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Original Article

Correlation between latent myofascial trigger point and peak torque production of lower limb muscles on sports person

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Abstract
Introduction: Latent Myofascial Trigger point is a musculoskeletal disorder and a component of myofascial pain syndrome. The literature suggests Myofascial Pain syndrome should be considered a potential cause of musculoskeletal pain. In the field of sports and exercise, it was found that musculoskeletal injuries are the most common and evidence supports sports persons develop myofascial pain syndrome. This musculoskeletal disorder is a barrier to sports performance. According to the literature, Latent Myofascial Trigger Points decreased force production, but this concept requires further investigation. Moreover, no study has been conducted on force production and lower limb muscles. **Purpose:** The objective of this study was to investigate the relationship between Latent Myofascial Trigger Points and force production in the lower limb muscles. Thus, it was hypothesized that there would be a significant positive correlation between Latent Myofascial Trigger points and force production in lower limb muscles in athletes. **Materials and methods.** There were 46 male national-level athletes selected for this study. Total 23 subjects (20.87±2.13 years; height:160.10±5.91; weight:52.40±5.55) were found with Latent Myofascial Trigger Point (Group-1) and 23 subjects (20.45±2.18 years; height:160±5.66; weight:59.80±5.81) were selected non-Latent Myofascial Trigger Point (Group 2). A pressure algometer was used to assess Latent Myofascial Trigger Points (FPX 25 Wagner Instruments, Greenwich, CT, USA) with the mean value of pain pressure threshold and muscular strength was measured by HUMAC NORM ISOKINETIC (Computer Sports Medicine, Inc. Stoughton, MA, USA) with the mean value of peak torque. In descriptive statistics, mean and standard deviation were used, and Pearson correlation was used to determine the relationship between the variables. The level of significance was set at 0.05. **Results.** A significant positive correlation was found between Latent Myofascial Trigger Points and lower limb force production ($p < 0.05$). **Conclusion.** Therefore, it was concluded that Latent Myofascial Trigger Points decreased muscular strength and negatively affect sports performance. Thus, Latent Myofascial Trigger Point should be considered a serious musculoskeletal disorder and proper preventive measures should be taken by health professionals.
Key Word: Latent Myofascial Trigger point. Myofascial Pain Syndrome. Muscular strength. Peak torque. Pain Pressure Threshold

Introduction

Myofascial trigger points (MTrP) or trigger points (TrPs) are hyperirritable spots located within taut bands of skeletal muscle fibres (Bethers et al., 2021). This associates local and/or referred pain patterns as well as autonomic, motor, and/or sensitive signs and symptoms on palpatory examination (Mayoral del Moral et al., 2018; San-Antolín, Rodríguez-Sanz, López-López, Romero-Morales, Carbajales-Lopez, et al., 2020). Clinically, MTrPs are classified as active and latent TrPs (Jiménez-Sánchez et al., 2021). MTrP that do not cause pain are known as latent MTrPs (L-MTrPs) (Cygańska et al., 2022), L-MTrPs can be accompanied by movement deficiency and also reduce muscle strength (Walsh et al., 2019). The symptoms of active MTrPs (A-MTrPs) include persistent pain, muscle weakness, decreased muscle elasticity, and referred pain (Ibrahim et al., 2021). From the literature, it observes that the trapezius muscle in the upper body is most susceptible to the occurrence of MPS (Abu Taleb et al., 2016), and in the lower body gastrocnemius muscle (Thummar et al., 2020). In the field of sports and exercise, it was found that musculoskeletal injuries are the most common (Lee et al., 2020). Research evidence suggests that myofascial pain accounts for 37% of males and 65% of females (Xia et al., 2017), therefore, MPS should be considered a potential cause of musculoskeletal pain (Wilke et al., 2018). According to the definition, a myofascial pain condition is characterized by shortened or contracted muscles that have an increase in tone and stiffness, and that also contain TrPs (Thummar et al., 2020). The effect of passive muscular stiffness on muscle injury symptoms following eccentric activity. In eccentric hamstring muscle exercise, those with stiffer hamstring muscles had more strength loss (Jr, 2018), discomfort, muscular soreness, and a higher creatine kinase rise. These effects are related to changes in sarcomere mechanics in stiff and compliant muscles during eccentric movements. Motor activation patterns and reciprocal inhibition mechanisms are affected by L-MTrP, leading to joint movement limitation and overload, physical deconditioning, and

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muscles getting exudated (Weller et al., 2018). From the research evidence it is confirmed that athletes may develop MTrPs during their life (Fousekis & Kounavi, 2016; Kisilewicz et al., 2018). But does this MTrPs decreased force production of muscle is not clearly mention by any author. From the review related literature, it was found that most of the study conducted on upper body muscle i.e., trapezius muscle. Doraisamy and colleague published an article, according to their study, L-MTrPs do not appear to negatively affect upper trapezius muscle strength (Doraisamy & Anshul, 2011). A study was conducted in 2011 to established the relation between TrPs and strength, fifty healthy adults were selected with TrPs in their upper and middle trapezius, supraspinatus, serratus anterior and rhomboid major and minor muscles. And they observed a positive correlation, but the researchers recommend further study for the better understanding of the mechanism of L-MTrPs and to test the relationship with muscle strength (Celik & Yeldan, 2011). Again a study was conducted by group of researcher and it was published on 2017 and they found that shoulder abductor strength in the group with MTrPs was significantly lower than in the group without MTrPs (Kim et al., 2017). all these studies are observed in sedentary population and no studies have been conducted on athletes. From this review of related literature, lower limb muscles of athlete and force production were considered as research gap. Thus, it was hypothesised that there would be significant positive correlation between L-MTrPs and force production in lower limbs muscles in athletes. Therefore, the purpose of this study to find out the relationship between L-MTrPs and force production of lower limb muscles of athletes.

Table No-1 General characteristics of the subjects (N = 46)

Parameter	**L-MTrPs** (N-23)	**Non-MTrPs** (N-23)
Subject characteristics	Mean ± SD	Mean ± SD
Age (Years)	20.57 ± 2.13	20.45±2.18
Height (Centimetre)	160.10±5.91	160±5.66
Weight (Kilogram)	52.40±5.16	59.80±5.81

N* Number of Participants; SD^ Standard Deviation

Methodology

Participants: Total 54 national level player were selected randomly in this study (Mean ± standard deviation; Age: 20.87 ± 2.33 years; height: 160.10 ± 5.32; weight:52.40 ± 5.55) from Madhya Pradesh, India. The study was conducted at the Exercise Physiology laboratory of Lakshmibai National Institute of Physical Education, Gwalior, India. The criteria recommended by Simons et al were used to diagnose L-MTrPs: (1) a palpable taut band in skeletal muscle; (2) a hypersensitive tender spot; (3) reproduction of referred pain of the MTrP in response to compression; (4) jump sign (Zuil-Escobar et al., 2015). MTrPs was detected by the difference in pressure pain threshold (PPT) more than 2kg/cm^2 as compared to the identical muscles in the opposite side (Park et al., 2011). Inclusion criteria for L-MTrPs group were: - (1)

Presence of L-MTrPs in the lower limbs (hamstring and quadriceps muscle groups). (2) Subjects were also required to be male athletes (determined as any sport in which jumping, sprinting, twisting, turning, acceleration and deceleration were important components), who played their sport competitively (determined as taking part a minimum of twice per week in an organized training or match situation for a team that competed in an official league or cup). (3) All subjects were collegiate athletes and were therefore in their competition phase of their sport. (4) PPT < 25 lbs/cm^2.(Cordeiro et al., 2021) Inclusion criteria for non-L-MTrPs were (1) no palpable taut band in the muscles, (2) PPT > 25 lbs/cm^2. Exclusion criteria: - subjects were excluded if they were experiencing any current injury or illness, including any systemic muscular or neural disease or any lower limb or lower back injury in the previous three months.

The study excluded subjects who had recently been diagnosed with or treated for fibromyalgia, suffered from vascular or neural conditions, or received treatment for MTrPs (active or latent). Each subject who met the criteria was explained the study, and the sample consisted of subjects who agreed to participate. First group was included 23 subjects purposively who diagnosed as positive in L-MTrPs examination. 11 subjects diagnosed with L-MTrPs in right quadriceps, 11 in Left Hamstring, 13 subjects in Left Quadriceps. Rest of them comes under second group with negative in MTrPs. The sample-size calculation was conducted using G-power software (Cordeiro et al., 2021) (Version 3.1.9.7), considering the following criteria: A 2-tailed hypothesis with 0.4 (Large effect), an error probability (1-β) of 0.80 and an α error probability of 0.05 provided an estimated sample size of 46 participants. For the equality of the sample size and from the sample-size calculation total 46 subjects were selected, 23 L-MTrPs and 23 non-MTrPs subjects. Informed written consent was obtained by all athletes. Ethical approval was attained from the institutional ethics committee.

Instruments: Pressure algometer (FPX 25 Wagner Instruments, Greenwich, CT, USA) was use for the measurement of PPT, the reliability of this device reported by Celik et al. 0.82–0.97 (Celik & Mutlu, 2013) and Castien et al. also found that pressure algometer is reliable instrument for research (Castien et al., 2021). HUMAC NORM ISOKINETIC (Computer Sports Medicine, Inc. Stoughton, MA, USA) used to measure the force production Peak Torque (Newton/meter^2) reliability in knee tests 0.74 to 0.89 (Habets et al., 2018).

Trigger Point Examination: Algometric measurement was used for the Pain Test FPX 25 Algometer (Wagner Instruments, Greenwich, CT, USA). The pain threshold was defined in lbs/cm^2 and the pressure was performed at a constant speed. PPT defined as the threshold at which pressure sensations change to pain (Ortega-Santiago et al., 2020). The pain threshold of selected muscle were measured, and the locations of the L-MTrPs were determined as mention by Cygańska AK et.al (Cygańska et al., 2022). Hamstring muscle measurement was conducted in the prone position and quadriceps muscles measurement was done in supine position. by applying the device at the angle of 90°to the surface of the skin (Fig-1), always starting from the points on the right side. The subject was asked to say "STOP" when they felt the first distinct sensation of pain at the test point. In order to determine the pain threshold, a trial measurement was conducted on the subject's forearm muscles before measuring the actual points. After each measurement, the result was read by the same researcher. Five-minute interval was observed between two measurements. Subjects who have at least one L-MTrP were assigned to group -1, subjects who don't have any MTrP were assigned to group -2. Each subject's muscles were tested in following order. Right and left quadricep muscle group (Vastus lateralis, Rectus femoris, Vastus Medialis), followed by right and left hamstring (Bicep femoris, semitendinosus, semimembranosus). The measurement was performed under the supervision of physical therapist who had more than 10 years of experience. A 30-second rest was allowed between each measure and the mean of 3 trials was calculated for the analysis. This method of evaluating PPT has been shown to exhibit high intra- and inter-examiner reliability (Chesterton et al., 2007).

Figure 1 Measurement of Pressure Pain threshold

Muscular strength Measurement: After algometric measurements 24hrs interval was given to the subjects, the next test was lower limbs force production measured by CSMi HUMAC NORM. Isokinetic dynamometer was used to measure knee flexion and extension muscles strength. The subjects were positioned on the knee testing table of the humac norm isokinetic dynamometer with the stabilisation straps across the chest, and a horizontal pad over the middle third and proximal half of the distal third of the thighs. The trunk was leaning against the back rest of the testing table. This was inclined so that the hips were at an angle of 110 degree with the trunk. The knee joint axis was aligned with the mechanical axis of the dynamometer. The shin pad was placed just superior to the medial malleolus, and the two stoppers were anchored to allow 85 degrees of movement from 5 degree to 90 degree of knee flexion. The subjects were instructed to firmly grip the handles to stabilize the upper body (Fig-2). Correction of gravity was obtained by measuring the torque exerted on the dynamometer lever arm by the weight of the arm. Before the test the subjects performed proper warming up of the lower limbs muscles which were involves in the testing to prevent from any kind of injury. First the right leg was tested in Isokinetic Con/Con Speed 60/60 degree/sec 5 Reps. before the main test one trail exercise was given to the subject to understand the exercise properly after that they perform the main exercise. When the test started the subject tried to flex and extent the leg with maximum force. The scores were recorded to the computer. The result was appeared on the monitor of the machine. The same procedure was given to the opposite leg.

Figure 2 Measurement of Muscular Strength

Statistical Analysis: IBM SPSS (version 26.0.0) data analysis software was used for statistical analysis. Descriptive statistics mean and standard deviation (SD) was used. The assumptions of normality of the data were verified using the Shapiro–Wilk test for the parametric test, and data did not violate the normality assumptions, therefore we used parametric test Pearson correlation was used to find out the relationship between L-MTrPs and Peak Torque. The magnitude of the correlation between test measures was interpreted as trivial (≤0.1), small (0.1–0.3), moderate (0.3–0.5), large (0.5–0.7), very large (0.7–0.9), and almost perfect (0.9–1.0) (Martín-Fuentes & van den Tillaar, 2022). The level of significance was set at $p \leq 0.05$.

Results

Descriptive statistics was used to address the first objective. The values were expressed as the mean, and SD. Characteristics of the subjects were given in the table no 1. Mean age and SD of L-MTrPs subjects were 20.57 ± 2.13 years, height 160.10 ±05.91 cm, and weight 52.40 ±05.16 kg. Non-MTrPs subjects mean age and SD 20.45±02.18 years, height 160.00 ±05.66 cm, and weight 59.80 ±05.81 kg. from the Table no 2 it was found that there was significant positive correlation between PPT and peak torque production at the level of 0.05. This result indicates that L-MTrPs in quadriceps muscles affect the extension force production and L-MTrPs in hamstring muscles affect the flexion force production significantly. And also observed that the magnitude of correlation coefficient was large (0.5–0.7), because correlation coefficient between right quadriceps PPT & right leg Extension (Peak Torque) correlation coefficient was 0.550, (p-0.00), left quadriceps (PPT) & left extension (Peak Torque) correlation coefficient was 0.555, (p-0.00), and left hamstring (PPT) & left flexion (Peak Torque) correlation coefficient was 0.521, (p-0.01).

Table No- 2 Descriptive statistics and Pearson Correlation between PPT and Peak Torque production

	Descriptive Statistics			Correlation			
	N	Mean	SD			Right Quadriceps	Right Extension
Right Quadriceps (PPT)	22	22.92	4.48	Right Quadriceps (PPT)	Pearson Correlation	1	0.550**
					Sig. (2-tailed)		0.00
Right Extension (Peak Torque)	22	186.54	38.59	Right Extension (Peak Torque)			
						Left Quadriceps	Left Extension
Left Quadriceps (PPT)	26	22.25	5.48	Left Quadriceps (PPT)	Pearson Correlation	1	0.555**
					Sig. (2-tailed)		0.00
Left Extension (Peak Torque)	26	182.65	47.97	Left Extension (Peak Torque)			
						Left Hamstring	Left Flexion
Left Hamstring (PPT)	22	23.25	4.71	Left Hamstring (PPT)	Pearson Correlation	1	0.521*
					Sig. (2-tailed)		0.01
Left Flexion (Peak Torque)	22	104.27	24.02	Left Flexion (Peak Torque)			

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Discussion

In this study, the researchers attempted to determine the relationship between L-MTrPs and Peak torque in lower limbs muscles. The existing literature has suggested that the presence of MTrPs in a muscle may lead to weakness, inhibition of muscle activity that has been seen in the upper trapezius after experimentally induced pain. One can infer from this finding that a muscle with L-MTrPs symptom would prone to inhibition, leading to poor contraction capacity and hence to weakness. Few studies verify this concept and few studies failed to verify (Doraisamy & Anshul, 2011). And no studies are available on lower limbs muscle most of the studies were done in upper body (Trapezius). Various authors recommended to conduct more study on this phenomenon to established a concrete concept (Kim et al., 2017). Therefore, in this article researchers want find out L-MTrPs in lower limb muscles. Pressure algometer was used to find out L-MTrPs. Among the 54 athletes 23 were found at least one TrPs in their lower limb muscle, and rest of them had no TrP as their PPT was higher than 25lbs/cm^2. From this investigation it was observed that PPT decreases with a presence of L-MTrPs (Cygańska et al., 2022). and athlete also develop MTrPs, Pedro, et al. published an article and they mentioned a MPS may develop in athlete as a result of overstraining a muscle and disrupting its normal recovery pattern. In addition, it may occur if a weak muscle gets overloaded in an attempt to perform a normal activity without preparing the muscle for it. MPS caused primarily by repetitive microtrauma and muscle overload, which may explain the high rate of injury in triathlons (Benito-de-Pedro et al., 2019).

Prolonged or unaccustomed exercise, low-load repetitive muscle work, sustained stress, and prolonged ischemia may lead to muscle cell damage and initiate the formation of the L-MTrPs (Ge & Arendt-Nielsen, 2011). Researchers Kisilewicz and colleagues stated in their article that MPS which featured by MTrPs can be developed with any type of sports training and performance (Kisilewicz et al., 2018). MTrPs may affect sports performance in 13% to 30% of the asymptomatic population (San-Antolín, Rodríguez-Sanz, Becerro-de-Bengoa-Vallejo, Losa-Iglesias, Casado-Hernández, et al., 2020). There are various causes of MTrPs, such as sports injuries or muscle imbalances, postural deficiencies, repetitive injury, and overloading. In this article we found a significant positive correlation found between PPT and peak torque production, this indicate that lower PPT had low peak torque production and higher PPT had higher peak torque production, existing literature also strengthen this findings (Albin et al., 2020; Sánchez-Infante et al., 2021). Literature suggested that athlete's performance is strongly impacted by greater muscular strength due to improved force-time characteristics. There is considerable research supporting the hypothesis that increasing muscular strength enhances performance of general sports skills, such as jumping, sprinting, and changing directions. Athletes with stronger muscles perform better during specific sports tasks. In addition to enhancing potentiation earlier and to a greater extent, increased muscular strength also reduces injury risk (Suchomel et al., 2016). From this investigation, MTrPs decreased the muscular strength thus, negatively impact sports performance. The presence of MTrPs exhaust the muscle easily, making them more sensitive to the activation of additional trigger sites (Pérez-Bellmunt et al., 2021).

Apart from the physical disadvantages, the MPS has psychological impacts, research evidence shows that greater depression symptoms and levels were exhibited for athletes with gastrocnemius myofascial pain compared to healthy athletes. According to new research, the rate of depression among athletes is high, ranging from 15.6 to 21%, and relevant risk factors such as involuntary career discontinuation, performance expectations, possibly overtraining, injuries or muscle conditions may all contribute to depression among them (San-Antolín, Rodríguez-Sanz, López-López, Romero-Morales, Carbajales-Lopez, et al., 2020). Greater kinesiophobia and fear-avoidance beliefs had been observed in athletes who were suffering from gastrocnemius MPS compared with healthy athletes (San-Antolín, Rodríguez-Sanz, Vicente-Campos, Palomo-López, Romero-Morales, et al., 2020). Neuroticism and anxiety are also found in athletes suffering from gastrocnemius A-MTrPs (San-Antolín, Rodríguez-Sanz, Becerro-de-Bengoa-Vallejo, Losa-Iglesias, Martínez-Jiménez, et al., 2020).Therefore, MPS can harm an athlete's performance, not only restricted physical performance but it also affects psychological well-being Therefore, it is very essential to focus on this area and explore. And develop a training programme to take proper prevention from MPS.

Conclusion

In conclusion, we found that the relationship between L-MTrPs and peak torque production of the lower limb muscles had significant positive correlation. MTrPs was evaluation by pressure algometer and lower PPT indicate presence of L-MTrPs (<25lbs/cm^2). From this article it concludes that athletes also develop L-MTrPs, and this TrPs reduce the force production, which negatively impact their performance capacity. These results will enable physiotherapists and sports therapists to raise the bar in clinical practice and provide value to athletes, and that could become very effective for sports person to maintain their physical fitness and achieve lots of success in their field. This research article also provides knowledge to the sportsperson, physiotherapists and sports therapists about L-MTrPs.

Conflicts of Interest

Authors have no conflict of interest to disclose

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