EFFICACY OF TRIGGER POINT THERAPY ON TRAPEZIUS MUSCLE TONE IN BASKETBALL PLAYERS ASSESSED BY MYOTONOMETRY

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- Shoulder
- Soft Tissue Therapy
- Sports Medicine

Abstract:
Introduction: Increased muscle tone contributes to various dysfunctions of movement structures. Among factors, that could cause muscle hypertension, authors decided to investigate myofascial trigger points. The most commonly used method for treatment of trigger points is an ischemic compression. However, best to our knowledge, this was the first study, where an attempt to verify this therapeutic technique by myotonometry was made. **The aim of the work:** was to evaluate the effect of compression trigger point therapy on the tone of the trapezius muscle. Additionally, we wanted to examine, if the unilateral treatment renders a contralateral effect on associated tissues. **The materials and the methodology:** Our study was conducted on 12 elite basketball players. MyotonPRO device was used to measure trapezius muscle tone, expressed by frequency. Measurements were performed directly before and after treatment. Obtained values were subjected to analysis of variance (ANOVA), after which Bonferroni post hoc test was performed. The level of significance $p<0,05$ was assumed for all tests. **Results:** Observed decrease of muscle tone showed statistical significance for the upper trapezius muscle. On average, decline was also observed for the middle and lower fibers of trapezius. Contralateral effect of applied therapy has also been shown. **Conclusions:** Our findings support the effectiveness of compression therapy for the treatment of trigger points, causing a significant decrease in trapezius muscle tone.

INTRODUCTION

Muscle tone is responsible for maintaining body posture and assuring background tension in active movements. Hyper- or hypotonia are often associated with certain neuromuscular disorders. However, there is a lack of clearness in the role of tonal changes in cumulative trauma, or stress disorders [Viir et al. 2006]. The connection between the muscle spindle, its afferent axons and the gamma motor neurons is responsible for maintaining muscle tone, by changing the length and tension of intrafusal fibers [Pearson, Gordon 2000]. Increased activity of above system, can indicate higher levels of resting tension. This leads to abnormalities in movement patterns and subsequent errors in coordination, which can disturb functional performance and increase risk of injury [Mobbs et al. 2009]. Muscle tone, defined as low-level steady state of muscle contraction at rest, refers to the degree of tension in relaxed muscle and its resistance of being passively lengthened. It exists unconsciously and affiliates with other mechanical properties of the skeletal muscles, such as stiffness or elasticity. Therefore, it has an important role for optimization of sport performance [Masi, Hannon 2008].

In recent years, the general training overload in professional spot performance has significantly increased, placing greater demands on musculoskeletal structures. The systematic practice of team sports, such as basketball, is often connected with higher risk of injuries. That can force player out of competition for a long time, or even end his sporting career. However, the extent of trauma, as well as the course of recovery progress, are very likely associated witch player's physical preparation. Appropriate soft tissue therapy techniques are presently inherent elements of correct sport training for professional athletes [Vahimets et al. 2006].

Myofascial pain syndrome (MPS) is a common problem that can develop with any type of training. Apart from sport injuries, MPS is another relevant factor, which aggravates sports performance of athlete. Upper trapezius muscle, together with shoulder and scapula regions, are the most common for MPS among overhead sport activities [Hidalgo-Lozano et al. 2013]. Various factors can contribute to the development of MPS. It is associated with prolonged imbalance of antagonist muscle groups; repeated micro-injuries, and other neuromuscular disorders caused by inappropriate exercise [Han et al. 1997]. It can arise from a peripheral disorder, which is characterized as a highly localized and hypersensitive spot within a taut band in skeletal muscle fibers, called the myofascial trigger point (MTrP). MTrPs can cause referred pain excessively reactive to external pressure, therefore contribute to extensive impairment in musculoskeletal function [Benjaboonyanupap et al. 2015].

There is a number of theories explaining the formation of MTrPs, wherein so-called integrated hypothesis is the most widely accepted. It assumes that an excessive release of acetylcholine, caused by an abnormal response of the sympathetic system, produces a sustained contraction of muscle sarcomeres. The termination of actin-myosin cross-bridge formation is blocked by constant release of intracellular calcium. Therefore, this sustained contraction causes a significant reduction in local blood flow, resulting in a lack of oxygen and nutrients to the region. Local energy crisis stimulates nociceptive receptors, what leads to pain and weakness in associated structures [Dommerholt et al. 2015]. The local inflammation can result in impairment of the entire muscle with surrounding fascia, and be further transferred through the myofascial chain, to distant tissues. These radiating pain patterns, that are characteristic of MTrPs, have their usage in clinical practice to identify the source of pain. The presence of MTrPs is, therefore, considered to be the first sign of muscle overload [Ge et al. 2011].

There has been many research for the last decades, investigating treatment of trigger points. Hong et al. [1997] proved high effectiveness of MTrPs compression in immediate myofascial pain relief, comparing to other therapeutic methods. Furthermore, they observed similar referred pain patterns induced by pressing on the same MTrPs in different patience. They also confirmed suppression of pain after high-pressure stimulation, which terminates "MTrPs circuit" in the spinal cord. Hou et al. [2002] investigated alternative variants of ischemic compression, using either low pressure (no exceeding pain threshold) and a long duration or high pressure (in the average of pain threshold and pain tolerance) and short duration. Their research confirmed efficacy of both therapeutic modifications.

The mechanism of ischemic compression consist of temporary obstruction of local blood flow, which is followed by a rapid inflow of oxygenated blood to the area upon the release of the pressure. It also stimulates mechanoreceptors, with an associated attenuation of pain signals. As such, the treatment of MTrPs indicates normalization of the biomechanical properties of muscle fibers, which restores the normal functional condition of the muscle and lowers the risk of injury [Gemmell et al.2008].

According to Chen et al. [2007; 2016] there is a lack of research on the effects of trigger point therapy on muscle tone. Authors assumed, that it is caused by subjectivity of diagnostic criteria and treatment of MTrPs. The identification and ischemic compression of trigger points significantly depends on an examiner's skills and clinician's interviewing. With those assumptions Chen et al. emphasized the need for objective methods evaluating the trigger point therapy effect on biomechanical properties of muscle tissue. As they say, medical advances depend on improvements in the ability to objectively diagnose and quantify the effects of treatment.

The number of research conducted by Fernandez-de-las-Penas et al [2008; 20010; 2014] showed the connection between trigger points occurrence and the mechanical pain of cervical spine or migraine headaches. They also used palpation to localize MTrPs, and local pressure to provoke a pattern of radiating pain that patients confirmed they experienced during their migraines. The reliability and relevance of palpation for the diagnosis of MTrPs was also demonstrated in study performed by Grieve et al. [2013]. Myofascial trigger points located in upper trapezius can modify the activation of shoulder rotators, and therefore result in a change of shoulder elevation plane. Moreover, this refers not only to active MTrPs, which are causing actual pain symptoms, but also for trigger points not symptomatic currently (latent MTrPs) [Lucas et al. 2010].

Although subjective, palpation and Ashworth scale remain the most popular methods to evaluate muscle tone in clinical practice [Walsh, Ashworth 1997]. This limits their value for monitoring the effects of rehabilitation or medical treatment. Therefore, there is a need for objective, noninvasive measurement technique, which can provide better understanding of biomechanical properties in muscle function [Simons, Mense 1998]. Aird et al. [2012], and Bailey et al. [2013] confirmed a high inter-rater reliability of the MyotonPRO (MyotonPRO, Myoton Ltd, Estonia) by analyzing muscle tone, stiffness, and elasticity. Agyapong-Badu et al. [2013] and Mooney et al. [2013] demonstrated excellent within-session intra-rater reliability, with intraclass correlation coefficients values for muscle tone: ICC 3,2 = 0.94-0.99 and ICC3,2>0.95, respectively. Mean and standard deviation (±) absolute and percentage differences were only 0.6 ±0.4Hz (4 ± 3%) for measured muscle tone. The findings indicate that the MyotonPRO can be used reliably by different users to assess muscle in clinical and research settings.

The research conducted by Gavronski et al. [2007] showed objectiveness and efficacy of myotonometry for the evaluation of skeletal muscles in athletes. According to their scientific background, the hand-held MyotonPRO device provides an *in vivo* measurement of three basic biomechanical parameters of soft tissues: muscle tension, stiffness, and elasticity. Muscle tension is quantified by the natural damping oscillation frequency of the tissue. The frequency characterizes the state of the soft tissue under mechanical stress. The increase of its value [Hz] is proportional to rising of muscle tension. The oscillation frequency of the nonactive muscle is defined as muscle tone [Renan-Ordine et al. 2011]. Viir et al. [2007] emphasized the role of upper trapezius (UT) muscle in neck and shoulder disorders. Myoton device was successfully used to record changes in muscle tension for UT. However, best to our knowledge, the usefulness of the MyotonPRO for assessing the effects of ischemic compression on MTrPs has yet to be evaluated. With this assumption, there is a need for further research to understand its full potential in muscle diagnosis.

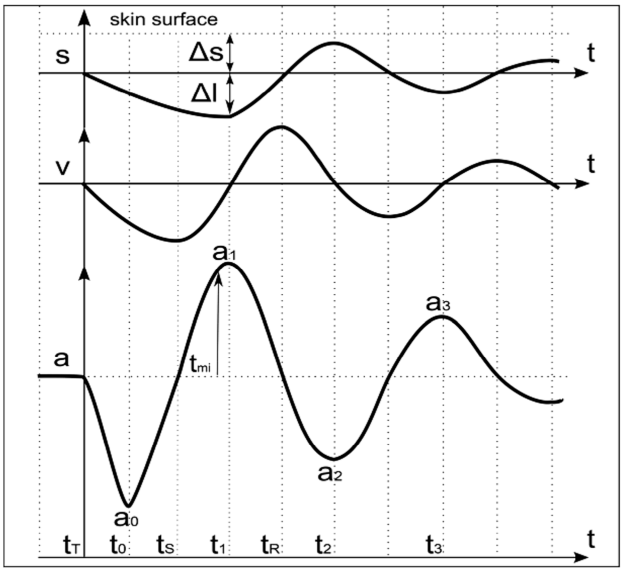
THE AIM OF THE WORK

In our study, we selected muscle tension, quantified using the MyotonPRO device, to evaluate the efficacy of ischemic compression for the treatment of myofascial trigger points. We hypothesized that trigger point therapy would produce a decrease in the tone of the trapezius muscle. Additionally, we wanted to verify, if unilateral treatment renders a contralateral effect of tension decrease on associated tissues. The aim of the study was to assess the effect of compression trigger point therapy on the tone of the trapezius muscle in basketball players.

THE MATIRIAL AND THE METHODOLOGY

Twelve players from the elite Polish basketball league were included in the study (mean ± SD; age, 19.8 ± 2.4; height, 197 ± 8.2 cm; weight, 91.8 ± 11.8). The sample size was calculated using G*Power software (version 3.1.9.2; Kiel University, Kiel, Germany)[1] with an expected "medium" effect size ($f^2 = 0.25$) for measured parameter within group, an α level of 0.05 and power (1-β) of 0.9. According to this calculation, at least 11 participants were necessary. One extra participant was included in case of potential dropout [Faul et al., 2007]. There was one criterion for exclusion: a recent injury to the shoulder or neck area, which would eliminate player from active training. It could also affect the measured parameters of muscle tone and obstruct therapy itself. All participants provided informed consent before participating in our research. The study was approved by the local ethics committee of the University School of Physical Education in Wrocław and conducted in accordance to Declaration of Helsinki.

The hand-held MyotonPRO was used to measure the muscle tone of the right and left trapezius muscle. For accurate measurement, the acceleration probe was placed perpendicular to the surface of the skin overlying the muscle under investigation. The device produces a short mechanical impulse with the duration of 15 ms and force of 0.4 N, preceded by slight pressure exerted by the weight of probe. It is transmitted successively to the deeper layers of the tissue. The damped oscillations generated as the result of mechanical impulse are recorded by an accelerometer and instantly processed, resulting in the oscillation waveform (Figure 1). From the obtained damped natural oscillation waveform, the frequency [Hz], the stiffness [N/m] and the logarithmic decrement are calculated directly within the device. Those three parameters quantify the functional state of the muscle [Schneider et al. 2015].



Symbol	Description
a	Acceleration of the damped oscillation – unit: mG
a_0	Maximum acceleration
a_1	Maximum displacement i.e. maximum tissue resistance measured in mG
a_2	Maximum opposite displacement due to the residual inertia of the tissue oscillation
a_3	Maximum displacement of the second period of oscillation which takes place due to the recuperation of stored residual mechanical energy in the tissue
ΔS	Pre-compression of subcutaneous tissues above the muscle being measured
Δl	Maximum displacement of the tissue
m_{probe}	Mass of the measurement mechanism
S	Displacement (tissue oscillation) – unit: mm
t	Time – unit: ms
t_{mi}	The end of mechanical impulse
t_0	The time when maximum acceleration was reached
t_T	Start of the mechanical impulse
t_r	The time when tissue returns to its initial shape
t_s	Zero acceleration and maximum velocity due to the force of deformation
$t_t - t_0$	The time from zero to maximum acceleration
$t_0 - t_s$	The time from maximum back to zero acceleration
$t_s - t_1$	The time from maximum velocity to zero velocity of deformation
$t_1 - t_r$	The time of acceleration from maximum displacement of the tissue to return to its initial shape. It represents the tissue Mechanical Stress Relaxation time
$t_r - t_2$	The time of acceleration from restored initial shape of the tissue to its maximum opposite displacement
t_1	The time when maximum displacement was reached
t_2	The time when maximum opposite displacement was reached
t_3	The time when maximum displacement of the second period of oscillation was reached
$t_2 - t_3$	The time of two consecutive displacements
V	Oscillation velocity – unit: m/s

Frequency [Hz]:	**Dynamic Stiffness [N/m]:**	**Creep (Deborah number):**	**Logarithmic Decrement:**	**Mechanical Stress Relaxation time [ms]:**
$F = f_{max}$	$S = a_1 \cdot m_{probe} / \Delta l$	$C = R / (t_1 - t_T)$	$D = \ln (a_1 / a_3)$	$R = t_R - t_1$

Fig. 1. Description of the relationship of the displacement oscillation (S) and oscillation velocity (V) in relation to the oscillation acceleration (a), from which the four parameters were derived: frequency (Hz), dynamic stiffness (N/m), logarithmic decrement and relaxation time (ms) [Schneider et al.2015].

The experimental procedure included two sessions. Each session began with measurements of muscle tension obtained from 5 points on the trapezius muscle, bilaterally (Figure 2). They were preceded by marking measurement points with skin marker on left and right trapezius. Points 01 and 02 were located in the upper fibers of the trapezius, at the line connecting the spinous process of C7 and the acromion, symmetrically, from the mid-point of the muscle belly. Point 03 was located in the middle fiber of the trapezius, at the mid-point of a line connecting the spinous process of T4 to the medial border of spine of the scapulae. Points 04 and 05 were located in the lower fibers of the trapezius, point 04 at the mid-point of a line connecting the spinous process of T6 to the medial border of spine of the scapulae, and point 05 at the mid-point of the lateral border of the lower fibers of the trapezius. Each participant was lying in a relaxed prone position on the investigation table, with the upper extremities placed along the trunk [Nie et al. 2005].

Fig.2. Trapezius muscle during measurement with MyotonPRO device.

After baseline measurements were obtained, the flat palpation technique was used to identify trigger points located in the trapezius muscle on the dominant hand side. Diagnostic criteria used to confirm presence of MTrPs were: presence of hypertensive spot or taut band within muscle fibers and referred or local pain with the characteristic radiation pattern. The number of identified MTrPs, and their specific location, was based on each individual's examination, although their common position described in literature, was taken into account [Barbero et al. 2013]. Subsequently ischemic compression was performed at each trigger point. Pressure was applied until pain relief, with usage of two different grips, according the localization of MTrPs. Those located in the upper fibers of the trapezius were treated using a pinch grip (with the free edge of upper trapezius between the forefinger and the thumb) (Figure 3a), and MTrPs located in the middle and lower fibers, with a flat compression technique (pressing down on the sensitive point with the thumb or the head of proximal phalange of index finger)(Figure 3b).The second measurement of muscle tone was performed immediately after the treatment.

The second session was performed identical procedure, for confirmation of obtained results. It was repeated with an 7 days interval. Its duration was determined based on the availability of participants, with the requirement of minimum 24 h between sessions to exclude a possible influence of previous therapy on the second measurements. All the interventions were applied by a physical therapist, who had completed a certified trigger point therapy course.

(a) (b)

Fig.3. Upper (a) and lower (b) trapezius muscle under trigger point therapy.

Average values of all the data collected from this study were used for statistical analysis.

The mean, standard deviation, and normality of the distribution were calculated. A repeated measures analysis of variance was performed to evaluate changes in the muscle tone, obtained before and after treatment, for the two treatment sessions. ANOVA was followed by Bonferroni post hoc correction for repeated measures. P < 0.05 was considered statistically significant for all analyses. All calculations were performed using PASW® Statistics (SPPS Inc.).

RESULTS

A significant change in frequency value for the upper trapezius muscle on the dominant side was identified in both sessions after treatment . For the upper fibers of trapezius, tension decreased from 15.01(±1.21), before treatment, to 14.11(±2.35) after trigger points compression (p = 0.031; Figure 4). For the second session, we observed a decrease of muscle tension from 15.61(±2.35), to 14.32(±2.67) after treatment (p = 0.029; Figure 5).

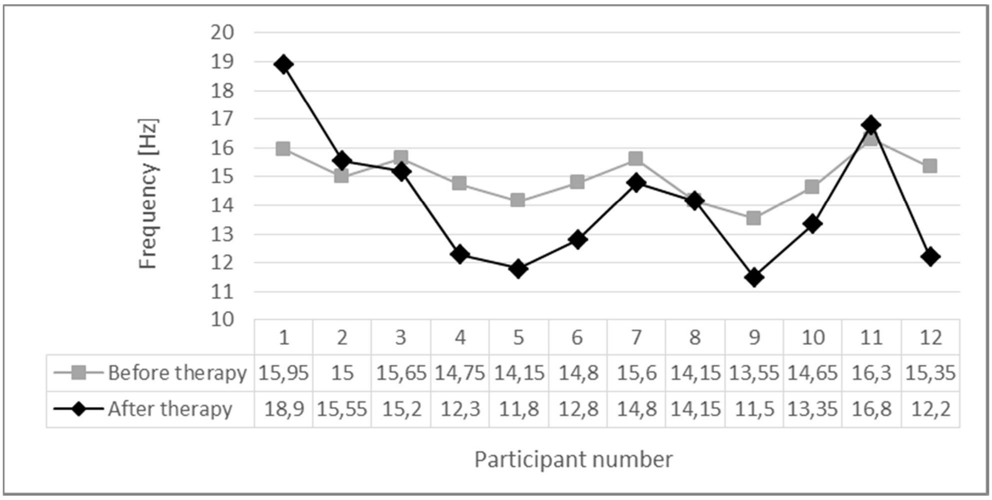
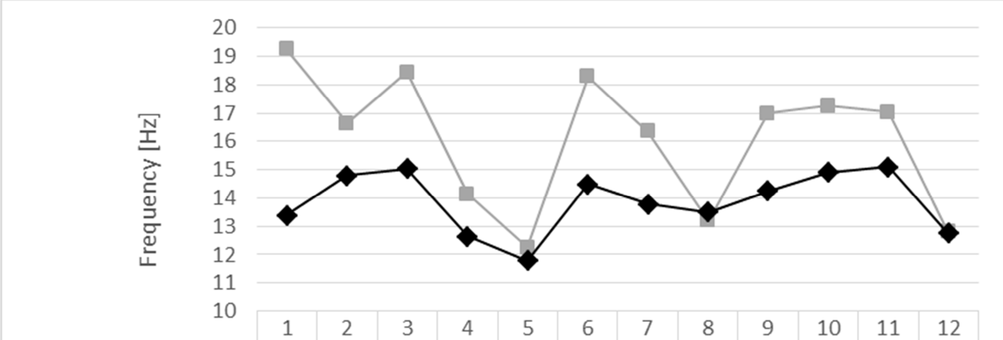


Fig.4. Upper trapezius muscle frequency, before and after trigger point therapy, at the first time point of measurement.



	1	2	3	4	5	6	7	8	9	10	11	12
Before therapy	19,25	16,65	18,45	14,15	12,25	18,3	16,35	13,2	17	17,25	17,05	12,8
After therapy	13,4	14,8	15,05	12,65	11,8	14,5	13,8	13,5	14,25	14,9	15,1	12,75

Fig.5. Upper trapezius muscle frequency, before and after trigger point therapy, at the second time point of measurement.

For the middle and lower fibers of trapezius, tension showed a decrease, from 16,68 (± 2.53), before treatment, to 16.39 (± 1.71), after treatment, for the first session (p = 0.464), and respectively from 17.57 (± 2.71) to 17.20 (± 1.76) for the second session (p = 0.431). No significant change in frequency was identified for the middle and lower trapezius muscle on the dominant side. On average for the non-dominant (untreated) trapezius muscle, frequency decreased from 15.25 (± 1.49), before treatment on the dominant side, to 14.76 (± 1.52) after therapy, this change being non-significant.

CONCLUSIONS

The aim of this study was to investigate the potential of trigger point therapy in the reduction of muscle tension. We believe that our findings provide an objective confirmation of the effectiveness of ischemic compression, which gives this method a clinical perspective. Reliable evaluation of muscle properties is important for assessing the effectiveness of therapeutic interventions. Our study proves that properly applied trigger point compression significantly decreases muscle tension. That could improve muscle performance, by bringing immediate pain relief, and lower the risk of injury, which is a very important aspect in professional sport. It should also be noted, that unilateral treatment of trigger points renders a contralateral effect of tension decrease on associated tissues. Moreover our research provides evidence of the accuracy of the MyotonPRO for accessing the effectiveness of trigger point therapy.

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