JBACHS
Journal of Basic and Clinical Health Sciences

J Basic Clin Health Sci 2022; 6: 408-414
https://doi.org/10.30621/jbachs.959275
RESEARCH ARTICLE

MYOTONOMETRIC EVALUATION OF LATENT MYOFASCIAL TRIGGER POINTS AND TAUT BAND IN ELITE ATHLETES

Ozgul Ozturk[1], Ozlem Feyzioglu[1], Furkan Guven[2], Tulay Cevik Saldiran[3]

[1] Acibadem Mehmet Ali Aydinlar University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Turkey
[2] Move Training House Physiotherapy Clinic, Istanbul, Turkey
[3] Bitlis Eren University Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Bitlis, Turkey.

ORCID: O.O. 0000-0002-5207-1893; O.F. 0000-0002-7479-4128; F.G. 0000-0002-7997-9906; T.C.S. 0000-0003-4048-1251

Corresponding author: Ozgul Ozturk, **E-mail:** ozgul.ozturk@acibadem.edu.tr
Received: 30.06.2021; **Accepted:** 11.02.2022; **Available Online Date:** 30.05.2022

Cite this article as: Ozturk O, Feyzioglu O, Guven F, Cevik-Saldiran T. Myotonometric Evaluation of Latent Myofascial Trigger Points and Taut Band in Elite Athletes. J Basic Clin Health Sci. 2022; 6: 408-414.

ABSTRACT

Introduction: Our aim was to identify the mechanical properties of the latent myofascial trigger points (MTrPs), the taut band and the non-taut band (surrounding muscle) within the gastrocnemius muscle using the myotonometric evaluation method.
Material and Methods: Thirty-one asymptomatic elite rugby players (23.0±4.16 y, 97.5±22.1 kg, 183.5±7.6 cm) with a latent MTrP in lateral gastrocnemius muscle included in this study. Muscle stiffness, decrement and muscle tone of latent MTrPs, taut band and the non-taut band were measured using a myotonometer (MyotonPRO, Myoton AS, Tallinn, Estonia). One-way ANOVA was conducted to determine the differences between the three measurement points. After pairwise comparisons, Cohen's d effect sizes were calculated to determine the magnitude of differences between the measurement points.
Results: Although the stiffness of the latent MTrPs was lower than its taut band, one-way ANOVA revealed that there was no difference between the latent MTrPs vs the taut band and the non-taut band for frequency, stiffness and decrement parameters ($p>0.05$). However, there was a difference between the taut band non-taut band for muscle tone ($P= 0.016$), for stiffness ($P=0.035$) and for decrement ($P=0.012$) and effect sizes were as $d=0.64$, $d=0.69$ and $d=0.62$ for stiffness, muscle tone and decrement respectively.
Conclusion: The MTrPs and the taut bands showed an increase in muscle stiffness and muscle tone compared to the surrounding muscle. The taut band can be easily identified from the surrounding muscle using the myotonometer. Therefore, myotonometric measurement is a potentially valuable method for the identification of the taut band in elite athletes.

Key Words: Trigger point, muscle tone, taut band, stiffness

INTRODUCTION

Myofascial trigger points (MTrPs) have been termed as hyperirritable spots located in the taut bands within the fibers of skeletal muscle. Trigger points have been classified as active or latent (silent) and both trigger points induce referred pain. Active MTrPs produce spontaneous, mechanical or local pain while latent MTrPs produce pain when pressure is applied (1). Trigger points may create changes in muscle activation patterns, delayed relaxation of the muscle after exercise and increased activation of the antagonist muscle (2). Latent trigger points may cause decrease in range of motion, stiffness within the muscle and presence of muscle cramps and also, may be a reason for sensory-motor dysfunctions (3). As a result of these changes, MTrPs may affect the potential performance of the athletes and may result in a damage to the muscle or muscle groups (3,4). It has been reported that biochemical changes occur within these points such as increased concentration of bradykinin, substance P and tumor necrosis factor alpha which may in turn increased of stiffness within the taut band or trigger point (5, 6). A latent trigger point may be caused by prolonged stress or repetitive and unusual exercises 3. Identification of the latent MTrPs and the taut bands with objective methods and treatment of these MTrPs with appropriate modalities may be beneficial in terms of improvement of motor functions and sportive performance, especially in elite athletes.

Assessment of the viscoelastic properties of the MTrPs and the taut bands may also give insight into the efficacy of the different treatment methods (7). Palpation, pressure pain threshold, surface electromyography (EMG), infrared thermography can identify the existence of the trigger points and the taut bands (8). However, among these methods, only palpation can be used easily by the clinicians in their daily practice, but the reliability of this method varies depending on the experience of the clinician (9, 10). Shear wave ultrasonography and magnetic resonance elastography are also able to assess the viscoelastic properties of the MTrPs and the taut bands (1,11). However, these methods are too expensive and not easily accessible to become a standardized method in clinical practice. There is a need for a practical method to measure the mechanical properties of muscle in sports (12). Determining the presence of these MTrPs and taut bands, and presenting their mechanical properties with inexpensive, reliable and portable tools can improve the clinicians' assessment and treatment approaches.

The gastrocnemius is a commonly injured lower extremity muscle in rugby players and the majority of injuries lead to disability (13). The activation level of the gastrocnemius muscle can affect the athlete's performance and the presence of MTrPs within the gastrocnemius muscle may limit especially vertical jump performance or other activities requiring the extension of the lower limbs (4,14). Thus, the early detection of trigger points in these athletes may prevent possible muscle injuries.

Myotonometer (MyotonPRO) is a simple, reliable, non-invasive and portable tool that provides quantitative information about muscle viscoelastic properties. The practitioner applies a short mechanical impulse on the skin via a hand-held device and obtains the generated oscillations of the tissue. Myotonometer has been shown to display good to excellent intra-rater and inter-rater reliability in detecting the muscle viscoelastic properties in various populations (healthy people, athletes, patients with orthopedic and neurological conditions) (15-18). MyotonPRO can be used to show the muscle-tendon properties such as muscle tone, elasticity and stiffness (17,19). Also, it has been reported that MyotonPRO is a practical and reliable method to detect the trigger points and reveal the changes in their properties in response to several treatment methods (12,20). Roch et al. found that the trigger point displayed increased tone, elasticity and stiffnes compared to non-trigger point measured by myotonometer in patients with shoulder pain (20). They have concluded that future studies should be designed to measure the viscoelastic properties of different muscles in patients with pain and in other populations. To the best of our knowledge, no studies have been conducted investigating the viscoelastic properties of muscles in elite athletes.

Therefore, this study aimed to determine the viscoelastic properties of the trigger point and the taut band using a myotonometer and to identify the difference between the trigger point, the taut band and the non-taut band (surrounding muscle) within the gastrocnemius muscle in elite athletes.

MATERIAL AND METHODS

Participants

This cross-sectional study was conducted with Koç University Rugby Team (RAMS) athletes in February 2021. All participants were informed about the study and gave their written consent. The study was approved by Acıbadem Mehmet Ali Aydınlar University, Medical Research Ethics Committee (ATADEK) (Date: 13.01.2021, Decision number: 2021-01/42) and was conducted in accordance with the principles of the Declaration of Helsinki.

The demographic variables such as age, gender, body mass index (BMI), education level, systemic diseases, history of injuries and total time for

Table 1. Demographic Variables of the Participants

Variables	Mean ± (SD) or N (%) (n=31)
Age, years	23.0±4.1
Dominancy; right handed	27 (87.1)
Trigger point detected side; right	13 (41.9)
Height, cm	183.5±7.6
Weight, kg	97.5±22.1
BMI (kg/m^2)	28.7±5.12
Total time for participating sportive activities (years)	10.35±2.66

BMI: Body Mass Index, SD: Standart Deviation, N: Number

participating sportive activities (years) were recorded. Thirty-one male elite athletes aged between 19 to 35 years (23.0±4.16 years) were included. The mean value for the total time for participating sportive activities was 10.35±2.66 years. To be included, participants had to; have a latent trigger point in the lateral part of the gastrocnemius muscle detected by palpation according to Travell and Simons criteria and aged above 18 years. The Travell and Simons criteria were described as the presence of a palpable taut band within the muscle, a hyperirritable spot within the taut band, a local twitch response occured with palpation and provocation of pain with palpation (9). Palpation of the trigger point started with identifying the taut band by palpating perpendicular to the fiber direction. After the taut band was located, the physiotherapist moved his hand along with the taut band to find a distinct area of hardness and evoked pain (21). The presence of the trigger points and taut bands were determined by a 5-year experienced sports physiotherapist and the myotonometric properties assessed by MyotonPRO (Myoton AS, Tallinn, Estonia) were identified by the same sports physiotherapist.

Those with the following conditions were excluded; i) a history of surgery or fracture within both extremities at least 12 months before the study; ii) pain within the lower extremities during the assessment; iii) peripheric or central nervous system diseases; iv) had a treatment due to trigger points in gastrocnemius muscle at least 6 months before the assessment. Measurement of height was performed using a stadiometer with a sensitivity degree of 0.01 cm. Body weights were determined using TANITA Bioimpedance Body Composition Analyzer. Body mass index (BMI) with height and body weight (kg/m2) was calculated.

Assessment of Muscle Viscoelastic Characteristics

The viscoelastic characteristics of the trigger point, the taut band and the non-taut band were determined using MyotonPRO (Myoton AS, Tallinn, Estonia). The following parameters were assessed; oscillaton frequency which is termed as muscle resting tone (Hz), elasticity (ms) and stiffness (N/m) (18). Demographic data of the participants were recorded before conducting the assessments via the software program and transferred to the device. The trigger point, the taut band and the non-taut band were marked using a special pen. The assessments were performed while the participants were in a prone position, the gastrocnemius muscle was in a relaxed condition and the knee joint was in 0° extension. The MyotonPRO device was held perpendicular to the skin and the sports physiotherapist applied the previously determined force (0.18 N) for 5 strokes. The duration between every stroke was 1 second. The sports physiotherapist kept the pressure constant during the test period. The exact location of the non-taut band was determined as 10 cm proximal to the taut band. After each measurement, the acceleration graphic was controlled to detect a deviation from the normal graph. The participants were informed not to consume caffeine or take medicine.

Sample Size Calculation

Sample size was calculated using GPower Sample Size Calculator assuming an effect size of 0.94 difference for muscle stiffness between the trigger point and the taut band. A total of at least 30 subjects had to be recruited based on a statistical power of 80% and an alpha error of 5% (22).

Table 2. Analysis of the viscoelatic properties of the trigger point, taut band and non-taut band.

	Trigger point (n=31)	Taut Band (n=31)	Non-Taut Band (n=31)	P Value*
Frequency, Hz	20.27±2.54	21.08±2.79	19.14±2.75	**.021**
Decrement	1.25±0.23	1.39±0.29	1.20±0.21	**.013**
Stiffness, N/m	403.77±70.77	424.87±73.84	377.03±78.33	**.045**

*One-Way ANOVA

Statistical Analysis
Data were analyzed with SPSS Version 21.0 (IBM, Armonk, NY, USA). Shapiro-Wilk test was performed to check the normality of the data. The comparison of the trigger point, the taut band and the non-taut band was conducted with one-way ANOVA. Post-hoc pairwise comparisons were made with the Independent-t test. Cohen's d effect sizes were calculated to show the difference. An α level of below 0.05 was accepted as significant.

RESULTS
A total of 31 male elite rugby athletes aged between 19 to 35 years (mean age 23.0±4.16) were included in this study. Demographic variables of the participants are summarized in Table 1. One-way ANOVA showed the difference between the three measurement points (Table 2). According to the pairwise comparisons shown in Table 3, there was a difference between the taut band and non-taut band of the gastrocnemius muscle for frequency (P= 0.01), for stiffness (P=0.03) and for decrement (P=0.01) and effect sizes were d=0.64, d=0.69 and d=0.62 for stiffness, frequency and decrement respectively. However, no difference was detected for frequency, stiffness and decrement between the trigger point, the taut band and the non-taut band (p>0.05).

DISCUSSION
Our study aimed to investigate the viscoelastic properties of the trigger point, taut band and non-taut band and showed that the myotonometer can determine the differences in muscle characteristics between taut band and surrounding muscle. However, when the viscoelastic properties of the

Table 3. Mean differences for pairwised comparisons between the trigger point, taut band and non-taut band.

		Mean Difference	P Value
Trigger Point vs Taut Band	Frequency, Hz	0.81 ± 1.76	0.23
	Decrement	0.13 ± 0.25	0.12
	Stiffness, N/m	21.09 ± 33.79	0.80
Trigger Point vs Non-Taut Band	Frequency, Hz	1.12 ± 1.76	0.31
	Decrement	0.55 ± 0.23	0.89
	Stiffness, N/m	26.74 ± 57.35	0.48
Taut Band vs Non-Taut Band	Frequency, Hz	1.93 ± 1.69	**0.01**
	Decrement	0.18 ± 0.27	**0.01**
	Stiffness, N/m	47.83 ± 50.80	**0.03**

*Independent-t-test

MTrPs compared to the taut band or surrounding muscle, no significant differences were detected.
Trigger points and taut bands have been shown to affect sportive performance levels in elite athletes (4). Trigger points can lead to changes in muscle activation and muscle pattern during the execution of movement and an increase in muscle fatigue (23). Also, MTrPs may be served as predisposing factors for possible sports-related injuries (24). The muscle including the MTrPs may also be affected and become stiffer compared to normal muscle tone (25). In individuals with chronic shoulder pain, it has been shown that the viscoelastic properties of the trigger and non-trigger points in the same muscle can be differentiated using myotonometer (20). We could not differentiate the viscoelastic properties of the trigger and non-trigger points in our study. One of the possible reasons for this result may be the experience of the physiotherapist who detected the presence of the trigger points, although the same person conducted all the assessments and palpations. Reliability of the palpation to detect the presence of trigger points display contradictory results according to the conducted studies. Rozenfeld et al. assessed the reliability of trigger points in 86 soldiers and found that physical examination including palpation can be served as a reliable method in detecting the trigger point within the lower leg muscles (26). Therefore, the reason for not determining the exact location of the trigger points could be the subjectivity of provoked pain when pressure is applied to the trigger points. Also, latent trigger points have been reported as smaller than active trigger points (25), thus the presence of the latent trigger point may not be correctly confirmed with palpation. Another reason for the lack of difference between taut band, surrounding muscle and latent MTrPs may be explained by not all tender points should be accepted as MTrPs, they can be classfied as points of spot tenderness (27). Other reasons for not detecting the exact location of the trigger point have been served as thick subcutaneous tissue, intervening of muscles or aponeuroses (27). Future studies should be designed to measure the viscoelastic properties of different muscle structures to add more evidence. Also, new study designes comparing different measurement tools to identify the viscoelastic properties of the trigger points, taut bands and surrounding muscle such as myotonometer, magnetic resonance elastography and shear wave elastogprahy are needed. So, it can be understood which method can more precisely detect the properties of the trigger points in a sensitive and clinically valuable way.
Muscle stiffness has been used to assess muscle force and impairments in muscle tissue. Muscle stiffness may lead to inhibition of the muscle strength (28). The MTrPs showed an increase in muscle stiffness compared to normal muscle tissue (25). In our study, both the trigger point and the taut band showed an increase in muscle stiffness than the surrounding muscle. Determining the level of muscle stiffness can be a useful approach to detect the presence of trigger points and to show the effectiveness of treatment approaches applied on trigger points.
The formation of active trigger points can be prevented by the treatment of the latent trigger points and the taut bands, so the early detection of latent trigger points or taut bands can be a clinically meaningful approach. Taut bands can show an increase in muscle tone and cause myofascial pain. In our study, the taut band could be detected within the muscle it was located, and the level of its muscle stiffness was higher than the surrounding muscle. When previous studies were examined, taut bands showed an increase in the level of stiffness compared to the surrounding muscle and the presence of these bands has been detected by magnetic resonance elastography (29). It has been reported that the difference in stiffness between the taut band and muscle in the same extremity can be a reliable marker for detecting the taut band (30). Taut bands are any tender areas within the muscle, maybe the early detection of only taut bands can lead us to prevent further muscle injuries that should be confirmed with future studies. We have compared the trigger point, the taut and the non-taut band within the same extremity, and our approach, analysis within the same extremity seems a reliable method to reveal the changes in muscle characteristics of the MTrPs and the taut band.
This study is not without limitations. One of the limitations of our study is that we did not compare the assessments with the control group or the contralateral extremity. The healthy control group was not evaluated because muscle tone parameters can be quite variable from person to person in terms of age, gender, body mass index, physical activity status and dominant side. Also, we included both right and left dominant athletes because it has been shown that the dominancy did not create a significant difference

in viscoelastic properties of the lower extremity muscles (31).

CONCLUSION

Myotonometer was able to easily isolate the taut band from the surrounding muscle and the taut band showed a higher level of muscle stiffness and increased muscle tone than the surrounding muscle. Our study reveals that myotonometer can become a useful tool to assess the viscoelastic properties of the muscles for musculoskeletal assessment of elite athletes.

Acknowledgements: The authors thank the participants for their time and permission.
Author Contributions: ÖÖ: Conceptualization, Study design, Writing, Data analysis, Manuscript review. ÖF: Data analysis, Writing, Manuscript review. FG: Study design, Data collection.
TÇS: Conceptualization, Study design, Manuscript review.
Conflict of interests: The authors declare no conflict of interest. No author has any financial interest or received any financial benefit from this research.
Ethical approval: The study was approved by Acıbadem Mehmet Ali Aydınlar University, Medical Research Ethics Committee (ATADEK) (Date: 13.01.2021, Decision number: 2021-01/42) and was conducted in accordance with the principles of the Declaration of Helsinki.
Funding: The MyotonPRO device has been obtained via the Scientific and Technological Research Council of Turkey 1002 Grant (TUBITAK; Project No: 118S750). The funding organization was not involved in the design, analysis, interpretation, and manuscript preparation.
Peer-review: Externally peer-reviewed.

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