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PHOTOBIOMODULATION IN THE ILIOTIBIAL TRACT IN WOMEN WITH PATELLOFEMORAL PAIN SYNDROME

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ABSTRACT

Purpose: To investigate the efficacy of photobiomodulation (PBM) on the iliotibial tract (ITT) in women with patellofemoral pain (PFP), analyzing pain, function, and ITT thickness.

Methods: The study is characterized as a longitudinal randomized clinical trial, with analysis conducted in a clinical laboratory. The sample consisted of 30 women with PFP and 15 without knee dysfunction who were not engaged in regular physical activities. Volunteers with PFP were randomly assigned to a group that received PBM treatment and a group that did not. The variables analyzed included the Knee Pain Scale, the Knee Injury and Osteoarthritis Outcome Score, the Visual Analogue Pain Scale, the Pressure Algometer, and the measurement of ITT thickness on ultrasound images. PBM was performed at a wavelength of 660 nm and an energy density of 10 J/cm^2 on five points along the ITT over four weeks, totaling 12 sessions, with a total deposited energy of 0.9 J. The accepted significance level was set at 5%.

Results: After treatment with PBM, there were no significant improvements in the group that received treatment ($p > 0.05$).

Conclusion: The use of PBM, in the parameters applied, on the ITT does not have an effective impact on the treatment of PFP.

KEYWORDS

Knee joint, patellofemoral pain, low-level light therapy, fascia lata, physical therapy modalities

INTRODUCTION

The patellofemoral pain (PFP) is characterized by diffuse pain in the anterior or retropatellar region of the knee[1]. This disorder is exacerbated by certain activities performed on a daily basis, such as going up and down stairs, squatting, and kneeling. It has a high incidence in the adult population, approximately 20%, mainly affecting women between 18 and 35 years of age[2]. Despite its high incidence, the etiology and biomechanical alterations present in this disorder remain poorly understood. Biomechanical variations are being investigated as specific musculoskeletal behaviors of PFP patients in an effort to help characterize

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this disorder[3,4]. The Anterior Knee Pain Scale (AKPS) is a valuable tool in diagnosing PFP. It assesses the functional limitations of the knee and indicates a tendency towards patellofemoral disorders[5].

The iliotibial tract (ITT) is the junction of the fascia formed by the tensor fascia lata muscle, the gluteus medius, and the gluteus maximus. It is a large, flat structure that originates at the iliac tubercle, runs along the lateral aspect of the thigh, and inserts into the lateral part of the proximal tibia, specifically the Gerdy tubercle and the lateral border of the patella[6]. The thickening of this structure is one of the predisposing factors of PFP because changes in its morphology may cause patellar lateralization[7]. This can lead to an increase in the lateral force vector during flexion, thereby increasing the stress of the patella on the femur[8]. Women with patellofemoral disorder often exhibit ITT thickening[7]. The ITT thickening may be associated with an inflammatory process resulting from friction with the lateral epicondyle of the femur, possibly caused by musculature weakness or poor knee alignment[9].

The use of photobiomodulation (PBM) has shown significant results in controlling the inflammatory process by reducing pain, edema, muscle spasm, inflammatory enzymes (cytokines), increasing blood flow, and promoting the repair of injured tissues (increasing the level of growth factors, and anti-inflamatory cytokines)[10–15].

In collagen-rich tissues, such as fascia, research has shown significant results in modulating inflammation, pain, function, and optimizing tissue repair[16,17], despite significant dosimetric discrepancies[18–21]. For the knee joint, several studies have shown favorable results in pain reduction and functional improvements for cases of osteoarthritis[22–24] and knee arthroplasty[25,26]. Specifically for people with PFP, there is little data in the literature, but, the use of PBM has proven useful in reducing pain and improving function, however, such a report is limited to the application on the medial and lateral aspects of the patella[27], but there are still no studies analyzing treatment or intervention on ITT. Thus, the objective of the present study was to evaluate the effect of PBM when applied not directly to the femoropatellar joint but rather to the iliotibial tract in women with PFP. The hypothesis was that the use of PBM on the iliotibial tract could reduce PFP symptoms.

MATERIALS AND METHODS

Sample

The study is characterized as a longitudinal randomized clinical trial, with analysis conducted in a clinical laboratory. The sample size was calculated based on the ultrasound images of subjects without dysfunction, with a minimum detectable difference of 0.35, a standard deviation of 0.29, a test power of 80%, and a significance level of 5%. Fifty women, aged between 18 and 30 years, with and without PFP, were selected, due to the higher incidence of cases in females and in this age group. They were not engaged in regular physical activities. The volunteers were recruited through advertisements on social networks, in parks, and at gyms in the city of Cascavel, Paraná, Brazil. All volunteers were informed about the nature of the research and provided their consent by signing the informed consent form approved by the Research Ethics Committee/UNIOESTE (2.681.238). The research project was registered in the Brazilian Registry of Clinical Trials (RBR-6XQRTR).

Of the total number of volunteers, there were 5 losses (1 due to dropout and 4 due to non-inclusion criteria), and the remaining 45 volunteers were divided into 3 groups: Group PFP + PBM (PBMG, n = 15), which received 12 laser treatment sessions, Group PFP control (PFPG, n = 15), and group without PFP (CG, n = 15), which received no treatment *(Fig. 1)*, not only PBM, but no other form of therapy during the period of the experiment. For the first two groups, the volunteers were randomized using the https://www.graphpad.com/quickcalcs/randomize1/ tool.

Inclusion, non-inclusion and exclusion criteria

Inclusion criteria for women with PFP were as follows: experiencing anterior or retropatellar knee pain while engaging in at least two of the following activities: prolonged sitting, squatting, kneeling, running, climbing stairs, and jumping and landing; exhibiting pain during patellar palpation; if there were bilateral symptoms, the site of greatest complaint would be the treated/placebo; reporting symptoms with an insidious onset lasting for a minimum of 1 month; having the highest pain level in the previous month of at least thirty millimeters on the visual analogue pain scale (VAS); and scoring less than 83 on the Anterior Knee Pain Scale (AKPS) questionnaire[28].

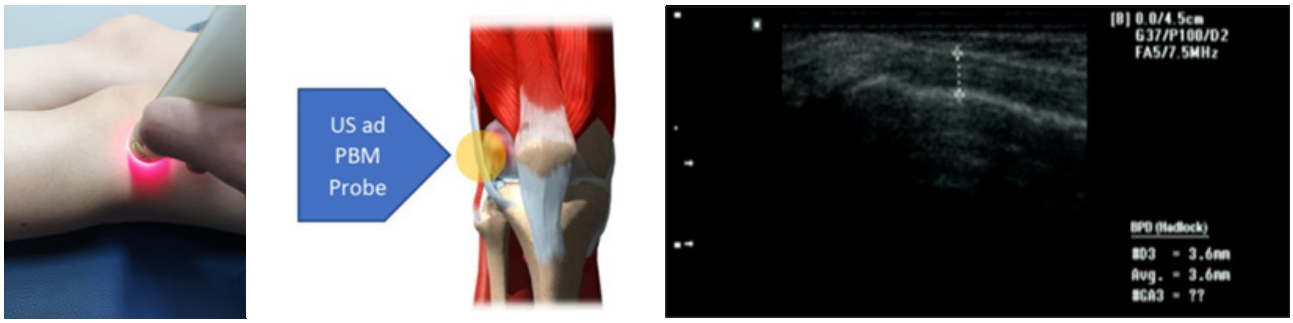


Figure 1. *On the left is a representative image of the region where the therapy was performed (with photobiomodulation) and the measurement of ITT thickness. On the right, representative image of ITT thickness (dashed lines).*

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As non-inclusion criteria, women with a history of neurological disease, knee joint surgery, patellar dislocation, meniscal injury, ligament instability, osteoarthritis, or patellar tendinopathy were excluded. In addition, the volunteers must not have received physiotherapy treatment in the past 6 months and should not have been undergoing drug treatment for at least the last month. Exclusion was caused by abandonment of treatment or assessments. The evaluators responsible for selecting the volunteers were two physical therapists with over 20 years of experience in the field.

Outcomes

Upon arrival at the laboratory, the volunteers were first familiarized with the facility and informed about the procedures. Soon after, they completed the Anterior Knee Pain Scale (AKPS) and Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaires, and assessed their pain using the Visual Analogue Scale (VAS) and a pressure algometer. Then, the images were captured using ultrasonography (evaluation 1 - EV1). At the end, a template with 5 points was presented, where the PBM was applied to the ITT, always targeting the knee identified as the most affected. These procedures were performed on the first day when the treatment was initiated, lasting for 4 weeks, divided into 3 sessions per week, totaling 12 laser applications. The day after the final treatment/placebo, the evaluations were repeated (evaluation 2 - EV2).

Anterior Knee Pain Scale (AKPS) and Knee Injury and Osteoarthritis Outcome Score (KOOS)

The AKPS questionnaire was used to assess functional limitations. The questionnaire comprises 13 items designed to assess the subjective symptoms and functional limitations related to anterior knee pain. The score ranges from 0 to 100 points, where 100 represents no functional limitation, and a score below 83 indicates a tendency for patellofemoral disorders[29]. Also used was the KOOS, which includes five subscales (pain, other symptoms, activities of daily living, function in sports and recreation, and knee-related quality of life), assessed separately, on a scale from 0 to 100 points (similar to the AKPS)[30].

Visual Analogue Pain Scale (VAS)

We also utilized the Visual Analogue Pain Scale (VAS), a one-dimensional instrument used to assess pain intensity. It is a scale with endpoints numbered from 0 to 10 cm, where one end of the line is labeled as “no pain” and the other as “worst pain imaginable”. The patient was asked to evaluate and mark on the line the pain present at that moment[31].

Pressure algometer

The volunteers were then assessed using a pressure algometer (Kratos®), which utilized a metal rod with a rounded tip measuring 1 cm^2. The rod was applied three times to the lateral region over the ITT, and the average of the values recorded in Kgf for the pressure pain threshold (PPT) was documented. The pressure application site was standardized at 5 cm above the lateral tuberosity of the tibia (LTT).

ITT Thickness

The thickness of the ITT was evaluated using an ultrasound machine (Shimadzu SDU 450xl, Columbia, USA) with a 5 cm 5~10 MHz linear array transducer was used. The ITT was scanned in a transverse plane at a 10° knee flexion, supported on a foam roller, with the transducer positioned on the lateral side of the patella perpendicular to the skin surface. Compression of the skin and underlying tissues was avoided. The thickness of the iliotibial tract was measured 5 cm above the LTT, at 0.5, 1.0, and 1.5 cm lateral to the femoral border, underlying the upper and lower limits of the ITT, respectively[32] *(Fig. 1)*.

Photobiomodulation

For the treatment, we used a low-power continuous therapeutic laser, 660 nm (Ibramed), with a power of 30 mW, a spot size of 0.06 cm^2, and an energy density of 10 J/cm^2. The laser was applied at 5 points (50 J/cm^2), in direct contact with the skin on the ITT, 5 cm above the LTT, with a distance of 1 cm between one point and another, which was previously marked with a template, resulting in a total energy of 0.015 J, with a total delivered energy of 0.9 J. The volunteers remained in a dorsal decubitus position, with the limb to be treated extended for the application of the laser. Prior to this, asepsis was performed with 70% alcohol. The volunteer wore eye protection that prevented them from being exposed to radiation. Before starting the treatment, the equipment was checked for emitted power. For the PFPG, the equipment was kept in contact for a similar amount of time as the PBMG, but without the application of radiation, only simulating. At the end of the treatment, all forms of evaluation were carried out again.

Statistical analysis

All other analysis was performed using SPSS 20.0 software. The data were analyzed using Generalized Linear Mixed Models, with LSD post-test. The accepted significance level was set at 5%. For variables with a normal distribution, Cohen’s Effect Size was assessed for the groups with femoropatellar dysfunction.

RESULTS

For the VAS, there was an interaction of factors ($X^2 = 3.66$, $p = 0.030$). In the first evaluation, the groups with dysfunction presented higher values than the CG ($p < 0.05$). In the first two groups, there was a reduction of values in the second evaluation ($p < 0.05$), but they were still higher than the CG ($p < 0.05$) *(Fig. 2A)*, with effect sizes considered large. The observed confidence intervals (CI) for the differences were as follows: in the pre- and post- for CG and PFPG: -6.484 and -4.850; CG and PBMG: -6.884 and -5.250; PFPG and

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PBMG: -1.217 and 0.417.

In the AKPS evaluation, the knee function for the groups with dysfunction was lower than the score of 83, which is accepted as the minimum for considering a good functional level. However, there was only a difference between groups (X^2 = 157.9, p <0.001), with no interaction of factors (X^2 = 0.58, p = 0.564). After treatment or placebo, both groups exhibited a non-significant increase in grades (p >0.05) without reaching the functional threshold value. The only differences observed were in comparison to the control group (CG) *(Fig. 2B)*, with all effect sizes considered small. The observed CI for the differences were, respectively, in the pre and post for CG and PFPG: 23.698 and 30.435; CG and PBMG: 21.582 and 28.319; PFPG and PBMG: -5.485 and 1.252.

For KOOS (X^2 = 98.6, p <0.001) *(Fig. 2C)* and PPT (X^2 = 383.8, p <0.001) *(Fig. 2D)*, the results were similar to those observed for AKPS. The observed CI for the differences in the pre- and post-assessment for the CG and PFPG: 21.973 and 31.160 (KOOS). 2.593 and 3.071 (PPT); for CG and PBMG: 24.809 and 33.996 (KOOS). 2.695 and 3.173 (PPT); and for PFPG and PBMG: -1.757 and 7.429 (KOOS). -0.137 and 0.341 (PPT).

Finally, for ITT thickness, there was no interaction *(Fig. 2E)*. However, the groups differed significantly from each other (X^2 = 96.7, p <0.001). Only PBMG showed large effect size, while in the other groups it was small. The observed CI for the differences in the pre- and post-conditions for CG and PFPG were -1.056 and -0.493; CG and PBMG: -1.506 and -0.939; PFPG and PBMG: -0.728 and -0.164. There were no sample losses, and no adverse effects of therapy reported.

DISCUSSION

The present study tested the hypothesis that the use of PBM over ITT could reduce the symptoms of young women with PFP. To this end, the efficacy of PBM (660 nm) with a dosage of 10 J/cm^2 in the ITT was investigated, in women aged between 18 and 30 years with patellofemoral pain, and also in women without PFP, in order to present values considered standard for ITT thickness, as well as for the other variables. But this hypothesis has been disproved.

The PFP is common among young adults, and causes functional limitations, especially in day-to-day activities such as squatting, climbing stairs, and other activities that put greater pressure on the patellofemoral joint. Although common, its causes are not well defined yet. It is believed that the thickening of the iliotibial tract, caused by an inflammatory process, has deleterious effects on

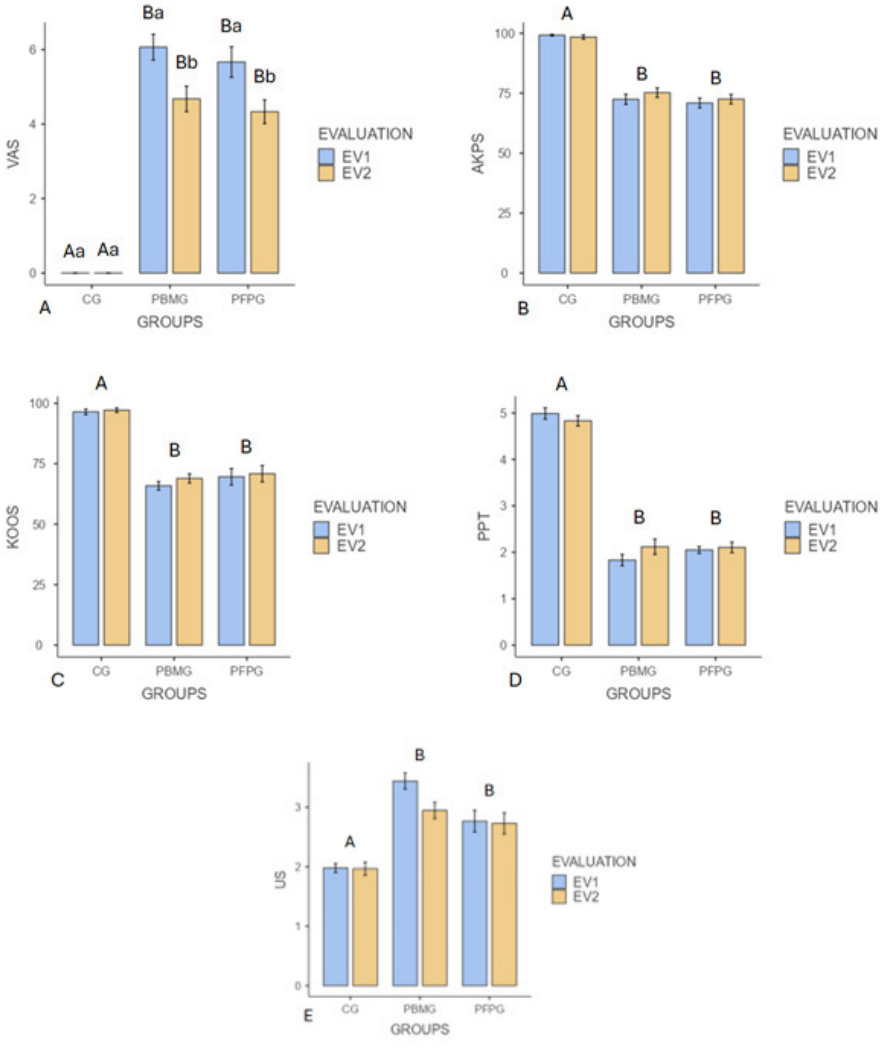


Figure 2. *Graphical representation of the results for the different variables analyzed. Visual Analogue Scale (VAS); Anterior Knee Pain Scale (AKPS); Knee Injury and Osteoarthritis Outcome Score (KOOS); Pressure Pain Threshold (PPT); Ultrasound thickness (US). Equal capital letters represent statistical similarity between the groups. Equal lowercase letters represent statistical similarity between moments in the same group.*

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this dysfunction[33,34]. Thus, PBM could be considered a treatment option due to its anti-inflammatory and analgesic effects. It also a non-invasive and painless method[35,36]. However, a recent study, despite showing an increase in ITT thickness in individuals with PFP (indicating a relationship between structure and dysfunction), found no correlation between this thickening and pain and function measurements[37]. It is emphasized that the commonly used treatment for PFP is the conservative, involving a combination of orthosis, physiotherapy, and medication, with the latter potentially causing side effects[38]. Therefore, the physiotherapeutic treatment is highly valued.

Treatment with PBM exerts an anti-inflammatory effect as well as accelerating cell proliferation, collagen synthesis, and consequently tissue repair[10–14,35,39]. Besides these effects, it also plays a crucial role as an analgesic by reducing nerve conduction velocity and the amplitude of compound action potentials. It inhibits peripheral nociceptors, depress spinal cord activity, leading to long-term pain reduction[40,41], and influences the activity of endogenous opioids and serotonin[42,43]. However, although these variables were not evaluated in this study, they seem to do not to have occurred. Although there was a reduction in pain intensity and an increase in pain threshold to pressure, this phenomenon also took place in the PFPG. There are reports that PBM produces effects on fascial tissues[35,44], indicating absorption and action. This likely resulted which in the decrease in thickness observed in the ITT treated group in this study. Even though there was no interaction of factors and thus no differences between the evaluations, this find is significant due to the large size identified. One of the limitations of this study was the use of radiation in the red spectrum, which may have limited penetration depth[45], but is used in cases of knee osteoarthritis[24]. Another point to highlight is the relatively low fluency, although still within clinically accepted parameters, as there is great variability for this in musculoskeletal issues, with 10 J/cm^2 being included in the window of positive results for some diseases[18,46,47]. It should also be noted that no adverse effects were observed with the therapy, which is in line with what has been observed in the literature for photobiomodulation[48,49].

Among the evaluation forms utilized in the current study, AKPS is a specific questionnaire designed for individuals with anterior knee pain. It aims to assess various different levels of function, with responses scored on a scale where “100” indicates “lack of deficit” and “zero” indicates the “greatest possible deficit”[29]. The volunteers, whether treated or not, showed similar progress in terms of PFP. This fact also applies to the KOOS, another instrument designed to assess the knee function.

For the VAS, which assess pain in a unidimensional manner based on intensity[50], there was an interaction of factors. Pain reduction was observed during the second evaluation in both groups with PFP, and between groups there were differences only evident in comparison to the control group. In the PPT, a method was used in which it is possible to quantify profound pain[51] There was an increase in values in the groups with dysfunction. Although the values were numerically different, the effect sizes were classified as small. The changes in the thickness of the ITT observed through ultrasonographic images are associated with PFP and an increase in the thickness of the lateral retinaculum[32,37]. The lateral retinaculus connects with the ITT and the tendon of the vastus lateralis obliquus[52], showing a strong relationship between ITT tension and a decrease in the medial sliding of the patella[53]. When analyzing the effect size, significant advantages for the patellar belt mechanism (PBM) can be observed, as the effect size which was large for this group.

The following can be cited as limitations of the study: the short duration of treatment, mainly to visualize possible morphological changes; the absence of patient follow-up which we consider to be important in clinical analysis, but which was not feasible in this study; in addition to the fact that the ultrasound evaluation method (although validated) is examiner-dependent. It is suggested that future studies should address these aspects. Moreover additional research is required to investigate the optimal dosages and applications areas of PBM to determine the most effective treatment strategy, because this study used fixed dosimetric parameters, it was not possible to analyze a dose-response curve, since longer wavelengths (in the infrared range) have greater penetration, they may be more useful for this disease. Furthermore, it should be noted that the multiplicity of risk factors for PFP, the limited dosimetric strategy, the wavelength within the red spectrum (which does not penetrate deeply) and the application technique may have influenced the results obtained.

CONCLUSION

This study has shown that the use of PBM, with the parameters applied, did not effectively impact PFP in ITT.

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