Smyrna Tıp Dergisi ***Araştırma Makalesi***

Acute Effects of Different Massage Techniques on Joint Position Sense and Neuromuscular Control Levels: A Randomized Controlled Trial

Farklı Masaj Tekniklerinin Eklem Pozisyon Hissi ve Nöromüsküler Kontrol Düzeyleri Üzerindeki Akut Etkileri: Randomize Kontrollü Bir Çalışma

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Summary
Objective: The aim of this study is to compare the acute effects of different types of massages on upper extremity joint position sense and neuromuscular control levels.
Material and Method: Thirty healthy female subjects were included in the study. The subjects were randomly divided into three groups as classic massage (CM), connective tissue massage (CTM) and control. The sociodemographic characteristics of the subjects were recorded. The sense of shoulder joint position was evaluated with the angle repetition test assisted by a laser pen. The Functional Throwing Performance index was used to evaluate the upper extremity neuromuscular control level. Evaluations were performed before and immediately after all interventions.
Results: Statistically significant difference was detected for both the Functional Throwing Performance Index and joint position sense ($p<0.05$) among the groups. According to the results of the paired group comparisons, there was a significant difference (p:0.016) between CM and CTM for the Functional Throwing Performance Index. A significant difference was found between (p:0.008) CM and control for joint position sense.
Conclusions: It is recommended that classic massage application should be included in physiotherapy and rehabilitation programs.
Key words: Classic massage, connective tissue massage, neuromuscular control

Özet
Amaç: Bu çalışmanın amacı, farklı masaj tiplerinin üst ekstremite eklem pozisyonu hissi ve nöromüsküler kontrol seviyeleri üzerindeki akut etkilerini karşılaştırmaktır.
Gereç ve Yöntem: Otuz sağlıklı kadın çalışmaya dahil edildi. Olgular klasik masaj (CM), konnektif doku masaj (CTM) ve kontrol grubu olarak rastgele üç gruba ayrıldı. Olguların sosyodemografik özellikleri kaydedildi. Omuz ekleminin pozisyonu hissi, lazer kalem kullanılarak açı tekrar testi ile değerlendirildi. Üst ekstremite nöromüsküler kontrol seviyesini değerlendirmek için Fonksiyonel Fırlatma Performansı indeksi kullanıldı. Tüm değerlendirmeler müdahalelerden hemen önce ve sonra yapıldı.
Bulgular: Gruplar arasında hem Fonksiyonel Fırlatma Performans İndeksi hem de eklem pozisyonu duygusu ($p<0.05$) açısından istatistiksel olarak anlamlı bir fark bulundu. Eşleştirilmiş grup karşılaştırmalarının sonuçlarına göre CM ve CTM arasında Fonksiyonel Fırlatma Performansı İndeksi için anlamlı bir fark bulundu (p:0.016). CM ile kontrol grubu arasında eklem pozisyonu hissi arasında anlamlı fark bulundu (p:0.008).
Sonuç: Klasik masaj uygulamasının fizyoterapi ve rehabilitasyon programlarına dahil edilmesi önerilmektedir.
Anahtar Kelimeler: Klasik masaj, bağ dokusu masajı, nöromüsküler kontrol.

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Introduction

Massage is a systematic and scientifically applied manipulation on the soft tissues of the body (1). Massage gives tactile sense and increases proprioceptive inputs. This helps stimulate large, fast nerve fibers and then block smaller and slower nerve fibers that detect pain. This effect

results from local lateral inhibition in the spinal cord (2). The mechanical effect of massage accelerates the capillary, vena and lymph circulation, dilates the vessels, resulting in a faster removal of lactic acid and other metabolic residues (3). Moreover; massage overcomes fatigue and helps recovery. An increase in muscle blood flow would hasten the delivery of oxygen, increase muscle temperature and protect blood pH, which would then assist in physical performance. Birukov et al. (4) thought that massage is more effective than passive rest in case of severe muscle fatigue. Fatigue causes a decrease in strength and speed, loss of motor coordination, slow reaction time and limited desire and ability. There are physiological, mechanical, reflex-related and psychological effects of massage such as reducing fatigue, increasing performance, increasing the level of neuromuscular control, providing personal well-being and increasing self-confidence (1).

There are different forms of massage therapy such as classical, connective tissue, shiatsu and acupressure massage (2).

The specific mechanisms of classical massage therapy are unknown, but different physiological treatments have been proposed for massage therapy. These mechanisms are increased lymph flow, transition from sympathetic to parasympathetic response, prevention of fibrosis, increased clearance of blood lactate and effects on the immune system, cognition and pain. Cutaneous mechanoreceptors may be stimulated by dynamic events on the skin, such as massage, friction or vibration, and by rhythmic or oscillatory movements (1).

Connective tissue manipulation (CTM), a manual reflex therapy, targets the superficial connective tissues to stimulate segmental and suprasegmental autonomic cutaneo-visceral reflexes in order to restore autonomic balance and reduce the dysfunction in the affected internal organs. By stimulation of segmental reflexes, CTM may be used to increase upper extremity performance and circulation, reducing fatigue in individuals (5).

Although different types of massage have been used for treatment of muscle strength, proprioception (6), muscle fatigue (4,7) and pain (8) there is no evidence for comparing classical massage and connective tissue massage in proprioception and throwing performance in people for their upper extremities.

Throwing performance requires attention and control of body movements and is influenced by many factors such as balance, shoulder and forearm control and postural control (9). Awareness of the orientation of the body in space and direction, extent and rate of movement in the shoulder is essential for positioning and coordination. Therefore, proprioception affects normal coordinated movement and performance. However, despite the important role of neuromuscular control and proprioception, the effect of therapeutic massage on neuromuscular control and proprioception remains unclear (6). There are controversial claims in the literature about massage and performance (1). Goodwin et al. (10) found that a 15-minute controlled lower extremity massage before warming up did not have a significant effect on sprint performance. In contrast, Crosman et al. (11) determined that a single massage on the hamstring muscle group increased passive range of motion in the hip joints. However, no study in the literature evaluated joint position sense and upper extremity performance together. Therefore, the aim of this study was to compare the acute effects of connective and classical massages on the joint position sense and neuromuscular control levels of healthy women.

Materials and Methods

Participants:
Thirty female university subjects who were right-dominant (age: 23.26±1.46 years, body-mass index (BMI): 20.92±1.86 kg/m^2) participated in a single-blind randomized controlled trial.

The inclusion criteria were as follows: adults aged 18 years or older, not having participated in any exercise program of the upper extremities at least 24 h before the study, lack of medical conditions such as acute inflammation or closed abscesses, skin and physiological problems that cause contraindications for massage.

Subjects were excluded from this study if they demonstrated any of the following: regular use of any analgesics or anti-inflammatory medications, contraindications to receiving massage, having any pain, injury and musculoskeletal problems in the upper extremities.

Study was carried out between 12.November.2018 and 3.June.2019 in an university hospital. Study was conducted based on institutional guidelines and the principles of the Declaration of Helsinki. All patients provided informed consent before the study began.

Simple size:
G*Power was used to conduct statistical power analyses. The sample size was determined as 8 subjects in each group with the alpha level set at .05 to achieve 85% power.

Randomization procedure:
Online random allocation was used for randomization by the list of volunteers. The subjects were randomly divided into three groups as a classical massage, connective tissue massage and control.

Blinding and intervention procedures:
One physical therapist who applied all interventions and another who assessed the outcomes were blinded to the interventions. The interventions were designated into 3 groups: CM CTM, and control. The subjects were placed in only 1 of these 3 groups based on randomization. The room temperature was stabilized at 22–24 °C, silence was provided without air flow throughout the interventions. Each intervention was performed by the same physiotherapist and completed in approximately twenty minutes. All outcome measurements were assessed before and immediately after all interventions.

Interventions:
a) Classical massage
Different kinds of strokes were performed, including superficial and deep stroking, kneading by using a nonaromatic topical lotion on the upper extremity and pectoral region of the dominant limb. It was performed one time a day (morning, 9 am) for 20 min in a supine position with the arm supported on a pillow on the level of the heart. A metronome with a frequency of 1 Hz was used to provide constant speed in the massage (12).

b) Connective tissue massage
One session of CTM was performed in this group on the basic regions (lower thoracic region, scapular region, interscapular region, cervical region, occipital region) and upper extremities. During the application, the person was seated with her back open, on a stool without back and arm support, in an upright position at a ninety-degree angle between the hips and the hips and the knees. In practice, appropriate strokes (long or short) were applied in the appropriate order on the respective regions as defined in the art. Six different sets of strokes were used, as proposed by Ebner (5). The strokes were short (approx. 3 cm) and long (approx. 10 cm). Each set of strokes was repeated three times, first on the right and then on the left lumbosacral and dorsal regions for the base. CTM was applied on the dominant upper extremity. The therapist used the index and middle fingers that were placed on the skin at an approximately 45 degree angle. The pressure was firm and may have felt like an uncomfortable scratching or cutting (12).

c) Control
The physical therapist instructed the subjects to just lie down in a supine position for 20 min, and no touch was applied (13).

Outcome measurements:
a) Joint position sense
The sense of shoulder joint position was evaluated with the angle repetition test by a laser pen. The dominant side shoulders of all subjects were included in the study. The subject was blindfolded using blackout goggles for preventing visual cues from aiding joint position sense acuity. The subject was asked to stand (approximately 1 m away from the wall) face to face on the millimeter paper while her face was revealed. A piece of tape was applied to the floor by ensuring the same starting point if the participant moved. A Velcro strap was used to attach the laser pen to the posterior aspect of the middle phalanx of the index finger. The test was performed at a 90 ° shoulder flexion position.

This shoulder joint movement was measured by the physiotherapist with a goniometer, and the subject was asked to keep her eyes open in this position for 10 seconds. The projection of the laser pointer was marked on the millimeter paper as a target angle. The 90 ° position was repeated with eyes open until memorization of this position. Then, the subjects were asked to repeat the same movement with eyes closed and point the laser pen to the marked point. According to the target angle, the x and y axes were measured. Deviations from the target angle was calculated by the formula $c=\sqrt{x2+y2}$. The test was repeated three times, and the average of three measurements was taken (14).

b) Neuromuscular control level

The Functional Throwing Performance Index (FTPI) was used for the neuromuscular control level of the upper extremities. The participant stood 4.57 m away from the target. A square with a height of 1.22 m from the floor and an edge of 3.48 cm was drawn on the wall as a target. The objective of the test was to throw a rubber playground ball (50.8-cm circumference) into the target as many times as possible over three 30-s trials. The test was repeated three times, and the average was taken (15).

Statistical Analysis:

Statistical analysis of the data obtained from the study was performed with the Statistical Package for the Social Sciences (SPSS) (Version 17, Chicago IL, USA). Descriptive statistics (mean, standard deviation, frequency and percentile) are given for the continuous variables in the study. Analyses were carried out by using nonparametric statistical methods. Wilcoxon signed-rank test was used to compare two related samples. Kruskal-Wallis Test was used to assess significant differences on a continuous dependent variable by a categorical independent variable. Mann-Whitney U test was used to compare the differences between two independent groups. Corrected Bonferroni test was used for multiple comparisons ($p<0.05$ was considered as statistically significant).

Results

There was no statistically significant difference based on age, body mass index, educational status and hand dominance ($p<0.05$). There was a statistically significant difference for the three groups in terms of both the Functional Throwing Performance Index and joint position sense parameters ($p<0.05$) (Table1).

Table 1. *Results of interventions between and within groups*

		CM		CTM		Control		p^2
		X±SD	p^1	X±SD	p^1	X±SD	p^1	
FTPI	**Pre**	4.90±1.59	**0.026***	4.40±2.36	0.457	5.80±1.98	0.121	**0.038***
	Post	6.10±2.07		4.10±1.37		5.00±1.49		
JPS	**Pre**	10.98±5.37	0.333	8.49±3.21	0.445	5.79±2.57	0.074	**0.025***
	Post	9.39±3.93		8.15±5.89		4.15±2.62		

*FTPI: Functional throwing performance index, JPS: Joint position sense, CM: classic massage, CTM: connective tissue massage, X: mean, SD: standard deviation, [1]Wilcoxon Signed Ranks Test, [2] Kruskal Wallis Test, * p<0.05.*

According to the results of the paired group comparisons, there was a significant difference found (p=0.016) between CM and CTM for the Functional Throwing Performance Index. There was a significant difference between (p=0.008) CM and control for joint position sense (Table 2).

Table 2. *Comparison of paired groups*

Pμ	CM- CTM	CM-Control	CTM-Control
FTPI	**0.016***	0.259	0.105
JPS	0.364	**0.008***	0.082

*FTPI: Functional throwing performance index, JPS: Joint position sense, CM: Classic massage, CTM: connective tissue massage, [μ]: Mann Whitney U test, *p < 0.017.*

Discussion

In this study, the acute effects of classical and connective tissue massages on upper extremity joint position sense and neuromuscular control levels were compared; whereas both the Functional Throwing Performance Index and joint position sense showed an improvement in the classical massage group. A decrease in proprioception may contribute to increased load on the shoulder joint while throwing, increased laxity of the joint and

higher energy demand during throwing, which, when combined, reduce the neuromuscular control levels. Decrements in proprioception could also contribute to impaired, decreased postural control, which increases the risk of injuring the shoulder. Although plyometric, exercise training, biofeedback and balance trainings have been performed to increase neuromuscular control and joint position sensation in the lower extremities (16), the effects of massage on the upper extremities have not been exactly investigated.

The literature investigated the effects of massage on muscle pain (17), joint movement (18), relaxation (8), blood pressure (19) and performance (19), but there are limited studies on the neuromuscular control levels and joint position sense in the upper extremities.

Functional Throwing Performance is used for the neuromuscular control level of the upper extremity. Both proximal and distal joints of the upper extremity play an important and different role in throwing. The proximal joints help place the hand in the proper position and orientation for throwing a ball and ensure that the maximum velocity is imparted to the object (20). In order to have good neuromuscular control, the sense of joint position is also very important. Shin and Sung (6) thought that classical massage may improve muscle strength and proprioception by influencing the superficial layer of the muscle. They found that proprioceptive acuity in the ankle joint was significantly greater in the massage-treated experiment group in comparison to the control group. They showed that ankle joint proprioception was increased after performing 15 minutes of massage in exercise-induced muscle damage. Poorbarzegar et al. (21) showed the effectiveness of massage in improving proprioception. There is a limited number of studies that have looked at the immediate and short-term effects of massage on joint position sense and neuromuscular control levels of healthy women. Differently from our study, Mine (22) showed no changes in vertical jump performance after lower extremity manual massage. The aim of CTM is to reach the fascial interface, where patterns of strokes are used to enable access to the deep fascia where it lies directly under the skin (13). Fascial layers play an important role in proprioception and nociception, and thus, these may have been one of the reasons why more effects were seen in the classic massage group (13,23). The improvements in most measures remained statistically significant at 6-month and 1-year time-points in CTM in the literature, which may have explained that, in this study, joint sense was improved only in the classical massage group. If we looked at the long-term and multi effects rather than the short-term effect and applied multi sessions, we may have seen improvements in the CTM group, too (24, 25).

Hemmings et al. (26) in a study similar to ours, showed the effects of classical massage on boxing performance, but some studies different from our study investigated the effects of longer-duration massage on muscle strength and explosive performance and found that it was not effective or even harmful (27,28).

The significant difference in throwing performance between the sexes may be explained by two components: size and non-size components. The non-size component is identified by comparing scaling curves (29). More et al. (20) investigated the relationship between throwing accuracy and arm dominance. Pedagana et al. (30) studied the relationship between upper extremity strength and throwing speed, Fleising (31) studied sex differences in release positions during various throwing events, and they found that males and females had different degrees of arm abduction and trunk flexion in all throwing events.

Moreover; Tillaar et al. (29) examined the effect of body size and sex on throwing performance and specific isometric strength, and they explained the difference in throwing velocity and isometric strength of the upper limb between men and women with body size. Men throw faster and produce more force because they have a higher body size, and this seems to be an important factor in physical performance. Also seen in research investigating performance with hormones, Bosco suggested that basal serum testosterone levels are correlated with countermovement jump height sprint speed in professional male soccer players (32). Crewter et al. (33) investigated salivary testosterone levels and also demonstrated a relationship with both sprint speed and strength. Therefore, we included only women to eliminate all these factors.

Even though there are studies showing the effects of different physiotherapy agents such as

cryotherapy on throwing performance (34), it was speculated that this study will contribute positively to the literature for being the first study that shows the effectiveness of classical massage for upper extremity performance and proprioception.

Limitations

There are some limitations of our study. One of the limitations was the number of sessions. Studies have shown that CTM is more effective when massage is practiced in multiple sessions, so, we may state that the one session in our study is not sufficient. The lack of an assessment of fatigue before the interventions also constituted a limitation of our study. Another limitation was that throwing performance could not only concern the upper extremity but also the back muscles such as the scapula or trapezius muscle. Throwing performance requires an intricate balance between the static and dynamic structures of the shoulder in order to maintain functional stability. Such an integration requires muscular strength and endurance, flexibility, and neuromuscular control. So, additional evaluation parameters and exercises such as neuromuscular control level, joint position sense assessments should be considered in training programs.

Conclusion

Classical massage could be included in routine rehabilitation programs, because it increases performance and proprioception. However, more studies with larger samples and longer follow up periods are needed.

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