) Additionally, the prevalence of full-thickness rotator muscle tears in postmenopausal women (8.9%) was found to be significantly higher than the prevalence in premenopausal women (3.1%) (3).

Most of the studies in the literature involving postmenopausal women investigated the risk of falls and fractures. Studies mostly focused on lower extremity functions, balance and bone mineral density (4, 5). However, evaluation and rehabilitation of the upper extremity in postmenopausal women is at least as important as the lower extremity. Protective exercise approaches that improve strength, endurance and stability of the muscles around the shoulder can help to prevent shoulder pathologies that is more prevalent in postmenopausal period. Literatue suggests that the clinical pilates program applied in the postmenopausal period is effective in improving bone mineral density, physical fitness, balance and quality of life, and also reduces the risk of falling (5, 6).

Clinical pilates is a popular exercise programme today that focuses on stabilizing the ‘core’ area. The word ‘core’ refers to the area surrounded by M. Diaphragma, M. Transversus abdominis (TrA), M. Multifidus and pelvic floor muscles. The core area is the center of the functional kinetic chain that provides proximal stability for distal mobility and optimal function of the extremities (7). The kinetic chain refers to the connection of multiple parts of the body that allows the transfer of forces and movement. The core area provides a base of support for the transfer of force and energy to the upper and lower extremities. Breaks or deficits in the kinetic chain can lead to injury or decreased performance (7).

Recent studies have an increasing interest focusing on the relationship between trunk stability and distal segments. Studies in different populations have shown that pilates exercises increase knee joint proprioception (8) and lower extremity endurance (9). Evidence has reported that poor core stability is a potential risk factor for lower extremity injuries (10). In addition, a recent systematic review reported that injury prevention programs that included core stability exercises in athletes reduced knee injury rates by 56% (11).

In some studies, it has been reported that there is a kinetic relationship between the core region and shoulder movement (7,12). Futhermore, insufficient postural stability has been reported in patients with pathological shoulder pain (13). These study findings, which support the relationship between shoulder and core stability, suggest that good core stability may play an important role in pevention of shoulder injuries (12,13). However, to best of our knowledge, no studies have investigated whether clinical pilates that increase core stabilization would improve upper extremity stability, endurance and shoulder joint proprioception in postmenopausal women. The aim of this study is to investigate the effects of clinical pilates training on upper extremity stability, endurance and shoulder joint proprioception in postmenopausal women.

METHODS

Study Design and Patient Population

This study is a research with a single-group pre-test research design, conducted between October and January 2017. All procedures were carried out in compliance with the Helsinki Declaration. It has been approved by the decision of the ethics committee of the university that the authors are involved with. (Approval date: 19.12.2016, decision number: 2016/36-01). The GPower (G*Power, version 3.1.9.4 for Windows XP, Germany) program was used to determine the sample size. The initial sample size was calculated as n=25 under the assumptions of (d)= 0.6, α=0.05, β=0.20. Considering that there might be participants who leave the study, the initial sample size was increased by 25% and the final sample size was determined as n=30 (14). Thirty postmenopausal women who lived in the Turkish Republic of Northern Cyprus (TRNC) Famagusta district and met the inclusion criteria were included in the study. The subjects were informed about the content of the study by the responsible physiotherapist. An informed consent form was signed by each participant.

Participants who had been in natural menopause for at least 6 months and were between the ages of 40 and 60 were included in the study. Participants with shoulder pain exceeding 3 centimeters (cm) on the visual analogue scale (VAS), any health problems that would contraindicate exercise, any diagnosed pathology or previous surgery on the shoulder, and participants receiving active hormone replacement therapy were excluded from the study.

Outcome Measurements

30 individuals participating in the study, in groups of 15, were included in the 6-week clinical pilates program. The sociodemographic information of the individuals were recorded before the exercise protocol. Shoulder joint position sense, dynamic shoulder stability and upper extremity muscle endurance were evaluated at pre-intervention and at the end of the 6 weeks exercise program. All measurements were performed by the same physiotherapist.

Shoulder Joint Position Sense

The assessment of shoulder position sense, which was the primary outcome measure of this study, was evaluated by using a Laser Pointer-Assisted Angle Reproduction Test (LP-ART). Measurements were repeated three times for 90° shoulder flexion and 90° shoulder abduction. The laser pointer was fixed 5 cm above the olecranon, in order to prevent angular deviations due to elbow and wrist movements. Measurements were taken from the dominant arm. The individual stood 1 meter away from a millimeter of paper fixed to the wall. During the test, the individual was asked to move their shoulder joint to 90° flexion position and the accuracy of the movement was evaluated by the physiotherapist using a digital goniometer (Baseline Absolute Axis Digital Goniometer). While maintaining 90º shoulder flexion, the projection of the laser pointer was marked on the millimetric paper as the target point. The individual was asked to keep the laser pointer light on that point for 10 seconds while the eyes were open. Then, the physiotherapist asked the individual to repeat the same movement by closing their eyes. When the 'OK' command was received, the coordinates of the position of the laser light which was on the paper were marked by the physiotherapist. The measurement was repeated thrice. Before each attempt, individuals opened their eyes and positioned the laser light on the target point. The test protocol for abduction movement was repeated at a 90° range of motion with the subject turned sideways against the wall. The angular deviation values obtained according to the x-y axis for the flexion and abduction positions were calculated by placing them in the formula $c=\sqrt{x^2 + y^2}$ in Microsoft Excel 2013 program. The average of the 3 values obtained in the abduction and flexion directions were used in the statistical analysis (15), (Figure 1).

Dynamic Shoulder Stability

Dynamic stability of the shoulder was evaluated using Closed Kinetic Chain Upper Extremity Stability (CKCUES) Test and Upper Quarter Y Balance Test (UQYBT).

The push-up position is commonly used in the CKCUES Test measurement, but in cases such as advanced age, the use of the modified version with the knees in flexion may be preferred (16). A modified version of this test was used in our study. Subjects took a push-up position with their hands placed 36 inches (91.44 centimeters) apart on 1.5 inches (3.81 centimeters) wide strips of tape attached to the floor. While one hand was fixed on the ground, the individual raised the other hand, touched the band under the fixed hand, and brought it back to the starting point. The same movement was repeated for the opposite side. The number of consecutive repetitions within 15 second timeframe was recorded. The test was repeated thrice with 45 sec resting periods in between. The average number of successful repetitions obtained from the tests was used in the analysis (16), (Figure 1).

UQYBT is used to determine the risk of injury in musculoskeletal problems. It is also important because it is the only test in the literature that evaluates shoulder stabilization while also evaluating core stability (17). In our study, a wooden platform with three PVC pipes connected in the medial, inferolateral and superolateral directions, was used. This device was manufactured by taking the Y Balance Test Kit as an example. A tape measure was attached to the pipes in order to measure the reach in three directions. Prior to measurement, the subject assumes a modified push-up position with the upper extremity shoulder-width apart, the right hand on the stance plate, and the left hand on the access cursor. Maintaining the push-up position, participant advances the access cursor with the left hand in 3 directions, medial, inferolateral, and superolateral, respectively. The maximum distance reached in each direction was recorded. Three measurements were made on the right arm and on the left arm. A measuring tape was used to determine the length of the upper extremity, the distance between the acromion and the longest fingertip that will be used in scoring. The combined distance reached was calculated using the furthest distance reached for both extremities in that direction, using the formula [(maximum medial + maximal inferolateral + maximal superolateral) / (3 x upper extremity length)] x 100 in Microsoft Excel 2013 program and was used in the statistical analysis (17).

Upper Extremity Endurance

In our study, a modified push up test was used to evaluate upper extremity endurance. The push-up test was initially developed in order to evaluate upper extremity muscle endurance. The test may be performed in two different ways: whole body push-up or modified push-up. The modified push-up test is mostly preferred in women (18). In the study, the subject was asked to take the modified push-up position with knees flexed and elbows extended on a mat. Subjects were asked to bring their upper body closer to the ground by flexing their elbows without disturbing the flexion angle of their knees, and then to push their upper body back by extending their elbows. The number of successful repetitions performed in 30 seconds was recorded. Average of the three trials was recorded to be used in the analysis (18).

Exercise Protocol

Clinical pilates exercise training was applied for a total of 18 sessions, 3 days a week for 6 weeks. The exercises were performed in the indoor exercise room of the xxx University Faculty of Health Sciences. The exercises were performed by the same physiotherapist in two groups, with each group consisting of 15 people. The sessions lasted a total of one hour and each exercise was performed with 6-8 repetitions throughout the training.

The clinical pilates program included 10-minute warm-up exercises, 40-minute trunk stabilization exercises, followed by 10-minute cool-down exercises. During the first session, the main principles of clinical pilates exercises (concentration, control, centering, fluency, precision and breathing) were explained and subjects were asked to perform these exercises accordingly. During the exercises, it was checked by the physiotherapist whether the people could meet those principles. The difficulty of the exercise program was gradually increased with an interval of 2 weeks for 6 weeks. In addition, an elastic band was introduced in the exercise program during 2nd week and a pilates ball during 4th week. The exercise program was personalized by considering the clinical conditions and strain levels of some participants during the study (Table 1).

Statistical Analysis

The data obtained during the study was analyzed using the IBM SPSS 20.0 (IBM Crop. Released 2011. IBM Statistics for Windows, Version 20.0 Armonk, New York). Wilcoxon Sign Test was used to compare pre-training and post-training measurements.

Descriptive statistics for discrete and continuous variables in the study were expressed as percentage, mean ± standard deviation, and number. Significant difference value was accepted as p < 0.05. P <0.001 was interpreted as a high level of significant difference. Mean values were given with 95% Confidence Interval (95% CI) lower and upper limit values. “P” values and “95% CI” values were used to interpret whether the pre-training and post-training measurements were significantly different from each other. The effect size was calculated to determine the clinical effectiveness of the training. Cohen’s d coefficient was used to calculate the clinical effect size. Effect size was interpreted as small (d = 0.2), medium (d = 0.5), or large (d = 0.8), (19).

RESULTS

Thirty postmenopausal women with a mean age of 53.5 ± 4.7 years participated in the study. Of these people, of whom the first measurements were taken, 26 of them completed the study and 4 people left the study due to health problems, transportation problems and foreign travels.

The average age at menopause of the individuals was 49.5 ± 2.9 years, and the average menopause duration was 4.09 ± 3.4 years. The average body mass index (BMI) value of the individuals participating in the study was 29.3 ± 4.7 kg/cm². While 57.7% of the individuals were housewives, 15.4% were retirees, 19.2% were those who worked with more mental effort, and 7.7% were those who worked with physical effort.

After 6 weeks of clinical pilates exercise training, a statistically significant difference was detected in CKCUES Test scores compared to pre-training (p = 0.000) The mean CKCUES test

Table 1. Clinical Pilates Exercise Protocol

0-2 Week	2-4 Week	4-6 Week	Warm-up Phase	Cooling Phase
Hundreds1 Hundreds 2 One leg stretch 1 Shoulder bridge 1 Hip twist 1 Clam 1 Side kick 1 Arm openings 1 Swimming 1 Swimming 2 Single leg kicks One leg circle	Hundreds 3 One leg stretch 2 Double leg stretch 2 Shoulder bridge 2 Hip twist 3 Clam 2 Side kick 2 Side kick-small circles Abdominal prepation Swimming 3 Single leg kicks One leg circle 2	Hundreds in supine crook lying One leg stretch 2 Hells together-tools apart Hip twist Shoulder bridge Side kick in lying One leg kick Swimming 1 Swimming 2 Side kick beginner Double leg stretch Mermaid	Mini squat, Kleopatra, Toy soldier, Upper extremity PNF Swinging Chest stretch	The saw, Mermaid Cat stretch Toy soldier Swinging Chest stretch

Table 2. Comparison of Individuals’ Pre- and Post-Training UQYBT, CKCUES Test, LP-ART and Modified Push Up Results.

Variables	Pre-Training	Post-Training	P *	d
UQYBT (cm)				
Right	90.75 ± 13.54 *(85.54— 95.95)*	101.07 ± 9.77 *(97.31 — 104.82)*	**<0.001***	**0.874**
Left	92.28 ± 12.34 *(87.54 — 97.02)*	102.28 ± 9.32 *(98.69 — 105.86)*	**<0.001***	**0,914**
CKCUES Test (repeat/15 sec)	8.48 ± 3.24 *(7.24 — 9.73)*	11.61 ± 2.49 *(10.66 — 12.57)*	**<0.001***	**1,083**
LP-ART (cm)				
Shoulder flexion	7.63 ± 2.64 *(6.61 — 8.65)*	5.23 ± 1.73 *(4.56 — 5.90)*	**<0.001***	**1,075**
Shoulder abduction	8.96 ± 3.85 *(7.48 — 10.44)*	6.35 ± 2.23 *(5.49 — 7.21)*	**<0.001***	**0,829**
Modified Push Up (repeat/30 sec)	5.19 ± 4.31 *(3.53 — 6.85)*	9.12 ± 4.80 *(7.27 — 10.97)*	**<0.001***	**0,861**

*: Wilcoxon Sign Test, UQYBT: Upper Quarter Y Balance Test, CKCUES Test: Closed Kinetic Chain Upper Extremity Stability Test, Laser Pointer Assisted Angle Reproduction Test (LP-ART)

Figure 1. (a) Closed Kinetic Chain Upper Extremity Stability Test, (b) Laser Pointer Assisted Repeat Test of Shoulder Flexion and Abduction

score increased from 8.5 ± 3.2 to 11.6 ± 2. A statistically significant decrease in both right extremity UQYBT (p=0.001) and left extremity UQYBT values (p=0.001) was observed post training compared to the beginning. Exercise was found to be large effect on right UQYBT, left UQYBT and CKCUES Test (d≥0.8)

When the pre-training and post-training Modified Push Up test values of the individuals were compared, a significant difference was observed (p=0.000). Although there was an overlap in the lower and upper limits of the 95% confidence interval, the difference between baseline and post-treatment mean values was considered significant because it did not include '0' (-6.44 — -1.36). When the effect size was examined, a clinically large effect was found for the Modified Push Up test (d=0,861). When shoulder position sense values were examined, joint position error values for both abduction movement (p = 0.000, d=0,829) and shoulder flexion movement (p=0.000, d=1,075) decreased significantly post-training compared to pre-training. It was determined that the exercise program had a large clinical effect on shoulder position sense (d≥0.8), (Table 2).

DISCUSSION

It was determined that there was an improvement in upper extremity dynamic stability, upper extremity endurance and shoulder joint position sense after a 6-week clinical pilates program in postmenopausal women.

Proprioception and neuromuscular control play an important role in the prevention of shoulder injuries (20). The main goal of clinical pilates exercises is to increase the strength and endurance of the core muscles responsible for the static and dynamic stabilization of the body (21). There is strong evidence that pilates exercises increase muscle endurance, reduce pain and improve quality of life in women (22). Core stability provides the transfer of torque and momentum between the lower and upper extremities, therefore it is considered to form the basis of the kinetic chain (7). There are various studies examining the relationship between core stability and distal segments (12,23). Joseph et al. hypothezise that the lumbopelvic (LP) region and the GHJ were associated with myofascial suspension systems called posterior and anterior oblique slings and provide force transfer between the lower and upper extremities (12). Some electromyography (EMG) studies in the literature confirmed this hypothesis (23, 24).

Studies mostly examine the effects of pilates exercises and core stabilization exercises on trunk and lower extremity proprioception, and there are various evidences on this subject (8, 25-28). Kısacık et al. reported that the clinical pilates exercise program applied for 10 weeks in their study improved knee proprioception in patients with knee osteoarthritis (25). Alaa et al. reported that core stability training added to the standard rehabilitation protocol in patients who had undergone ACL reconstruction made a clinical difference in terms of improvement of knee proprioception (26). Mazloum and Rahnama reported that pilates training significantly increased knee joint proprioception in individuals with knee osteoarthritis (8). In the study of Kim et al. found that core stabilization-based exercise program increased trunk extension and flexion proprioception in women with chronic low back pain (27). Our study is the first to examine the effect of an exercise program on shoulder proprioception in postmenopausal women. Our study concluded that there was a significant increase in shoulder joint flexion and abduction position sense with clinical pilates exercises. These findings support other studies in the literatüre (8, 25-28). This increase was thought to be due to the fact that the load on the shoulder during closed kinetic chain exercises activates more mechanoreceptors in the shoulder joint. In addition, increased core stability with pilates exercise program may lead to the firing of more muscle spindles in the distal segments, resulting in an increase in upper extremity proprioception. However, authors suggest that further high quality studies are required on this subject.

In the evaluations made at the end of the clinical pilates exercise program, statistically significant impovements occurred in both shoulder stability and upper extremity endurance compared to pre-training. In our study, it is thought that myofascial force transmission realized between the LP region and the GHJ has contributed in the increase in shoulder stability and endurance with clinical pilates exercises. This can be explained by the transmission of the core stability and endurance increase provided by clinical pilates training to the upper extremity with myofascial suspension systems. The results obtained support the studies examining the relationship between core stability and upper extremity (12,23). Evidence-based studies examining the effect of core stability training on shoulder stability and endurance are insufficient. Micoogullari et al. reported that individuals who do regular pilates exercises for at least 6 months have significantly more scapular muscle strength than age and gender-matched sedentary individuals (29). In another study by Katayifçı et al., 35 healthy individuals were given pilates exercises 3 days a week for 8 weeks (30). A statistically significant increase was found at the end of the study, in the upper extremity muscle endurance, which was evaluated with the modified push-up (30). A previous study by Kloubec reported that Pilates training applied for 2 days a week for 12 weeks significantly increased shoulder endurance evaluated with the upper extremity push up test (31). In another study, it was found that there was an increase in tennis serve speed and abdominal muscle endurance in tennis players after pilates mat exercises applied twice a week for 6 weeks (32). However, to best of our knowledge, there is no study in the literature examining the relationship between core stability training and shoulder joint on postmenopausal women. Our study has found that there was an increase in shoulder stability and endurance with clinical pilates training applied in postmenopausal women. The results obtained from our study support previous study findings (29-31). In addition, the results obtained support the studies examining the kinetic relationship between core stabilization and upper extremity. In our study, it was thought that the increased core stability after clinical pilates training may have increased glenohumeral stability and endurance by providing torque and momentum to the upper extremity.

The limitation of our study is that the pilates exercise program was carried out within the lower limit of 6 weeks. Another limitation of our study is that our sample was not selected from the population, so it cannot be generalized to the population. Additionally, due to the nature of the one group pre-post design, it is not possible to attribute changes over time to intervention components. The changes observed in this study may be due to nonspecific effects of the intervention, such as the attention paid by the therapist, the ritual of the exercise routine, or the natural improvement of symptoms over time, rather than the effect of the Pilates exercises. An additional untreated control group is therefore recommended in future studies.

This study shows that clinical pilates training significantly improves shoulder dynamic stability, endurance and position sense in postmenopausal women. Clinical pilates exercises can be an appropriate exercise choice for postmenopausal women, as increase shoulder stabilization, endurance and proprioception. Authors believe that clinical pilates exercises can be used as an appropriate, protective approach against shoulder injuries such as rotator cuff tears and shoulder impingement syndrome, which are seen in high incidence in the postmenopausal period.

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