Acute Effects of Connective Tissue Manipulation on Autonomic Function in Healthy Young Women

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Keywords

Autonomic response · Blood pressure · Connective tissue manipulation · Massage · Physical activity level

Abstract

Background: Connective tissue manipulation (CTM) has therapeutic effects on diseases with autonomic imbalance, yet its mechanisms of action are not clearly identified. **Objective:** The aim of this study was to investigate acute autonomic responses to CTM in healthy young women with various physical activity levels. **Method:** The study was designed as a nonrandomized, controlled single-center study. Healthy women aged between 18 and 25 years were assigned to a connective tissue manipulation group (CTMG) ($n = 150$) or a control group (CG) ($n = 60$). CTM was applied to the CTMG while the CG did not receive any intervention. Respiratory rate (RR), heart rate, systolic/diastolic blood pressures (SP/DP), oxygen saturation (OS) and body temperature were measured. The International Physical Activity Questionnaire short form was used to determine physical activity levels. **Results:** Analysis revealed significant reduction in SP and DP and an increment in RR in the CTMG ($p < 0.05$). RR increased and SP decreased among inactive, SP decreased among moderately active, and SP and OS decreased among highly active participants in the CTMG ($p < 0.05$). There were no significant alterations in the CG ($p > 0.05$). **Conclusions:** CTM has an immediate reducing effect on sympathetic activity in healthy young women independently from the physical activity level. Future studies are needed to clarify long-term effects of CTM on autonomic functions in healthy individuals.

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Autonome Akutreaktionen auf Manipulation des Bindegewebes bei gesunden jungen Frauen

Schlüsselwörter

Autonome Reaktion · Blutdruck · Manipulation des Bindegewebes · Massage · Körperlicher Aktivitätslevel

Zusammenfassung

Hintergrund: Die Manipulation des Bindegewebes ("connective tissue manipulation", CTM) hat therapeutische Effekte auf Erkrankungen, bei denen ein Ungleichgewicht des autonomen Nervensystems vorliegt, wobei die Wirkmechanismen jedoch nicht eindeutig geklärt sind. **Ziel:** Mit der vorliegenden Studie sollten die autonomen Akutreaktionen auf CTM bei gesunden jungen Frauen mit unterschiedlichem körperlichem Aktivitätslevel untersucht werden. **Methode:** Bei dieser Studie handelte es sich um eine nichtrandomisierte kontrollierte monozentrische Studie. Gesunde Frauen im Alter von 18 bis 25 Jahren wurden der CTM-Gruppe ($n = 150$) oder der Kontrollgruppe ($n = 60$) zugewiesen. Bei den Teilnehmerinnen der CTM-Gruppe erfolgte eine Manipulation des Bindegewebes, wohingegen die Kontrollgruppe keine Intervention erhielt. Die Atemfrequenz (AF), Herzfrequenz, systolischer/diastolischer Blutdruck (SBD/DBD), Sauerstoffsättigung (sO_2) und Körpertemperatur wurden gemessen. Zur Ermittlung des körperlichen Aktivitätslevels wurde der International Physical Activity Questionnaire – Short Form verwendet. **Ergebnisse:** Die Analyse ergab eine signifikante SBD- und DBD-Senkung und eine Steigerung der AF

in der CTM-Gruppe ($p < 0,05$). Bei den Inaktiven kam es zu einem AF-Anstieg und zu einem SBD-Abfall; bei denjenigen mit mäßiger Aktivität nahm der SBD ab, und bei denjenigen mit hohem Aktivitätslevel in der CTM-Gruppe war ein Rückgang von SBD und sO_2 zu beobachten ($p < 0,05$). In der Kontrollgruppe fanden sich keine signifikanten Veränderungen ($p > 0,05$). **Schlussfolgerungen:** CTM hat bei gesunden jungen Frauen einen unmittelbaren dämpfenden Effekt auf die Aktivität des sympathischen Nervensystems unabhängig vom körperlichen Aktivitätslevel. Weitere Studien sind erforderlich, um die Langzeiteffekte von CTM auf die autonomen Funktionen bei gesunden Personen zu klären.

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Introduction

Connective tissue manipulation (CTM) is an alternative reflex therapy that stimulates autonomic nerve endings in order to restore the balance between the sympathetic and parasympathetic components of the autonomic nervous system (ANS) [1–3].

The therapeutic influences originate from local responses to massage, which include the reduction of muscle spasm, mobility increment of connective tissue, superficial hyperemia and local analgesia [1]. CTM is disparate from traditional massage techniques in terms of both technical and physiological effects. The process is characterized by strong and sometimes disturbing pull strokes applied to the ligaments and subcutaneous tissues and is a closer application to manipulation [3]. The therapeutic effect is directed to the diseased organ by mechanically stimulating the appropriate dermatome [4].

Hitherto, several studies were conducted investigating the physiological effects of various massage techniques [5–9]. Most of them showed that massage therapy benefited to regulate vital signs, yet one demonstrated that type of massage was associated with change in blood pressure (BP). To the results of that study, Swedish massage had the greatest effect at BP reduction, and contrarily trigger point therapy and sports massage both increased the BP [9]. However, there have been very few studies investigating the effects of CTM on autonomic function, and the results are conflicting [10–12]. The results of a recent one showed that the nonspecific CTM applied to a group of 8 healthy volunteer women produced some small measurable physiological changes in the autonomic system which includes skin temperature and diastolic BP (DP) [11]. However, the authors declared that the small sample size could not show much physiological response to CTM, and the absence of a control group was another limitation of their study.

It is important to prove physiological effects of CTM in order to clearly identify indications and improve the

therapeutic effects of this technique. The mechanism of influence was explained by the autonomic regulation as distinct from traditional massage techniques in the studies that revealed the therapeutic effects of CTM [4, 13–21]. However, there is a limitation in comprehensive studies exploring physiological effects of CTM and the possible impact on the ANS has not yet been clearly elucidated. Besides, as the physiological responses vary depending on the activity level, investigating the physiological effects of any intervention specifically in the various levels of physical activity may also help to reveal more realistic findings about the influences [22, 23]. The aim of this study was to investigate the acute effects of CTM on autonomic function in healthy young women with various physical activity levels through traditional vital signs. Our hypothesis was that CTM would have a regulatory effect on autonomic responses of healthy young women.

Materials and Methods

Study Design and Population

The study was conducted at Zonguldak Bülent Ecevit University (Zonguldak, Black Sea Region in Turkey) during the period April 2018 to July 2018 following a nonrandomized, controlled single-center design. The study was carried out in Zonguldak Bülent Ecevit University Physiotherapy Training and Research Laboratory with the college students who were residents of Zonguldak Bülent Ecevit University Dormitories. Inclusion criteria were: healthy volunteer females aged between 18 and 25 years. Subjects with contraindications to CTM practice, such as pregnancy, acute inflammation, malignancy and those who were using drugs regularly, were not included in the study. Additionally, subjects were excluded if they had a BP of 140/90 or higher.

The current study was conducted in accordance with the Helsinki Declaration and its subsequent amendments. All the subjects volunteered to participate in this research and signed the informed consent form approved by the Zonguldak Bülent Ecevit University Clinical Research Ethics Committee (Protocol No.: 2018-104-11/04).

After explaining the options of the applications to the individuals who accepted to participate in the study, they were asked which group they would prefer to be included. Participants' assignment to the connective tissue manipulation group (CTMG) or control group (CG) was based on their willingness.

Outcome Measures

Each participant was invited to the Physiotherapy Training and Research Laboratory where the study was conducted. As the study was concerned with the evaluation of autonomic functions, the factors that could affect the autonomic responses were kept under control. For this purpose, the temperature of the laboratory was set to a constant 24 °C. Due to possible effects on the ANS, the participants were reminded not to consume alcohol, cigarettes, caffeinated beverages and exercise before assessments.

Vital signs which are objective measures of the physiological function were measured to evaluate autonomic responses. Respiratory rate (RR), heart rate (HR), systolic BP (SP) and DP, oxygen saturation (OS) and body temperature (BT) were measured at the baseline. The measurements were conducted while the participant was sitting on a chair and leaning back in a relaxed position. RR

Fig. 1. Connective tissue manipulation application to the lumbosacral area.

was obtained by multiplying the number of breaths taken over 30 s by 2. SP and DP (mm Hg) were measured using an automated cuff (Omron® 10 Series Plus Blood Pressure Monitor) in order to provide objectivity in assessment. The same instrument was used to learn the HR of the participants. OS (%) was measured on a saturation probe (Nellcor®) placed on the second digit. BT (°C) was measured on admission with an infrared aural thermometer.

The International Physical Activity Questionnaire short form (IPAQ-SF) was used to evaluate physical activity levels of the participants. The questionnaire contains 7 items which evaluate the frequency of daily activities and duration (minutes and/or hours) in vigorous- and moderate-intensity activities, walking and sitting activities. The physical activity level is stated “inactive (IA),” “moderately active (MA)” and “highly active (HA)” as in three classifications [24, 25]. Reliability and validity of the Turkish Version of the IPAQ-SF have been reported previously [26].

Initial and final assessments were conducted by a physiotherapist blinded to the group assignment. Final assessments of the CTMG were conducted right after the CTM session had been completed. To avoid possible spontaneous changes in vital signs, the CG was reevaluated 5 min later.

Intervention

Following the initial assessments, CTM was applied to the individuals in the CTMG while the CG did not receive any intervention. CTM was carried out by 3 experienced physiotherapists.

A 5-min single-session CTM including the lumbosacral area (basic section) was applied to the individuals in the CTMG. During practice, the participants in the CTMG were seated in an upright position, with their low backs uncovered, on a stool with no back and arm support, with 90° flexion of the hips, knees and ankles. The back was straight, and the hands were placed on the thighs for optimal tension of the connective tissue. In practice, appropriate long and short pulls in accordance with the respective zones were applied in the order as defined below [27, 28] (Fig. 1a).

- 1 Short pull strokes, starting from the anal cleft, going through the lateral margin of the sacrum, extending from just below the iliac crest to the spina iliaca anterior superior (Fig. 1b).
- 2 A long pull in an oblique direction upside down along the lateral margin of the sacrum.
- 3 3–4 short pull strokes to the sakrolumbal angle (Fig. 1c).
- 4 Long pulls onto the ilium; the first underneath the iliac crest, the second over the iliac crest, the third from the anal cleft up to the trochanter major.
- 5 5 short pull strokes on the fields between the transverse processes of lumbar vertebrae from L₅ to T₁₂ (Fig. 1d).
- 6 A long pull through the subcostal line.

Each pull was applied 3 times and symmetrically to the right and left sides. CTM was terminated by a subcostal long pull and the long pull underneath the iliac crest following the application of pectoral strokings to the anterior surface of the chest.

Fig. 2. Flow diagram.

Fig. 3. Intergroup comparison of the baseline vital outcomes.

Statistical Analysis

Statistical analysis was performed with SPSS for Windows release 19.0.0/2010 (IBM-SPSS Inc., Chicago, IL, USA). A level of 5% was used to determine significant differences. Normality tests (visual and analytical) revealed that continuous variables were not normally distributed. Demographic data and baseline outcomes of the two groups were compared using the Mann-Whitney U test.

Baseline vital signs of the 3 subgroups according to the physical activity level were compared with the Kruskal-Wallis test. Binary comparisons were performed using the Mann-Whitney U test and adjusted with Bonferroni correction. Intragroup analyses of the dependent variables were conducted using the Wilcoxon signed-rank test.

Fig. 4. Intragroup comparison of the vital outcomes.

Table 1. Demographic features of the participants (means ± SD)

	CG (n = 60)	CTMG (n = 150)	p
Age, years	20.37±1.28	20.17±1.40	0.273
Height, m	164.40±5.05	163.31±4.92	0.153
Weight, kg	56.61±8.97	56.50±8.65	0.948
BMI	20.91±2.95	21.15±2.87	0.453

CG, control group; CTMG, connective tissue manipulation group.

Results

Two hundred twenty-five subjects were assessed for eligibility, 7 were excluded, and 218 were enrolled into the study and allocated to either the CTMG ($n = 158$) or the CG ($n = 60$). One hundred fifty subjects in the CTMG and all 60 subjects in the CG completed the study (Fig. 2).

There were no significant differences between the CTMG and CG in terms of demographic features including age (years), height (cm), weight (kg), and BMI (weight per height squared) ($p > 0.05$) (Table 1). RR, SP, DP and BT outcomes were significantly different ($p < 0.05$) while HR and OS outcomes were similar between groups at the baseline ($p > 0.05$) (Fig. 3).

Intragroup comparison of the vital signs of the CTMG revealed a significant reduction in BP (both in SP and DP) and an increment in RR ($p < 0.05$) while none of the vital signs changed in the CG ($p > 0.05$) (Table 2) (Fig. 4).

Groups in this study were additionally divided into 3 subgroups as IA, MA and HA according to their physical

Table 2. Intragroup comparison of the vital signs (means ± SD)

	CG (n = 60)	p	CTMG (n = 150)	p
RR, breaths/min				
Initial	19.73±2.31	0.197	20.64±2.90	0.035*
Final	20.06±2.38		21.14±3.10	
HR, beats/min				
Initial	83.06±12.18	0.729	84.63±13.22	0.826
Final	82.60±12.44		84.32±12.01	
SP, mm Hg				
Initial	103.15±9.71	0.402	115.03±14.90	<0.001*
Final	102.51±11.45		111.57±14.14	
DP, mm Hg				
Initial	67.05±8.37	0.989	70.52±8.44	0.022*
Final	66.51±7.72		69.76±8.17	
OS, %				
Initial	98.41±1.39	0.051	98.50±0.70	0.786
Final	98.75±0.50		98.23±2.26	
BT, °C				
Initial	36.86±0.29	0.731	36.75±0.26	0.191
Final	36.86±0.27		36.75±0.32	

CG, control group; CTMG, connective tissue manipulation group; RR, respiratory rate; HR, heart rate; SP, systolic pressure; DP, diastolic pressure; OS, oxygen saturation; BT, body temperature. * $p < 0.05$.

activity levels in order to analyze the autonomic responses of the participants with various physical activity levels. Participants in the CG consisted of 21.66% ($n = 13$) IA, 58.33% ($n = 35$) MA and 20% ($n = 12$) HA women while the CTMG contained 27.33% ($n = 41$) IA, 52.66% ($n = 79$)

Table 3. Intra-subgroup comparison of the vital signs (means $\pm$ SD)

	RR, breaths/min	<i>p</i>	HR, beats/min	<i>p</i>	SP, mm Hg	<i>p</i>	DP, mm Hg	<i>p</i>	OS, %	<i>p</i>	BT, °C	<i>p</i>
CG												
IA (<i>n</i> = 13)												
Initial	19.69 $\pm$ 2.56	0.157	86.15 $\pm$ 9.49	0.310	105.00 $\pm$ 11.96	0.083	66.61 $\pm$ 9.57	0.648	97.92 $\pm$ 2.46	0.157	36.81 $\pm$ 0.31	0.943
Final	20.30 $\pm$ 2.56		83.38 $\pm$ 13.00		100.07 $\pm$ 13.66		64.38 $\pm$ 9.50		98.76 $\pm$ 0.43		36.81 $\pm$ 0.27	
MA (<i>n</i> = 35)												
Initial	20.11 $\pm$ 2.27	0.527	82.80 $\pm$ 11.29	0.824	103.77 $\pm$ 8.82	0.454	68.25 $\pm$ 8.13	0.718	98.62 $\pm$ 1.00	0.527	36.88 $\pm$ 0.28	0.798
Final	20.34 $\pm$ 2.24		83.00 $\pm$ 11.02		103.20 $\pm$ 10.11		68.02 $\pm$ 7.55		98.77 $\pm$ 0.49		36.86 $\pm$ 0.28	
HA (<i>n</i> = 12)												
Initial	18.66 $\pm$ 1.96	0.564	80.50 $\pm$ 16.89	0.838	99.33 $\pm$ 9.35	0.331	64.00 $\pm$ 7.48	0.919	98.33 $\pm$ 0.49	0.157	36.89 $\pm$ 0.33	0.160
Final	19.00 $\pm$ 2.48		80.58 $\pm$ 16.27		103.16 $\pm$ 13.22		64.41 $\pm$ 5.24		98.66 $\pm$ 0.65		36.93 $\pm$ 0.25	
CTMG												
IA (<i>n</i> = 41)												
Initial	20.09 $\pm$ 2.44	0.014*	84.87 $\pm$ 14.07	0.443	115.24 $\pm$ 14.68	0.008*	70.68 $\pm$ 10.14	0.119	98.41 $\pm$ 0.80	0.275	36.70 $\pm$ 0.30	0.514
Final	21.19 $\pm$ 3.02		85.68 $\pm$ 11.73		111.65 $\pm$ 13.02		69.68 $\pm$ 7.29		98.56 $\pm$ 0.50		36.69 $\pm$ 0.40	
MA (<i>n</i> = 79)												
Initial	20.97 $\pm$ 3.03	0.513	84.01 $\pm$ 12.72	0.684	112.98 $\pm$ 14.78	<0.001*	69.83 $\pm$ 7.63	0.137	98.51 $\pm$ 0.69	0.668	36.74 $\pm$ 0.24	0.482
Final	21.18 $\pm$ 3.09		83.40 $\pm$ 11.07		109.83 $\pm$ 14.51		69.34 $\pm$ 8.75		98.51 $\pm$ 1.02		36.75 $\pm$ 0.28	
HA (<i>n</i> = 30)												
Initial	20.53 $\pm$ 3.10	0.528	85.93 $\pm$ 13.68	0.495	120.13 $\pm$ 14.74	0.042*	72.13 $\pm$ 7.95	0.263	98.60 $\pm$ 0.56	0.046*	36.83 $\pm$ 0.24	0.354
Final	20.93 $\pm$ 3.31		84.90 $\pm$ 14.70		116.03 $\pm$ 14.10		70.96 $\pm$ 7.84		97.03 $\pm$ 4.61		36.87 $\pm$ 0.27	

CG, control group; CTMG, connective tissue manipulation group; IA, inactive; MA, moderately active; HA, highly active; RR, respiratory rate; HR, heart rate; SP, systolic pressure; DP, diastolic pressure; OS, oxygen saturation; BT, body temperature. *p < 0.05.

MA and 20% (*n* = 30) HA women. Intergroup analysis showed that baseline vital signs were not significantly different between subgroups (*p* > 0.05) except OS in the CG (*p* < 0.05). Binary comparisons of OS in the CG revealed a significant difference between MA and HA subgroups (*p* = 0.007).

Intragroup comparison of vital signs of the subgroups showed that RR significantly increased and SP significantly decreased among IA participants, SP significantly decreased among MA participants, SP and OS significantly decreased among HA participants in the CTMG (*p* < 0.05). There were no significant alterations in vital signs of the subgroups of the CG (*p* > 0.05) (Table 3).

Discussion

The current study was conducted to investigate the acute effects of CTM on autonomic function on the basis of changes in autonomic responses including RR, HR, SP and DP, OS and BT parameters. Our results showed significant reduction in BP in terms of both SP and DP and increment in RR immediately after CTM application. Regarding the physical activity levels of the participants, the present study also revealed that SP decreased in all subgroups while RR increased in IA participants and OS decreased in HA participants.

There are very few studies investigating the autonomic responses to CTM in the literature, and the reports are conflicting [10–12]. In a previous study conducted with 9 healthy volunteers by using autonomic parameters including HR, BP, galvanic skin response and peripheral skin temperature revealed that both the CTM and superficial stroking increased sympathetic activity, but the severity of the sympathetic response, which was revealed by the application of superficial stroking, was found to be less than the CTM [12]. In a recent study, Holey et al. [11] similarly showed that a single-session CTM practice had acute effects on the ANS in 8 healthy volunteers. According to the results of that study, an immediate increase occurred followed by a drop to pre-CTM levels, but DP started increasing again at about 30 min after CTM. Unlike these, another study demonstrated that even 9 sessions of CTM had no acute or cumulative effect on ANS in healthy middle-aged women [10].

As to the results of our study, reduction in SP and BP immediately after CTM application indicates that sympathetic activity was diminished [29, 30]. Although this result is not consistent with the previous literature, it supports the theoretically described effect mechanism of CTM. This technique is applied with the aim of stimulating autonomic nerve endings and balancing the sympathetic and parasympathetic parts of the ANS [1–4]. The manual process is performed in accordance with a spe-

cific sequence of specific anatomical points [27, 28]. Such interactions between deep and superficial tissues mediate neural mechanisms involving autonomic pathways known as cutaneous-visceral reflexes. Glycosaminoglycan and histamine release from fibroblasts and mast cells reduces sympathetic activity. Thus, parasympathetic activity increases [1–4].

Another consequence of our study was the increment in RR which indicated a decrease in sympathetic activity as a contradiction [31]. The fact that no change was detected in the CG removes the possibility that some of these parameters might be spontaneous. At this point, the remaining possibility might be the varying factors among participants.

In this study, we identified a narrow border in terms of age and gender in order to reduce the factors that might affect autonomic responses [32, 33]. Besides, the large sample size in the intervention group provided the possibility to create subgroups according to the level of physical activity, which was another factor that might affect the autonomic responses [22, 23]. Analysis of IA, MA and HA subgroups revealed that SP decreased in all. This result showed that CTM decreased sympathetic activity independently of the physical activity level. Varied responses related to the level of activity were increased RR in the IA group and decreased OS in the HA group. In the IA group, even with a slight stimulus arising from manipulation might cause a response in the form of increased RR possibly due to decreased peripheral resistance, but we could not reach any evidence in the literature explaining the association of decreased OS and high level of activity. In addition, we could not reach any study investigating the relation between CTM and physical activity level.

The results of this study show that CTM is effective in healthy young women with acute ANS responses. In the literature, CTM was used for varied health conditions. Most of the previous studies on CTM were conducted in diseased populations with the autonomic imbalance such as fibromyalgia syndrome and tension-type headache [4, 14, 19–21, 34]. In these studies, the effects of CTM on the parameters such as pain and functionality were investigated. Studies investigating the effects of CTM on autonomic function are conflicting [10–12]. The contradictory results of previous studies might arise from very small sample sizes and lack of the standardized CGs. The results of this study support some of the previously reported effects of CTM in the literature. Studies have shown that the stimulation of autonomic nerve endings which may result in a reduction of sympathetic vasoconstrictor tone leads to vasodilatation [13]. This manipulation has mechanical effects on cells and fibroblasts, which constitute the connective tissue. CTM also increases the arterial-venous and lymphatic flow by stim-

ulating the connective tissue and increases the elasticity of the connective tissue [35]. In addition to the previous studies, CTM was found to have immediate effects on the ANS in the individuals without known autonomic dysfunction.

This study is limited as not to be blinded. Yet, given the fact that it is hard to perform a study blinded, for such interventions, we believe that this controlled experimental study, with its large sample size, still offers important evidence to the literature on this subject. However, the addition of a “placebo control group” to the “control group” could have increased the objectivity of our results. Also, just the investigation of the postintervention immediate effects of CTM was another limitation of this study. In order to interpret the effect mechanisms more clearly, there is a need to investigate long-term effects of CTM in future studies. Further studies investigating the long-term effects (follow-up) may be helpful to address the efficacy of CTM in healthy populations to resolve the conflicts.

Statement of Ethics

Subjects have given their written informed consent. The study protocol has been approved by the Zonguldak Bülent Ecevit University Clinical Research Ethics Committee.

Disclosure Statement

The authors declare that there is no conflict of interests concerning this paper.

Author Contributions

E.A.: designed the study, organized and supervised the course of the article, data management, and drafted the manuscript; B.Ü.: designed the study, performed the statistical analysis, helped in reporting the study; E.U.E.: designed the study, contributed performing the statistical analysis, reviewed the article for spelling, grammar and its intellectual content. All authors have read and approved the final paper.

References

- 1 Goats GC, Keir KA. Connective tissue massage. *Br J Sports Med*. 1991 Sep;25(3):131–3.
- 2 Michalsen A, Bühring M. [Connective tissue massage]. *Wien Klin Wochenschr*. 1993; 105(8):220–7. German.
- 3 Holey EA. Connective tissue massage. In: Everett T, Dennis M, Ricketts E, editors. *Physiotherapy in Mental Health*. Oxford: Elsevier; 1995. p. 274–80.
- 4 Holey LA, Dixon J. Connective tissue manipulation: a review of theory and clinical evidence. *J Bodyw Mov Ther*. 2014 Jan;18(1): 112–8.

- 5 Lindgren L, Rundgren S, Winsö O, Lehtipalo S, Wiklund U, Karlsson M, et al. Physiological responses to touch massage in healthy volunteers. *Auton Neurosci*. 2010 Dec;158(1-2):105–10.
- 6 Supa'at I, Zakaria Z, Maskon O, Aminuddin A, Nordin NA. Effects of Swedish massage therapy on blood pressure, heart rate, and inflammatory markers in hypertensive women. *Evid Based Complement Alternat Med*. 2013; 2013:171852.
- 7 Xiong XJ, Li SJ, Zhang YQ. Massage therapy for essential hypertension: a systematic review. *J Hum Hypertens*. 2015 Mar;29(3):143–51.
- 8 Kaye AD, Kaye AJ, Swinford J, Baluch A, Bawcom BA, Lambert TJ, et al. The effect of deep-tissue massage therapy on blood pressure and heart rate. *J Altern Complement Med*. 2008 Mar;14(2):125–8.
- 9 Cambron JA, Dexheimer J, Coe P. Changes in blood pressure after various forms of therapeutic massage: a preliminary study. *J Altern Complement Med*. 2006 Jan-Feb;12(1):65–70.
- 10 Reed BV, Held JM. Effects of sequential connective tissue massage on autonomic nervous system of middle-aged and elderly adults. *Phys Ther*. 1988 Aug;68(8):1231–4.
- 11 Holey LA, Dixon J, Selve J. An exploratory thermographic investigation of the effects of connective tissue massage on autonomic function. *J Manipulative Physiol Ther*. 2011 Sep;34(7):457–62.
- 12 Kisner CD, Taslitz N. Connective tissue massage: influence of the introductory treatment on autonomic functions. *Phys Ther*. 1968 Feb;48(2):107–19.
- 13 Holey EA. Connective tissue massage: a bridge between complementary and orthodox approaches. *J Bodyw Mov Ther*. 2000; 4(1):72–80.
- 14 Ekici G, Bakar Y, Akbayrak T, Yuksel I. Comparison of manual lymph drainage therapy and connective tissue massage in women with fibromyalgia: a randomized controlled trial. *J Manipulative Physiol Ther*. 2009 Feb;32(2):127–33.
- 15 Bayrakci Tunay V, Akbayrak T, Bakar Y, Kayihan H, Ergun N. Effects of mechanical massage, manual lymphatic drainage and connective tissue manipulation techniques on fat mass in women with cellulite. *J Eur Acad Dermatol Venereol*. 2010 Feb;24(2):138–42.
- 16 Bakar Y, Sertel M, Oztürk A, Yümin ET, Tatarlı N, Ankaralı H. Short term effects of classic massage compared to connective tissue massage on pressure pain threshold and muscle relaxation response in women with chronic neck pain: a preliminary study. *J Manipulative Physiol Ther*. 2014 Jul-Aug;37(6):415–21.
- 17 Reis C, Hardy E, Sousa M. The effectiveness of connective tissue massage in the treatment of primary dysmenorrhea among young women. *Rev Bras Saúde Mater Infant*. 2010; 10(2):247–56.
- 18 Castro-Sánchez AM, Moreno-Lorenzo C, Matarán-Peñarrocha GA, Feriche-Fernández-Castany B, Granados-Gómez G, Quesada-Rubio JM. Connective tissue reflex massage for type 2 diabetic patients with peripheral arterial disease: randomized controlled trial. *Evid Based Complement Alternat Med*. 2011;2011:804321.
- 19 Kalichman L. Massage therapy for fibromyalgia symptoms. *Rheumatol Int*. 2010 Jul;30(9):1151–7.
- 20 Akbayrak T, Akarcalı I, Karabudak R, Demirtürk F. The results of connective tissue manipulation in the treatment of tension type headache. *Pain Clin*. 2002;13(4):343–7.
- 21 Yuan SL, Matsutani LA, Marques AP. Effectiveness of different styles of massage therapy in fibromyalgia: a systematic review and meta-analysis. *Man Ther*. 2015 Apr;20(2):257–64.
- 22 Casonatto J, Tinucci T, Dourado AC, Polito M. Cardiovascular and autonomic responses after exercise sessions with different intensities and durations. *Clinics (São Paulo)*. 2011; 66(3):453–8.
- 23 Hughson RL, Shoemaker JK. Autonomic responses to exercise: deconditioning/inactivity. *Auton Neurosci*. 2015 Mar;188:32–5.
- 24 Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003 Aug;35(8):1381–95.
- 25 Çolak TK, Acar G, Dereli EE, Özgül B, Demirbüken İ, Alkaç Ç, et al. Association between the physical activity level and the quality of life of patients with type 2 diabetes mellitus. *J Phys Ther Sci*. 2016 Jan;28(1):142–7.
- 26 Saglam M, Arikan H, Savci S, Inal-Ince D, Bosnak-Guclu M, Karabulut E, et al. International physical activity questionnaire: reliability and validity of the Turkish version. *Percept Mot Skills*. 2010 Aug;111(1):278–84.
- 27 Huckle JW, Carter AJ, Cotton NJ, et al. US Patent No. 7789841. Washington, DC: US Patent and Trademark Office; 2010.
- 28 Yuksel I, Akbayrak T, Baltacıoğlu S. Konnektif doku masajı. In: Yuksel I, editor. *Masaj Teknikleri*. Ankara: Pelikan; 2013. pp. 329–50.
- 29 Nelson NL. Massage therapy: understanding the mechanisms of action on blood pressure. A scoping review. *J Am Soc Hypertens*. 2015 Oct;9(10):785–93.
- 30 Philipp T, Distler A, Cordes U. Sympathetic nervous system and blood-pressure control in essential hypertension. *Lancet*. 1978 Nov; 2(8097):959–63.
- 31 Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. *Med Hypotheses*. 2006;67(3):566–71.
- 32 Piha SJ. Cardiovascular autonomic reflex tests: normal responses and age-related reference values. *Clin Physiol*. 1991 May;11(3):277–90.
- 33 Barantke M, Krauss T, Ortak J, Lieb W, Repel M, Burgdorf C, et al. Effects of gender and aging on differential autonomic responses to orthostatic maneuvers. *J Cardiovasc Electrophysiol*. 2008 Dec;19(12):1296–303.
- 34 Çıtak-Karakaya I, Akbayrak T, Demirtürk F, Ekici G, Bakar Y. Short and long-term results of connective tissue manipulation and combined ultrasound therapy in patients with fibromyalgia. *J Manipulative Physiol Ther*. 2006 Sep;29(7):524–8.
- 35 Özgül S, Üzelpasacı E, Orhan C, Baran E, Beksaç MS, Akbayrak T. Short-term effects of connective tissue manipulation in women with primary dysmenorrhea: a randomized controlled trial. *Complement Ther Clin Pract*. 2018 Nov;33:1–6.