Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain

Maíelen Teixeira Gonçalvez¹, Aline Santos Vieceli¹,², Tayane Cristina Rigon¹, Guilherme Bertolino³, Lais Mara Siqueira das Neves¹, Marisa de Cassia Registro Fonseca⁴, Rafael Inácio Barbosa¹,², Heloyse Uliam Kuriki¹,², Alexandre Marcio Marcolino¹,²

¹Laboratório de Avaliação e Reabilitação de Aparelhos Locomotores, Universidade Federal de Santa Catarina (UFSC) – Araranguá (SC), Brazil
²Programa de Pós-Graduação em Ciências da Reabilitação, Universidade Federal de Santa Catarina (UFSC) – Araranguá, Brazil
³Universidade Paulista (UNIP) – Campus Ribeirão Preto (SP), Brazil
⁴Programa de Pós-Graduação em Reabilitação Funcional e Performance, Universidade de São Paulo (USP) - Ribeirão Preto (SP), Brazil

Corresponding author: Alexandre Marcio Marcolino - Laboratório de avaliação e reabilitação do aparelho locomotor, Universidade Federal de Santa Catarina – Rua Pedro João Pereira 150 – CEP: 88905-120 - Araranguá (SC), Brazil – E-mail: alexandre.marcolino@ufsc.br

Declaration of interests: Nothing to declare

©2022 The authors
ABSTRACT

Introduction: About 10 million people have low back pain (LBP) disability in Brazil. Several therapies are used to treat this condition, such as kinesiotherapy, manual therapy (MT), and photobiomodulation (PBM). Although the use of these methods in LBP has been investigated, studies to evaluate the efficacy of the association between these techniques are still needed.

Objective: To evaluate the activation of the lumbar region muscles by PBM or MT associated with kinesiotherapy for the treatment of LBP. Methods: Twenty individuals with chronic LBP were randomly divided into two groups. The first group (MT) received vertebral mobilization associated with a kinesiotherapy exercise program. The second group (830nm-PBM) received PBM associated with the exercise program, twice a week for 8 weeks. Evaluation of pain perceived was performed by the visual analogic scale (VAS), lumbar disability by the Oswestry questionnaire, muscle strength by a strain gauge, and activation through surface electromyography (EMG). Data were collected before and after the treatment. EMG data analysis was performed by MatLab® software. The ANOVA two-way test was used (degree of significance p<0.05), and the size of the effect by the Hedge test. Results: Considering pain, the two groups presented a significant result (p<0.05). In muscle activation, only the multifidus was different during the side bridge (p<0.05) when compared to the intragroup. None of the variables were different when evaluating intergroup. Conclusion: Both MT and PBM associated with kinesiotherapy for 8 weeks are effective in reducing pain, and improving motor control and stability of the lumbar spine in patients with chronic LBP.

Keywords: low back pain; musculoskeletal manipulations; lasers; exercise therapy.
INTRODUCTION

Non-specific low-back pain (LBP) is defined as pain or discomfort between the margins of the lower ribs and the gluteal folds, associated or not with neurological symptoms in the inferior members\textsuperscript{1,2}. This pain is one of the main causes of absence from work, affecting life quality and leading to functional incapacity and disability to perform daily-life activities, resulting in higher economic costs for social security systems and health services\textsuperscript{3,4}. Around 10 million people present some deficiency associated with lumbar pain in Brazil, and data suggest that at least 70% of the population will have a painful episode throughout life\textsuperscript{5}. The etiology of LBP is considered multifactorial, highlighting occupational factors (heavy physical work, rotation movements, inclination, and vibrations) and others such as for overweight, muscle weakness, postural changes, shortening, and imbalance of the muscle chain\textsuperscript{2,6,7}. Thus, musculoskeletal injuries have an important role in the LBP symptoms by leading to changes in the control of the deep musculature, failure of the activation of the trunk muscles, and consequently spinal instability\textsuperscript{8}. The instability is the result of a tissue injury that makes the segment less resistant and with weak muscle control, is thus suggested as the cause of functional disorders, such as tensions and pain\textsuperscript{8}.

Studies describe that kinesiotherapy presents positive effects on the treatment of the LBP symptoms, improving spine and lumbar stability, incapacity, strength, flexibility, and range of motion (ROM), besides reducing pain\textsuperscript{9,10}. In the systematic review study carried out by Chou et al.\textsuperscript{11}, they recommend the use of exercises for the rehabilitation of patients with chronic low back pain.

Other treatments encompass non-thermic or photochemical reactions to modify the condition of damaged tissues, such as photobiomodulation, or manual therapy, acting as possible treatments for chronic low back pain\textsuperscript{3,12}. A metanalysis pointed out that
photobiomodulation when used alone or in combination with other modalities, presents an important role in the reduction of lumbar pain\textsuperscript{13}. The articular mobilization proposed by Maitland is based on the evaluation and treatment through passive accessory intervertebral movements, and analgesia is produced by stimulating mechanical periarticular receptors, inhibiting nociceptors, and generating a positive response of the descendent pain inhibition systems\textsuperscript{3,14,15}. The study of Ali et al.\textsuperscript{15} demonstrated that manual therapy leads to a significant improvement in pain time, movement amplitude, back extensor muscular activity, and chronic LBP disability.

Kreiner et al.\textsuperscript{16} organized a study to answer eighty-two clinical questions seeking to answer them as a summary of the clinical guidelines for the treatment of low back pain. In this research, the authors presented strong recommendations for physical exercise. However, for manual therapy and PBM, the recommendations were poor. In the guideline written by Meroni et al.\textsuperscript{17}, the authors describe physical exercises with a strong recommendation for patients with chronic low back pain whereas the other modalities used in the present study, there is a need to be studied as the weak recommendations for the isolated use of manual therapy and the evidence do not support the use of photobiomodulation\textsuperscript{17} for this patient profile so we justify the present study by associating physical exercises with manual therapy and PBM with the objective was to evaluate the activation of the muscles lumbar region with the influence of photobiomodulation and Manual Therapy associated with kinesiotherapy in the treatment of non-specific Chronic Low Back Pain.

**METHODS**

**Design**

The project and execution followed the orientation of the consort checklist. This study had a prospective character, presenting a randomized clinic essay with two parallel groups:
MT, or manual therapy with ten exercises; and PBM, or 830 nm photobiomodulation with ten exercises. The Randomized Clinical Trial was performed for eight weeks, with a two-time weekly frequency, totaling 16 visits.

Participants

The sample occurred by convenience. The participants were recruited in the period between November 2014 and July 2016, in Universidade Paulista, through social media and flyers distributed in the city of Ribeirão Preto, Brazil. We recruited twenty men and women between 18 and 60 years old with chronic non-specific LBP. The individuals were included when presented with chronic LBP with or without irradiation to lower members, with more than three months of symptoms. The participants were excluded if they presented low back pain due to injuries in the central or peripheral nervous system, spine fracture, specific LBP (such as scoliosis, spondylolisthesis, and disc protrusion), or association to red flag (e.g., tumors, cauda equina syndrome, infections, and abdominal aortic aneurysm). The flowchart of the participants screened and included in this research is shown in Figure 1.

Randomization

The randomization was performed through a brown envelope with 23 papers containing the numbers 1 (PBM group) and 2 (MT group). On the first day of attendance, the individual took a paper from the envelope, which indicated the group to which he would be forwarded. The numbers one to eleven were designated for the MT group and 12 to 23 for the PBM group. Only three patients did not perform the procedures until the end and were excluded from the study.
Intervention

To better describe the interventions, we used the TiDier checklist. Costa et al. demonstrated that the motor control exercise leads to a decrease in persistent lower back pain. The two groups in the present study received the kinesiotherapeutic protocol consisting of 12 exercises. Only eight exercises were performed during each attendance, and some were changed along with the attendances, thus embracing all the exercises. The protocol was composed of ground exercises, where the individual could remain in sedation, supine, lateral, and ventral positions, being able to move to positions on four supports. The voluntaries performed eight repetitions of eight exercises, with a progression along the weeks to ten repetitions. The PBM protocol (Table 1) was explained through an Ibramed® Laserpulse device of Gallium, Aluminum, and Arsenieto (GaAlAs) with infrared light in continuous emission mode. The pen was in direct contact, perpendicular to the individual's skin. Were performed at ten points in the voluntaries lower back, with irradiation performed bilaterally in the region of the vertebral foramina of the five lumbar vertebrae.

In the MT group, the individuals were submitted to vertebral mobilization maneuvers varying according to the pain degree of each evaluated individual. The maneuver was applied over the spinous process of the lumbar vertebrae, where the patients reported the biggest pain picture. Three series of 30 seconds each were realized for mobilizations of I and II degree, and 60 seconds for mobilizations of III and IV degree.

The treatment protocol for both groups was performed before the exercises, two times a week (with a minimum interval of 48 hours), with a duration of two consecutive months (eight weeks), totalizing 16 attendances of 60 minutes each. The attendances were performed by two trained people at the physiotherapy clinic of the Universidade Paulista.
Data collection

All volunteers were individually submitted to blind assessment before and after treatment protocols. The evaluations were made by the one trained evaluator, which was not aware of which group the participant would be referred to. In the initial evaluation, personal data, weight, BMI, pain level (visual analogic scale – VAS, primary outcome), and isometric muscle resistance (through side bridge and Sorensen test).

The tests and observation of muscle tension points performed in both initial and final evaluation characterized the studied sample. After the tests, an Oswestry questionnaire was applied to characterize the lumbar disability and an evaluation with superficial electromyography (EMG) was performed with two Miotec® Miotool 400 devices. The software used to observe the recruitment of muscle motor units was MiotecSuite 1.0, through the evaluation of the transverse abdominal muscles/internal oblique (TrA/OI) and lumbar multifidus (ML). The electromyographic data were analyzed through the software MatLab® (MathWorks Inc., Natick, MA, EUA) and processed through algorithms developed for this evaluation. Data was passed through a bandpass filter with cut frequencies from 20 to 500 Hz, then was performed the normalization of the signal of the right and left lateral and transverse abdominal muscles/right and left internal oblique, by the signal peak in the performed activity.

Before performing the Sorensen test, the maximum voluntary isometric concentration of the lumbar extension movement was collected to quantify the strength of this musculature. The skin cleansing care and the positioning of the electrodes in the multifidus muscles were through the recommendations of SENIAM (Surface ElectroMyoGraphy for the Non-Invasive Assessment of Muscles)\(^22\) and positioning in the transverse abdominal muscles/internal oblique muscles (TrA/OI) was recommended by Alves et al.\(^23\).
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

Statistical analysis

Data were submitted to the Shapiro-Wilk test for the data normality. After that, an ANOVA Two-Way test was performed with a significance level of p<0.05, and effect size by g de Hedges. The statistical analyses were performed using the software GraphPad Prisma® 8.0 (GraphPad Software, La Jolla, California, USA). The delta consists of the difference between the final and initial evaluation, to demonstrate how much variation occurred in intergroup or between the groups.

Ethics

This research was approved by the ethical and research committee of the Universidade Paulista, under the number 1.041.755. The research was registered in the Brazilian registry of clinical trials (REBEC) under the number RBR-243w6r. The voluntaries read and sign an informed consent form before any methodological procedure.

RESULTS

The recruitment period and interventions occurred from November 2014 to July 2016. Only data analysis was carried out at the federal university of Santa Catarina, from August 2016 to June 2017. Twenty-three individuals were selected to participate in the research, but three did not finish the intervention. The individual characterization is described in Table 2, containing ten randomized individuals for each group (N=20) divided into MT and PBM groups, they are homogeneous in age and BMI with p>0.05. The Oswestry disability questionnaire resulted in average punctuation of 38% before intervention and 18% post-intervention in the MT group, reflecting minimal disability and presenting the effect size g=0.86. For the PBM group, the questionnaire resulted in average punctuation of 41% before intervention and 24% post-intervention, reflecting a moderate disability in the final evaluation.
and presenting the effect size $g=0.64$. In the intragroup analysis, there was a difference between the pre and post-intervention, in the analysis between the groups, there was no statistical difference. The analyzes of the maintenance time in the position of the side bridge and the Sorensen test were quantified by time (seconds) but without statistical differences between intragroup or intergroup. The greatest variation in time was observed in the Sorensen test of the MT group, which varied from 64 seconds in the initial evaluation to 85 seconds in the final evaluation (Table 2), of all the tests only the Sorensen and right side bridge of the MT group present the effect size $g=0.85$ and $G=0.81$ respectively.

Data referring to perceived LBP are presented in Figure 2, evaluated through the VAS. Data presented significant differences in intragroup GMT before and after intervention with $p<0.05$. Both groups showing effect size negative GMT $g=-1.93$ and GPBM $g=-1.51$.

The values of the RMS of the Sorensen test are shown in Figure 3A, indicating the variation in muscle activity. It showed that the activation of most of the evaluated muscles decreased, although for the PBM group there was an increase in the activation of the right transverse abdominal muscle, there was no statistical difference between the pre and post-intervention assessment. The left multifidus and the transverse left abdomen of the manual therapy group had a large effect size ($g=0.73$ and $g=-0.93$ respectively) and the right multifidus of the PBM group obtained moderate effect size, however negative with $g=-0.46$.

Figure 3B showed the comparison between intergroup and intragroup, where the MT and PBM groups did not present a significant difference for the right side bridge test. Figure 3B showed a decrease in activation of MD, ME, and TrA/OI muscles, and an increase in inactivation of the right TrA/OI muscle in the MT group. A decrease in activation of MD and ME muscles was found for the group PBM, with an increase in inactivation of both left and right TrA/OI muscles. The GMT in the ML, TTR, and TRL muscles demonstrated a moderate
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

effect size (g=-0.57, g=0.49, and g=0.48), in GPBM only TRL showed a moderate effect with g=0.52.

In the left side bridge test the MT group presented a significant difference in activation of the MR muscle, while for PBM this difference occurred in the activation of the ML muscle (p<0.03). Figure 3C shows a decrease in activation of MR and ML muscles, with an increase in inactivation of both right and left transverse abdominal muscles in the MT group. Considering the PBM group, there was a decrease in activation of the MR, ML, and right transverse abdominal muscles, with an increase in inactivation of the left transverse abdominal muscle. In both MT and PBM groups, only the left multifidus muscle had a moderate effect size and negative with g=-0.55 and -0.58.

Lastly, there was an increase in the force value (Kgf) considering the evaluation pre- and post-intervention in the maximum isometric voluntary contraction of the groups Figure 4. However, there were no significant differences in intergroup between the MT and PBM. When evaluating the maximum voluntary isometric contraction (muscle strength) the two groups obtained large effect sizes, GMT with g=0.91 and GPBM with g=0.82.

**DISCUSSION**

The objective of this study was to analyze and compare the influence of manual therapy and photobiomodulation, associated with kinesiotherapy, on pain, CVIM test, disability questionnaire of Oswestry, and ML and TrA/OI muscle activation on individuals with non-specific LBP after eight weeks of intervention. In pain evaluation, it was observed a positive effect of the group submitted to manual therapy. When evaluating the electromyographic parameters, there were changes in muscle activation for both groups, but with no significant difference between them.
Costa et al.\textsuperscript{19} evaluated 154 individuals with chronic LBP, which performed 12 exercise sections of motor control or placebo conducted through eight weeks. This study demonstrated that the motor control exercise leads to a decrease in persistent pain for 12 months, evidencing that this exercise was better than a placebo in people with chronic LBP. Our findings corroborate this study, since the individuals presented a decrease in pain after eight weeks of interventions with exercises, indicating that it can be useful for the treatment of chronic LBP by decreasing its intensity.

Ferreira et al.\textsuperscript{24} compared a group treated with the Maitland method to another group treated with therapeutic exercises and concluded that both are efficient to decrease the pain chart in individuals with chronic LBP. This also corroborates our findings, since we verified that the vertebral mobilization associated with kinesiotherapy was efficient to decrease the pain chart in individuals with chronic LBP. The association of these two methods demonstrates significant statistical results when compared between groups.

Tavares et al.\textsuperscript{25} conducted a study comparing joint mobilization of the lumbar region with two Sam and control groups and the mobilization group was more effective only when compared to the control group in the analysis of pain. In the present study, both groups were effective in altering muscle strength and improving pain. According to Isenburg et al.\textsuperscript{26}, joint mobilizations can increase cortical connectivity, causing modulation and decrease in pain.

Djavid et al.\textsuperscript{27} performed a controlled and randomized study with 61 participants allocated to three intervention groups: low-intensity laser therapy of 810 nm GaAlAs, laser therapy and exercises, and placebo laser therapy and exercises for 12 sessions. There were no significant differences between groups for any measurement, but the pain decreased more in the laser therapy with exercises than in the placebo and exercises group, demonstrating that the low-intensity laser therapy associated to exercise is more promising in the treatment of chronic lower back pain than just exercises. We found that, although both groups decreased their pain

\url{https://doi.org/10.7322/abcshs.2020138.2121}
Considering EMG for the evaluation of muscle activation, the results showed lower muscle activation for both groups, although non-significant when compared between groups. Machado et al.\(^2\) used Pilates exercises for eight weeks, and the results also indicated a decrease in muscle activity comparing pre- and post-intervention, suggesting an improvement in motor control, since fewer motor units were recruited to perform the activities. The results of the present study also demonstrated less recruitment of motor units in the test performance, leading to the improvement of motor control, which is expected in healthy and painless individuals.

An eight-week intervention study compared a group with stability exercises and another group with balance exercises\(^2\)\(^9\). The results of the EMG evaluation showed that the activity of TrA/OI muscle decreased and the external oblique and erector spine muscles increased for the stability group, suggesting an appropriate muscle co-contraction effect as a strategy of motor control, thus reducing pain and increasing muscle functioning\(^2\)\(^9\). In the present study, we showed an increase in activation of the abdominal transverse for the Sorensen test and side bridge in both evaluated groups, indicating a greater activation of these fibers to perform the movement not only of the extensor musculature, with a rebalancing and appropriate distribution of muscle activation, generating greater lumbar stability and large effects size for the strength of the muscle and in EMG evaluation any muscles obtained moderate effect size.

Bae et al.\(^3\)\(^0\) compared a training device with a conventional trunk stabilization exercise in 12 sections, and both groups demonstrate statistical differences in the activation level of the external oblique compared to the rectus abdominis, corroborating our findings in the present study and indicating a change in the patterns of activation. Our results showed greater
Activation of the abdominal transverse muscle in pre and post-intervention, with simultaneous of these muscles together with the multifidus to perform the activity. This led to a distribution of activity between the muscle groups, tending to balance between the evaluated muscles.

Considering the motor control in the lumbar region, some evidence indicates that the capacity of the central nervous system in regulating agonist-antagonist muscle activity may be impaired in people with chronic LBP. This leads to a disharmony in the activation of the superficial and deep muscles responsible for the movement and stabilization of the lumbar spine, reducing the quality of the movement and increasing the spine compressive load, thus reflecting in the control of the forces acting on the lumbar spine10,31.

We can highlight some limitations of this study, such as the non-assessment of Onset and the co-contraction of the muscles acting in the lumbar spine, the low number of participants, and the lack of a control group. The impossibility of blinding can also be considered a limitation.

Conclusion

From the results obtained in the present study, we can conclude that an exercise program associated with manual therapy or photobiomodulation for eight weeks is efficient to decrease pain and improve electromyographic parameters. We observed statistical difference in any parameters with moderate effect size in any evaluations in this study and observed greater trunk strength, a decrease in the activity of the multifidus muscle, and an increase of activity of the abdominal transverse/internal oblique after the treatment, leading to an appropriated redistribution of activation between muscle groups and consequently rebalance of muscle activation, improvement of motor control and greater stabilization of the lumbar region compared to the preintervention. This suggests that both interventions are efficient and can be indicated as effective options for the treatment of individuals with non-specific chronic LBP.
ACKNOWLEDGEMENTS

We thank all people who participate and help with this research, especially Vanessa Pereira Corrêa and Talita Tuon.
REFERENCES

1. Natour J, Cazotti LA, Ribeiro LH, Baptista AS, Anamaria Jones A. Pilates improves pain, function and quality of life in patients with chronic low back pain: a randomized controlled trial. Clin Rehabil. 2015;29(1):59-68. [https://doi.org/10.1177/0269215514538981](https://doi.org/10.1177/0269215514538981)

2. Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, et al. What low back pain is and why we need to pay attention. Lancet. 2018;391(67):2356-68. [https://doi.org/10.1016/S0140-6736(18)30480-X](https://doi.org/10.1016/S0140-6736(18)30480-X)

3. Choi J, Hwangbo G, Park J, Sangyong Lee S. The Effects of Manual Therapy Using Joint Mobilization and Flexion-distraction Techniques on Chronic Low Back Pain and Disc Heights. J Phys Ther Sci. 2014;26(8):1259-62. [https://doi.org/10.1589/jpts.26.1259](https://doi.org/10.1589/jpts.26.1259)

4. França VL, Koerich MHAL, Nunes GS. Sleep quality in patients with chronic low back pain. Fisioter Mov. 2015;28(4):803-10. [https://doi.org/10.1590/0103-5150.028.004.AO17](https://doi.org/10.1590/0103-5150.028.004.AO17)

5. Possebom M, Bernardi DL, Alves IA. Lombalgia: the pharmaceutical role in identification, accompanying, managing and prevention. Rev Interdisc Cienc Saúde Biol. 2019;3(1):86-100. [https://dx.doi.org/10.31512/ricsb.v3i1.2932](https://dx.doi.org/10.31512/ricsb.v3i1.2932)

6. Dorta HS. Relationship between the ischiotibial and paravertebral muscles and low back pain. Coluna/Columna. 2016;15(3):241-3. [https://doi.org/10.1590/S1808-185120161503137772](https://doi.org/10.1590/S1808-185120161503137772)

7. Rossi DM, Morcelli MH, Cardozo AC, Denadaí BS, Gonçalves M, Navega MT. Rate of force development and muscle activation of trunk muscles 1 in women with and without low back pain: a case-control study. Phys Ther Sport. 2017;26:41-8. [https://doi.org/10.1016/j.ptsp.2016.12.007](https://doi.org/10.1016/j.ptsp.2016.12.007)

8. Melo Filho J, Menossi BRS, Preis C, Bertassoni Neto L, Stabelini Neto A. Lumbopelvic stabilization musculature analysis in young subjects with and without low back pain. Fisioter Mov. 2013;26(3):587-94. [https://doi.org/10.1590/S0103-51502013000300012](https://doi.org/10.1590/S0103-51502013000300012)

9. Miyamoto GC, Franco KFM, van Dongen JM, Franco YRDS, Oliveira NTB, Amaral DDV, et al. Different doses of Pilates-based exercise therapy for chronic low back pain: a randomised controlled trial with economic evaluation. Br J Sports Med. 2018;52(13):859-68. [https://doi.org/10.1136/bjsports-2017-098825](https://doi.org/10.1136/bjsports-2017-098825)
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

10. Searle A, Spink M, Ho A, Cuter V. Exercise interventions for the treatment of chronic low back pain: a systematic review and meta-analysis of randomised controlled trials. Clin Rehabil. 2015;29(12):1155-67. https://doi.org/10.1177/0269215515570379

11. Chou R, Deyo R, Friedly J, Skelly A, Hashimoto R, Weimer M, et al. Nonpharmacologic Therapies for Low Back Pain: A Systematic Review for an American College of Physicians Clinical Practice Guideline. Ann Internal Med. 2017;166(7):493-505. https://doi.org/10.7326/M16-2459

12. Alayat MSM, Atya AM, Ali MME, Shosha TM. Long-term effect of high-intensity laser therapy in the treatment of patients with chronic low back pain: a randomized blinded placebo-controlled trial. Lasers Med Sci. 2013;29(3):1065-73. http://doi.org/10.1007/s10103-013-1472-5

13. Glazov G, Yelland M, Emery J. Low-level laser therapy for chronic non-specific low back pain: a metaanalysis of randomised controlled trials. Acupunct Med. 2016;34(5):328-41. http://doi.org/10.1136/acupmed-2015-011036

14. Maitland GD, Hengeveld E, Banks K, English K. Maitland´s vertebral manipulation. 7 ed. Philadelphia: Elsevier Butterworth Heinemann, 2007.

15. Ali MN, Sethi K, Noohu MM. Comparison of two mobilization techniques in management of chronic non-specific low back pain. J Bodyw Mov Ther. 2019;23(4):918-23. http://doi.org/10.1016/j.jbmt.2019.02.020

16. Kreiner DS, Matz P, Bono CM, Cho CH, Easa JE, Ghiselli G, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of low back pain. Spine J. 2020;20:998-1024. https://doi.org/10.1016/j.spinee.2020.04.006

17. Meroni R, Piscitelli D, Ravasio C, Vanti C, Bertozzi L, De Vito G, et al. Evidence for managing chronic low back pain in primary care: a review of recommendations from high-quality clinical practice guidelines. Disabil Rehabil. 2021;43(7):1029-43. https://doi.org/10.1080/09638288.2019.1645888

18. Delitto A, George SZ, Van Dillen L, Whitman JM, Sowa G, Shekelle P, et al. Low back pain. J Orthop Sports Phys Ther. 2012;42(4):A1-57. http://doi.org/10.2519/jospt.2012.42.4.a1

https://doi.org/10.7322/abcshs.2020138.2121
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

19. Costa LOP, Maher CG, Latimer J, Hodges PW, Herbert RD, Refshauge KM, et al. Motor control exercise for chronic low back pain: a randomized placebo-controlled trial. Phys Ther. 2009;89(12):1275-86.
https://doi.org/10.2522/ptj.20090218

20. Ay S, Doğan SK, Evcik D. Is low-level laser therapy effective in acute or chronic low back pain? Clin Rheumatol. 2010;29(8):905-10.
http://doi.org/10.1007/s10067-010-1460-0

21. Calonego CA, Rebelatto JR. Comparação entre a aplicação do método Maitland e da terapia convencional no tratamento de lombalgia aguda. Rev Bras Fisioter. 2002;6(2):97-104.

22. Hermens HJ. Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol. 2000;10(5):361-74.
http://doi.org/10.1016/s1050-6411(00)00027-4

23. Alves MC, Souza Neto RJ, Barbosa RI, Marcolino AM, Kuriki HU. Effects of a Pilates protocol in individuals with non-specific low back pain compared with healthy individuals: Clinical and electromyographic analysis. Clin Biomechanics. 2020;72:172-178.
https://doi.org/10.1016/j.clinbiomech.2019.12.009

24. Ferreira MGS, Melo LC, Nascimento LSG, Ferreira APL, Araújo MGR. Eficácia do Método Maitland no tratamento da dor lombar crônica em estudantes de fisioterapia. Available from: http://www.anaiscobraf.com.br/arqAnais/Eficacia_do_Metodo_Maitland_no_Tratamento_da_Dor_Lombar_Cronica_em_Estudantes_de_Fisioterapia.pdf.

25. Tavares FAG, Chaves TC, Silva ED, Guerreiro GD, Gonçalves JF, Albuquerque AAA. Efeitos imediatos da mobilização articular em relação à intervenção sham e controle na intensidade de dor e incapacidade em pacientes com dor lombar crônica: ensaio clínico aleatorizado controlado. Rev Dor. 2017;18(1):2-7.
https://doi.org/10.5935/1806-0013.20170002

26. Isenburg K, Mawla I, Loggia ML, Ellingsen D, Protsenko E, Kowalski MH, et al. Increased salience network connectivity following manual therapy is associated with reduced pain in chronic low back pain patients. J Pain. 2021;22(5):545-55 6.
https://doi.org/10.1016/j.jpain.2020.11.007

27. Djavid GE, Mehrdad R, Ghasemi M, Hazan-Zadeh H, Sotoodeh-Manesh A, Pouryaghoub G. In chronic low back pain, low level laser therapy combined with exercise is more

https://doi.org/10.7322/abcshs.2020138.2121
beneficial than exercise alone in the long term: a randomised trial. Australian J Physiother. 2007;53(3):155-60.
https://doi.org/10.1016/S0004-9514(07)70022-3

28. Machado PM, Alves MC, Hendler KG, Benetti VB, Souza Neto RJ, Barbosa RI, et al. Effectiveness of the Pilates method for individuals with nonspecific low back pain: clinical and electromyographic aspects. Motriz. 2017;23(4):e101721.
http://doi.org/10.1590/S1980-6574201700040009

29. Kim DH, Kim TH. Comparison of the effects of stability exercise and balance exercise on muscle activity in female patients with chronic low back pain. J Exerc Rehabil. 2018;14(6):1053-8.
http://doi.org/10.12965/jer.1836438.219

30. Bae CR, Jin Y, Yoon BC, Kim NH, Park KW, Lee SH. Effects of assisted sit-up exercise compared to core stabilization exercise on patients with non-specific low back pain: A randomized controlled trial. J Back Musculosk Rehabil. 2018;31(5):871-80.
http://doi.org/10.3233/BMR-170997

31. Ferreira LCM, Araujo AC, Oliveira CBS, Jassi FJ, Oliveira VC, Negrão Filho RF. Associação entre recrutamento de músculos abdominais com desfechos clínicos e risco prognóstico em indivíduos com dor lombar crônica não específica: estudo preliminar. Fisioter Pesqui. 2016;23(1):45-51.
http://doi.org/10.1590/1809-2950/14560723012016
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

**Figure 1:** Flowchart showing the division of the participants

- **44 participants previously evaluated**
  - **21 participants were excluded**
    - 3 did not attend the evaluation
    - 6 by exclusion criteria
    - 12 for not having time for the sessions
  - **23 participants selected and randomized into two groups**
    - **12 participants in the Manual Therapy Group**
      - 2 participants dropped out of the treatment
      - 10 participants completed the intervention
    - **11 participants in the Photobiomodulation Group**
      - 1 participant dropped out of the treatment
      - 10 participants completed the intervention

[https://doi.org/10.7322/abcshs.2020138.2121](https://doi.org/10.7322/abcshs.2020138.2121)
Table 1: Photobiomodulation parameters used.

| Photobiomodulation Parameters          |       |
|---------------------------------------|-------|
| Beam Area                             | 0.11 cm² |
| Laser Power                           | 30 mW |
| Wavelength                            | 830 nm |
| Power density                         | 0.27 W/cm² |
| The energy density per point          | 32.4 J/cm² |
| Energy per point                      | 3.6 J |
| Energy per session                    | 36 J |
| Total energy                          | 576 J |
| Time per point                        | 120 seconds |

Table 2: Characterization of all individuals who completed the intervention.

| Group | N | SEX | AGE (Kg/m²) | IMC OSWESTRY* | RSB | LSB | Sorensen test |
|-------|---|-----|-------------|---------------|-----|-----|--------------|
| MT    | 10 | M=5 | 23.1 (±2.94) | 24.88 (±3.60) | Pre | 25  | 25  | 64           |
|       |    | F=5 |             |               | Post| 35  | 29  | 85           |
| PBM   | 10 | M=4 | 30.9 (±10.63)| 27.39 (±8.12) | Pre | 21  | 24  | 57           |
|       |    | F=6 |             |               | Post| 27  | 30  | 63           |

ICM: body mass index; Kg/m²: kilogram per square meter; RSB: Right Side Bridge; LSB: Left Side Bridge; *final evaluation

https://doi.org/10.7322/abcshs.2020138.2121
Figure 2: Comparison of VAS (visual analog scale), pre and post-intervention between groups (MT: Manual Therapy, PBM: Photobiomodulation). *p<0.01; **p<0.05.
Figure 3: (A) Comparison Intra and intergroup of the data obtained RMS the initial and final evaluation of muscle activation during the Sorensen test. MR: Multifidus - Right; ML: Multifidus - Left; TTR: Transverse abdomen - Right; TRL: Transverse abdomen – Left; (B) RMS values of surface electromyography of the muscles in the right side bridge test in pre and post-intervention of the groups. MR: Multifidus - Right; ML: Multifidus - Left; TTR: Transverse abdomen - Right; TRL: Transverse abdomen - Left. *p<0.05; (C) RMS values of surface electromyography of the muscles in the left side bridge test in pre and post-intervention of the groups. MR: Multifidus - Right; ML: Multifidus - Left; TrR: Transverse abdomen - Right; TrL: Transverse abdomen - Left. * p<0.05; **p<0.05; #p<0.01.
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

https://doi.org/10.7322/abcshs.2020138.2121
Gonçalvez et al. Electromyography in muscle activation lumbar region in a comparison between manual therapy and photobiomodulation associated with kinesiotherapy in individuals with low back pain. ABCS Health Sci. [Epub ahead of print]; DOI: 10.7322/abcshs.2020138.2121

**Figure 4:** Data referring to the strong muscle extensors in the lumbar in both groups in this study. *p<0.05. (MT: manual therapy; PBM: Photobiomodulation).*

[Data referring to the strong muscle extensors in the lumbar in both groups in this study. *p<0.05. (MT: manual therapy; PBM: Photobiomodulation).]