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Photobiomodulation and Trigger Band Technique on Groin Adductor Strain in Athletes: Single-Blinded Randomized Control Trial

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Abstract

Aim of the study: In athletes, groin pain-related adductor strain is a common problem in sports medicine, like groin injuries, so the study investigated the effect of Photobiomodulation (905 nm) and Trigger Band Technique (TBT) on handball athletes' groin adductor strain. Methods: Forty handball athletes with adductor groin strain were divided into an experimental group (A) that received Diode laser 905nm, TBT, and medical treatment, while the control group (B) received sham laser with TBT and medical treatment for four weeks. Outcome measures investigated Copenhagen hip and groin outcome score, pressure algometry, creatine kinase, and lactate dehydrogenase levels. Results: Both groups showed a significant improvement in the post-treatment outcome measures, where the experimental group showed more significant improvement than the control group with a p-value >0.05. Conclusion: results imply that treatment of handball athlete's groin adductor strain by TBT and a low-level laser is more effective than TBT alone.

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Contents

1 Introduction

Handball is played in 199 countries by over 20 million players worldwide in over 800,000 teams over the years (Åman et al., 2016). Handball injuries to the groin and hip have gotten less attention than injuries in other sports such as football (Bere et al., 2015). The groin pain-related adductor strain in athletes is a common problem in sports medicine, accounting for 10% of all visits to sports medicine centres, while groin injuries account for 5% to 28% of all athletic injuries (Giroto et al., 2017). The musculotendinous junction is frequently the site of acute groin injuries, but in certain circumstances, the tendon itself is injured (Serner et al., 2018), and the most severe injury in the groin is to the adductor muscles, particularly the adductor longus (Serner et al., 2018).

In recent years, Photobiomodulation (PBM) has been increasingly popular in clinical practice, particularly in physiotherapy and sports medicine, as well as other sectors of traditional medicine, for describing therapeutic efficacy on many types of biological tissues (Farivar et al., 2014). They have opened up new prospects for better treatments in arthritis, joint or tissue inflammation, and pain relief because their wavelengths match the medical treatment required to optimize effectiveness (Yeh et al., 2010).

The trigger band technique (TBT) of the Fascial distortion Model (FDM) is a newly developed anatomical model used to diagnose and treat various musculoskeletal injuries caused by specific alterations of the body's fascia like a pulled muscle (Cole, 2017). So, FDM treats the anatomical fascial distortion involved only accompanying the diagnosis (Wien, 2012).

Creatine kinase (CKmm) and Lactate dehydrogenase (LDH5) are abundantly found in skeletal muscle serum enzymes released in substantial amounts in the presence of muscular injury (Baird et al., 2012), and are the biochemical diagnostic method for monitoring muscle tissue damage in sports (Chatzinikolaou et al., 2010). Also, the Copenhagen Hip and Groin Outcome Score (HAGOS) is a valid and reliable questionnaire assessing symptoms, activity limitation, participation restriction, and quality of life in physically active young to middle age with hip or groin pain (Chatzinikolaou et al., 2010). Moreover, pressure algometry is a valid and reliable measure (YooW, 2013; Park et al., 2011) with wireless capability and smaller digital pressure sensors that help quantify a patient's pressure pain threshold (Koo et al., 2013; Wilharm et al., 2013).

Some research tested the effectiveness of low-level laser (LLLT 905 nm) or Fascial distortion Model (FDM) in treating groin adductor strain separately, but, up to our knowledge, no controlled randomized research directly compared the efficacy of both modalities. Therefore, the present study aimed to investigate the efficacy of PBM (905 nm) and FDM on CKmm, LDH5, and pain level on groin adductor strain in handball athletes (Alpysbaev et al., 2021).

2 Materials and Methods

Study design

A single-blinded pre-post experimental control randomized design was conducted in Al-Ahly Club outpatient clinic from May 2019 to November 2019. It was approved by the "National Institute of Laser Enhanced Sciences - Cairo University" (Cu-NILES/23/20) and by PACTR with a registry number

(PACTR202008911789002). Also, before participating in the study, the patients completed informed consent and revealed the aim and approach following the principles outlined in the Helsinki Declaration.

Study population

The eligibility included 40 participants out of sixty by conducting a preliminary power analysis with a power of 80%. They were referred by the handball team's orthopedist as assessed as acute second-stage groin adductors while playing handball for at least three months with ages ranging from (12-24) years of both sexes. They were excluded if they had any athletic injuries such as sports hernia and osteitis pubis and hip joint injuries like avulsion or stress fracture (Trung et al., 2022). Then, patients were randomly assigned into two groups, A and B, to avoid bias using an envelope prepared by an independent subject with a random number generation of 20 participants in each group with an allocation ratio of 1:1.

Study interventions

Randomly assigned participants either received a program of Chattanooga Gallium Aluminum Arsenide Diode Laser (wavelength 905nm) in addition to medical treatment (Ambezim-G 5mg) and TBT (Group A), or sham laser, TBT, and medical treatment (Group B). Sessions were conducted three sessions per week for twelve sessions day after day over four weeks. The evaluation measures were applied before and after the treatment (Djuraev et al., 2021).

CKmm and LDH5 tests:

A qualified nurse drew three to five cm blood samples from the patient to detect the level of CKmm and LDH5 in blood, considering all patient infection control precautions. In a laboratory, a blood sample was converted to serum for analysis by VACSERA (Egyptian Company for Production of Vaccines, Sera, and Drugs) to detect the normal values of CKmm, which ranged from (52 to 336 units per L, or U/L) for adult males while (30 to 176 U/L) for adult females (Brancacciop et al., 2010; Chernecky & Berger, 2012) while a normal value of LDH5 ranged from (105-333 IU/L) (Chernecky & Berger, 2012; Rosell-Ortiz et al., 2015).

The Copenhagen Hip and Groin outcome scores (HAGOS):

A valid and reliable HAGOS was used (Chatzinikolaou et al., 2010). The patients answered 6 HAGOS subscale questions of the questionnaire that were scored separately: Symptoms (7 items); Pain (10 items); ADL (5 items); Sport/Rec (8 items); PA (2 items), and QOL (5 items). The patient's past week was considered when answering questions (Chatzinikolaou et al., 2010; Hinman et al., 2014; Thorborg et al., 2010). The pain level from (0) represented extreme hip and/or groin problems, and (100) represented no hip and/or groin problems.

Pressure pain threshold (PPT) by pressure algometer:

A valid and reliable (Jespersen, 2007) portable Wagner Force One Model FDIX 50TM, Wagner Instruments, Greenwich, Conn algometer was applied by the same trained physiotherapist to measure PPT and tolerance levels of groin trigger points through a 4-digit LCD screen with 3 buttons keypad and a 1cm2 round rubber tip. The patient was supine lying while the therapist vertically pressed the round rubber tip on the proximal attachment of the pubic ramus (Arendt-Nielsen, 2010). It was picked at two points (point 1 and point 2) along the pain pathway. The Wagner FPIX™ digital algometer detected the patient's minimum pressure, which induced pain in tender and trigger tissue points.

Photobiomodulation

Chattanooga Gallium Aluminum Arsenide Diode Laser – Italy (2015), with a wavelength of 905nm, an average power of 70.5 mW, the maximum frequency of 30000HZ, pulse mode of 30 HZ, target irradiance of 22mJ/cm2, energy per pulse of 2.35mJ, peak power of 13.5W, beam surface at laser aperture of 12.5 mm2 and pulse width at 50% of peak power of 155ns was used. Irradiation of 2 points with an area of 1.25cm2 for 30 seconds 2 times for each point with a total of 1056 J. Used a contact spot laser technique by the same therapist on the medial side of thigh at adductor muscle tendon along with the two most tender points along the muscle length determined by the patient and also identified by common adductor muscle trigger points (pain patterns of adductor longus and brevis muscles, pectineus, and gracillis muscles) for four weeks (Cotler et al., 2015).

Trigger band technique of fascial distortion model

Standard protocol applied for four weeks and defined by the FDM was used to identify distortions. The therapist palpated the painful points along the course of adductor groin strain as a wrinkling in the cross band of the adjoining trigger band (smooth pea-sized found in thighs) and noted the patients' verbal expression at the distortion's location as a "burning" or "pulling" pain (Schlattner et al., 2006). Then the TBT (a subtype of FDM) applied physical force from the physician's thumb twist along its entire pathway till untwisting is felt on distortion while the patient was lying supine (Baird et al., 2014).

Data analysis

The IBM SPSS statistics 22 software was used for statistical analysis. Data analysis was done using descriptive statistics and a 2×2 mixed model Analysis of Variance (ANOVA) with two groups (experimental vs. control) as the between-subject factor and two times for measuring the dependent variables (pre-treatment and post-treatment) as the within-subject factor. The P-value was set at 0.05. Before data analysis, Shapiro–Wilk and Levene's tests were used to test the data normality and the equality of variances. The differences in demographic characteristics for both groups were assessed using unpaired t-tests. A sample size of 20 participants in each group was determined by conducting a preliminary power analysis with a power of 80%.

3 Results and Discussions

There were 20 participants in each group, and their demographic data is represented in Table (1). There was no statistically significant difference between both groups in demographic data.

Table 1
Demographic characteristics of the participants

Characteristics	Experimental group	Control group	P-value
Age	18.85 ±3.15(year)	18.55 ±3.83(year)	0.78
Weight	59.45 ±7.87(Kg)	58.6 ±9.4(Kg)	0.75
Height	162.1 ±6.97(Cm)	160.3 ±7.32(Cm)	0.43
BMI	22.53 ±1.94(Kg/m^2)	22.63 ±1.91(Kg/m^2)	0.86

Shapiro–Wilk and Levene tests did not reveal violations of normality assumptions and homogeneity of variance for the dependent variables. Descriptive statistics of CKmm, LDH5, HAGOS score, and pressure algometer at 2 points are presented in Table (2). All pre-treatment dependent variables showed no significant difference between the two groups (P>0.05).

The 2×2 ANOVA analysis showed significant improvements in HAGOS score in groups A and B after treatment as the main effect of time was statistically significant (p<0.0001), but the experimental group showed a statistically higher significant improvement than the control group post-treatment as both the main effect of group was (p<0.0001) and time × group interaction effect was (p<0.0001) as shown in Table (3). The pressure algometer at Point 1 and Point 2 showed significant improvements in both groups after treatment where the main effect of time was (p<0.0001) for both but, the experimental group showed higher significant improvement than the control group post-treatment as the group main effect was (p<0.005 and p<0.003) respectively and time × group interaction effect was (p<0.0001) for both as shown in Table (3).

Table 2
Descriptive statistics of CKmm, LDH5, HAGOS score and pressure algometer at 2 points for both groups pre-treatment and post-treatment

Variables	Group	Pre-treatment	Post-treatment
CKmm	Experimental	116.06±7.84	46.4±6.23
	Control	117.28±10.8	65.37±7.89
LDH5	Experimental	41.94±4.72	6.03±0.82
	Control	41.53±6.83	12.48±0.84
HAGOS score	Experimental	287.72±22.26	108.7±7.81
	Control	290.45±25.77	143.34±14.65
Pressure Algometer Point 1	Experimental	2.24±0.47	4.13±0.31
	Control	2.34±0.55	3.12±0.66
Pressure Algometer Point 2	Experimental	2.47±0.58	4.21±0.35
	Control	2.58±0.5	3.16±0.58

*SD: standard deviation

Table 3
Results of a 2 X 2 mixed-model ANOVA

Source of variance		F-value	P-value
CKmm	Between subjects (Group)	30.01	<0.0001*
	Within subjects (Time)	1028.98	<0.0001*
	Time X group	21.94	<0.0001*
LDH5	Between subjects (Group)	9.06	<0.004*
	Within subjects (Time)	1402.11	<0.0001*
	Time X group	15.64	< 0.0001*
HAGOS score	Between subjects (Group)	17.76	<0.0001*
	Within subjects (Time)	1636.66	<0.0001*
	Time X group	15.66	<0.0001*
Pressure Algometer Point 1	Between subjects (Group)	8.82	<0.005*
	Within subjects (Time)	539.44	<0.0001*
	Time X group	95.11	<0.0001*
Pressure Algometer Point 2	Between subjects (Group)	10.39	<0.003*
	Within subjects (Time)	253.69	<0.0001*
	Time X group	64.52	< 0.0001*

*Significant at $\alpha < 0.05$.

Discussion

The investigated outcome measures were conducted pre- and post-treatment (after twelve sessions). Regarding CKmm, LDH5, HAGOS score, and two algometry points, there was a significant difference between pre-and post-treatment in favour of group (A). So, the results imply that treatment of adductor groin strain in handball athletes by FDM and PBM is more effective than FDM alone. So, applying PBM to trigger points reduces tenderness and relaxes contracted muscle fibres (Erthal et al., 2013). Furthermore, the reduction of pain severity after administration of PBM would thus be associated with increased oxygen delivery to hypoxic tissues (Agung et al., 2018).

Accordingly, five minutes of LLLT results in increased blood flow that subsequently increases nitric oxide locally and systematically, causing increased blood vessel diameter, inhibiting other inflammatory mediators, including prostaglandin E and cyclooxygenase, and also promoting the endogenous opioid release and increasing serotonin (Schünke et al., 2007; Ahmad et al., 2013). This non-invasive, low-cost, and simple-to-use form of therapy can help reduce medication use primarily associated with adverse effects (Ahmad et al., 2013). However, the wavelength, power output, beam area, total energy, exposure time, regularity of treatment, mode of application, and the onset of treatment parameters used by LLLT are essential to achieving beneficial effects in the treatment of muscle injuries (Jenkins & Carroll, 2011).

Also, inhibition of action potentials where there is approximately 30% neural blockage within 10 to 20 minutes of application suppresses synaptic activity in second-order neurons, so that cortical areas of the pain matrix would not be activated (Bashiri, 2013). Furthermore, a laser applied to trigger points reduces tenderness and relaxes contracted muscle fibres (Erthal et al., 2013).

Furthermore, almost all articles reported beneficial effects of LLLT in the treatment of acute muscle injuries, by modulation of the inflammatory process (de Almeida et al., 2013; Rodrigues et al., 2013; Brunelli et al., 2014; Alves et al., 2014; de Almeida et al., 2014) the stimulation of new vascularization (Alves et al., 2014; de Souza et al., 2011), remodelling of the extracellular matrix (Alves et al., 2014; de Souza et al., 2011; Baptista et al., 2011) and stimulation of the proliferation of a new muscle fibre to enhance muscle repair process after strain (Rodrigues et al., 2013; Vatansever et al., 2012; Assis et al., 2013; Ahmad et al., 2013) through its capacity to minimize oxidative damage and minimize inflammatory responses (Mann et al., 2011).

Additionally, both vitro and vivo studies have confirmed that LLLT stimulates the regeneration of muscle tissue through the activation of satellite cells by introducing them into the cell cycle which promotes its proliferation and progression to the status of new muscle fibres (Nakano et al., 2009). Studies have attributed that LLLT can attenuate the deleterious effects of muscle damage on muscle function and reduce LDH and CKmm serum levels through one of the mechanisms underlying the prevention of induced muscle damage and accelerating healing of muscle fibres (Alves et al., 2014).

De Marchi et al. (2012), improved in human studies that LLLT reduced muscle damage markers (CKmm and LDH5 activity). It further delayed the onset of muscle soreness and improved the pain threshold (Antonialli et al., 2014). Baroni et al. (2010), the study was consistent with our study as they found that serum levels of LDH5 and CKmm after treatment by LLLT and eccentric knee exercises were reduced, which could decrease muscle damage and increase sports training performance. Also, Takenori et al. (2016), proved that LLLT provided an immediate pain relief effect in college athletes with painful action at a defined site.

Additionally, this study's results agreed with a systematic review that proved LLLT as an excellent therapeutic modality for treating skeletal muscle injuries in the short term (Alves et al., 2014). Moreover, LLLT decreased the serum CKmm and lactate levels post fatigue, indicating that LLLT improves muscle performance (Dos Reis et al., 2014).

Furthermore, there is a moderate effect of LLLT on CKmm, LDH5, and performance in water polo players after applying it to eight points of the adductor Magnus and adductor longus muscles (Zagatto et al., 2016). The insignificant effect may be due to the small area covered by irradiation (Leal Junior et al., 2010). On the other hand, a study reported a partial reduction of CKmm when using LLLT during exercise intervals but no effect on strength performance, muscle function, and ADL activity improvements (Felismino et al., 2014). This could be due to the small sample size used, the application of LLLT on physically active healthy males only, and the use of the one-repetition maximum test, which may not be sensitive enough to detect changes in maximum strength performance.

As for FDM, it significantly improved the pain and muscle repair process, as proved by lowered CKmm and LDH5 scores. This is generally due to its ability to facilitate the flow of nutrients to muscle fascia and supply nutrients and oxygen to various tissues resulting in improved nutritional status of tissues by discharging them from the tissues and reducing pain. Also, membrane shrinkage is reduced, causing reduced metabolites which reduce the excitement of sensation of afferent pain fibres. This promotes fascial relaxation (Typaldos, 2002). Eventually, it activates the counter-irritation theory to reduce intense pain (Kim & Lee, 2019).

Furthermore, applying thumb pressure on muscle fascia could remove solid cross-links at the nodule points, changing the membrane viscosity to a liquid state, increasing the flexibility of the fascia (muscles and tendons), restoring the condition of the peripheral nervous system, promoting relaxation, improving function, resulting in reduction of excited pain afferent fibres sensation and eventually, promotes fascial relaxation, and blood rushing into muscle (Park & Bae, 2014; Park & Oh, 2015). Other studies on fascia and its properties suggested that the mechanical forces generated by manual therapies, such as FDM, may stimulate fascial mechanoreceptors that trigger tonus changes in connected skeletal muscle fibres (Chaudhry et al., 2008).

However, some authors (Lederman, 2011; Moseley, 2015), believe that the benefits experienced from FDM were due to nonspecific factors, while another explanation was due to activation of neurophysiological modes of action caused by the sensation of intense pain induced by pressure from the therapist's thumb on the injured area (Bland & Altman, 1994; Di Blasi et al., 2001; Ernst, 2009; Benedetti, 2010; Benedetti, 2011; Hall et al., 2010).

The present study results following Kim & Lee (2019), results found the FDM was the most effective and rapid treatment method used compared to self-myofascial release and myofascial release after four weeks of treatment for neck range of motion and pain (Kim & Lee, 2019). FDM could also increase speed without pain in patients with medial tibial stress syndrome (MTSS) (Schulze et al., 2014). Additionally, FDM had a significantly better result than manual therapy in managing shoulder pain syndromes (Fink et al., 2012).

Also, Engel (2009), attributed in a study that treatment following the principles of FDM is effective in treating patients with chronic low back pain as their functional status, pain, finger-floor distance improved, and intake of analgesics reduced. On the contrary, it was reported in a systematic review focusing on the clinical proofs of concept for FDM treatment techniques in musculoskeletal medicine that FDM is based on a biomechanical/structural paradigm (Thalhamer, 2018). However, there is no evidence that all musculoskeletal conditions are amenable to biomechanics and peripheral tissue pathology laws (Lederman, 2011; Moseley, 2015).

This study was limited by obtaining the results of either LLLT or TBT alone due to combining LLLT with TBT and medical treatment and the small sample size. So, it is recommended to investigate the effect of LLLT and TBT alone and investigate the effect of LLLT on different sports injuries, different wavelengths, and the power of LLLT. Also, the study combined the effect of PBM on other subtypes of FDM, such as Cylinder Distortion in athletes.

4 Conclusion

It could be concluded that both low-level laser 905nm and TBT together effectively treat acute groin adductor strain in handball athletes. So, the results could help physiotherapists consider a proper treatment for adductor groin strain in handball athletes rather than consuming time and effort on other techniques that could be less effective.

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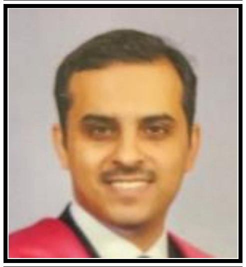

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