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The effect of manual therapy on abdominal scars in patients with nonspecific chronic low back pain - a double-blind, randomized, and controlled study

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ABSTRACT

Manual therapy in the treatment of scars has garnered significant interest in recent years. However, there is a paucity of literature addressing these tissues in patients with nonspecific chronic low back pain (CLBP), and there are limited studies on the subject. The objective of this study was to analyze the effect of scar release in the lower abdominal region in patients with nonspecific chronic low back pain.

Methodology: Forty-four participants were recruited and randomly divided into three groups: the control group, where patients lay down for 5 min; the placebo group, where participants received therapist touch for 5 min in the suboccipital region; and the treatment group, where individuals received intervention on abdominal scars for 5 min. Inclusion criteria were men or women aged 18–70 with chronic low back pain who had undergone abdominal surgery between the umbilical scar and the pubic symphysis. Pain levels, disability, and range of motion were measured for all participants, with follow-ups at 10 and 20 days post-intervention.

Results: Both the placebo and treatment groups showed a significant improvement in the Visual Analog Scale (VAS) at T1 and T2 compared to the control group ($P < 0.05$); however, there was no significant difference between the placebo and treatment groups. The treatment group exhibited a high Effect Size at T1 when analyzing VAS and Pressure Pain Thresholds (PPT) of the paravertebral mass and spinous processes compared to the control group, while the placebo group showed a medium Effect Size compared to the control group. Disability levels and flexibility of the spine and lower limbs, however, did not show significant differences between groups and different time points.

Conclusion: This study suggests that mobilizing scar tissues in patients with nonspecific chronic low back pain for 10 min does not show a significant difference compared to releasing suboccipital muscles for 5 min, immediately after as well as in follow-ups. However, due to the high Effect Size, it confirms the potential acute effect of manual therapy on scar tissues in patients with nonspecific chronic low back pain.

1. Introduction

Studies conducted by the “Global Burden of Disease” have defined low back pain (LBP) as “pain in the area of the posterior aspect of the body, from the lower margin of the twelfth rib to the lower gluteal folds, with or without referred pain in one or both lower limbs lasting at least one day” (Hoy et al., 2014; Raja et al., 2020). LBP is considered a common global problem with high prevalence, affecting approximately 7.5 % of the global population, or around 577 million people (Wu et al., 2020). In Brazil, where the present study was conducted, according to the National Household Sample Survey (PNAD) by the Brazilian Institute of Geography and Statistics (IBGE), spine pains (cervical, thoracic, lumbar, and pelvic) rank as the second most prevalent health condition (13.5 %).

When specifically addressing chronic low back pain (CLBP), the prevalence is 4.2 % in individuals aged 24–39 years and 19.6 % among those aged 20–59 years. Among the elderly, the prevalence of CLBP is 25.4 % (Meucci et al., 2015). Research has shown that LBP has an 84 %

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chance of affecting individuals at some point in their lives, and in about 10 % of cases, it persists for more than three months, becoming CLBP (Beeckmans et al., 2016). It is noteworthy to mention the recent report from the World Health Organization (WHO) stating that CLBP is one of the leading causes of health-related work absences. Therefore, CLBP represents a significant worldwide issue with substantial medical, social, and economic impact (Balagué et al., 2012).

The specific diagnosis of chronic low back pain (CLBP) and its potential causes are not determined in 95 % of cases (Krismer and Van Tulder, 2007), highlighting the ongoing need for studies to substantiate or develop effective assessment methodologies. It is recognized that CLBP should be viewed and interpreted through its multifactorial characteristics, incorporating factors such as lifestyle, sociodemographic factors, health conditions, occupation, among others, to better understand potential risks for its development (O'Sullivan, 2005; Rose-Dulcina et al., 2018; Beynon et al., 2019a; Williams et al., 2015; Eccleston et al., 2021).

One factor to consider is surgical procedures. Depending on the procedure, a significant percentage of post-surgical chronic pain (PSCP) may occur (Kalso, 2013; Thapa and Euasobhon, 2018). Some research already demonstrates the incidence of PSCP ranging from 5 to 85 %, with approximately 18 % of them being moderate or intense (Schug et al., 2019; Johansen et al., 2012). However, there is still limited literature addressing the relationship between abdominal surgeries and CLBP (Lewit and Olsanska, 2004; Weibel et al., 2016; Kobesova et al., 2007; Chia et al., 2016).

To combat the progression and substantial impact of chronic low back pain (CLBP) worldwide, various treatment proposals are suggested, accompanied by research endeavors seeking scientific evidence. One cost-effective proposal showing promising clinical responses is the use of manual therapy (MT), as demonstrated in a recent Practical Guideline (George et al., 2021). MT has the potential to improve various outcomes such as pain, disability, pressure pain threshold, and range of motion (Aspinall et al., 2020; Didehdar et al., 2020; Ford et al., 2019; Hidalgo et al., 2015; Chen et al., 2021).

However, when examining MT in patients with nonspecific CLBP who have undergone abdominal surgeries, leading to a worsening of symptoms or the development of CLBP symptoms, the number of studies is limited. Thus, the purpose of this study was to analyze the responses to a specific MT technique applied to abdominal scar tissues in patients with nonspecific CLBP, comparing it to a control group and a placebo group, and assessing potential changes in disability levels, pain, and range of motion.

2. Methods

2.1. Participants

This randomized clinical trial included 44 volunteers of both sexes with nonspecific chronic low back pain. Participants were selected according to defined inclusion and exclusion criteria. Eligible individuals were men or women aged 18–70 years who had been experiencing low back pain for more than three months, with or without limitations in the range of motion, and who had a history of surgery with a visible abdominal incision located between the umbilicus and the pubic symphysis (e.g., cesarean section, hysterectomy, appendectomy). Additionally, participants had to exhibit tenderness on palpation at one or more vertebral levels between L1 and S3.

Exclusion criteria included: failure to sign the informed consent form; absence of abdominal surgery between the umbilicus and pubic symphysis; no reported low back pain in the past three months; absence of tenderness on palpation between L1 and S3; and diagnosis of rheumatic disease or fibromyalgia.

This study was approved by the Research Ethics Committee of Faculdade Integrada Einstein de Limeira (approval number 58522122.7.0000.5424) and registered in the Brazilian Clinical Trials Registry (ReBEC) under the code U1111-1283-6413 (RBR-2cxwvcy). All participants were informed about the procedures and ethical guidelines, including data confidentiality and voluntary participation, and signed the informed consent form (Appendix 1) in accordance with Resolution 466/12 of the Brazilian National Health Council.

2.2. Sampling method

Participants were recruited through purposive sampling using digital platforms and social media linked to the research institutions (Academia Brasileira de Fáscias and Colégio Brasileiro de Osteopatia). A total of 91 volunteers expressed interest in participating. After applying the eligibility criteria and accounting for voluntary withdrawals, 44 participants were included in the final sample (Fig. 1.

These participants were randomly allocated into three groups: a control group (CG), a placebo group (PG, n = 15), and an intervention group (IG, n = 14). The allocation process used simple random sampling with a 1:1:1 allocation ratio, and random sequence generation was performed by an independent research assistant using the *Research Randomizer* software (https://www.randomizer.org). Group assignment was concealed until the interventions began.

2.3. Research procedures

All procedures were conducted between October and December 2022 at the BASE Health and Wellness Space in Piracicaba, São Paulo. Upon arrival, participants completed a standardized screening questionnaire that collected demographic, anthropometric, and clinical data (e.g., age, sex, pain duration, surgical history, comorbidities, and physical activity habits).

To minimize bias, the study employed a **double-blind** design. Participants were blinded to group allocation and only identified by anonymous codes (e.g., Group 1, 2, or 3). Moreover, outcome assessors were blinded to the allocation and intervention procedures. The researcher responsible for the assessments was not involved in the intervention process and had no access to allocation data. Conversely, the therapist delivering the interventions—an experienced physiotherapist and osteopath with over 10 years of clinical practice—was not involved in any assessment phase and remained blinded to the data collected.

This blinding strategy ensured that both participants and assessors were unaware of group allocation, thereby reducing performance and detection bias throughout the study.

2.3.1. Control group

In the Control Group (CG), participants were invited to remain in a comfortable supine position, with both knees flexed, for 5 min without receiving any intervention. They were allowed to interact and converse with the examiner throughout the entire duration (Fig. 2)).

2.3.2. Placebo group

In the Experimental Group (GP), participants received a 5 min release of the suboccipital muscles, following a procedure previously described in earlier studies (Kang et al., 2021; Heredia Rizo et al., 2012) with some minor adaptations. The participant was instructed to lie in a supine position with both knees flexed, while the examiner sat at the head of the treatment table and placed their hands on the participant's occipital bone. The examiner then used the middle and index fingers of both hands to locate the space between the occipital bone and the atlas. Employing the metacarpophalangeal joint bent at a 90° angle, the examiner applied constant pressure without causing pain, maintaining the 90° angle. Subsequently, the examiner gently applied a slight cranial traction while keeping this gentle pressure and traction (Fig. 3) for 5 min. After this period, the therapist slowly repositioned the patient's head on the treatment table.

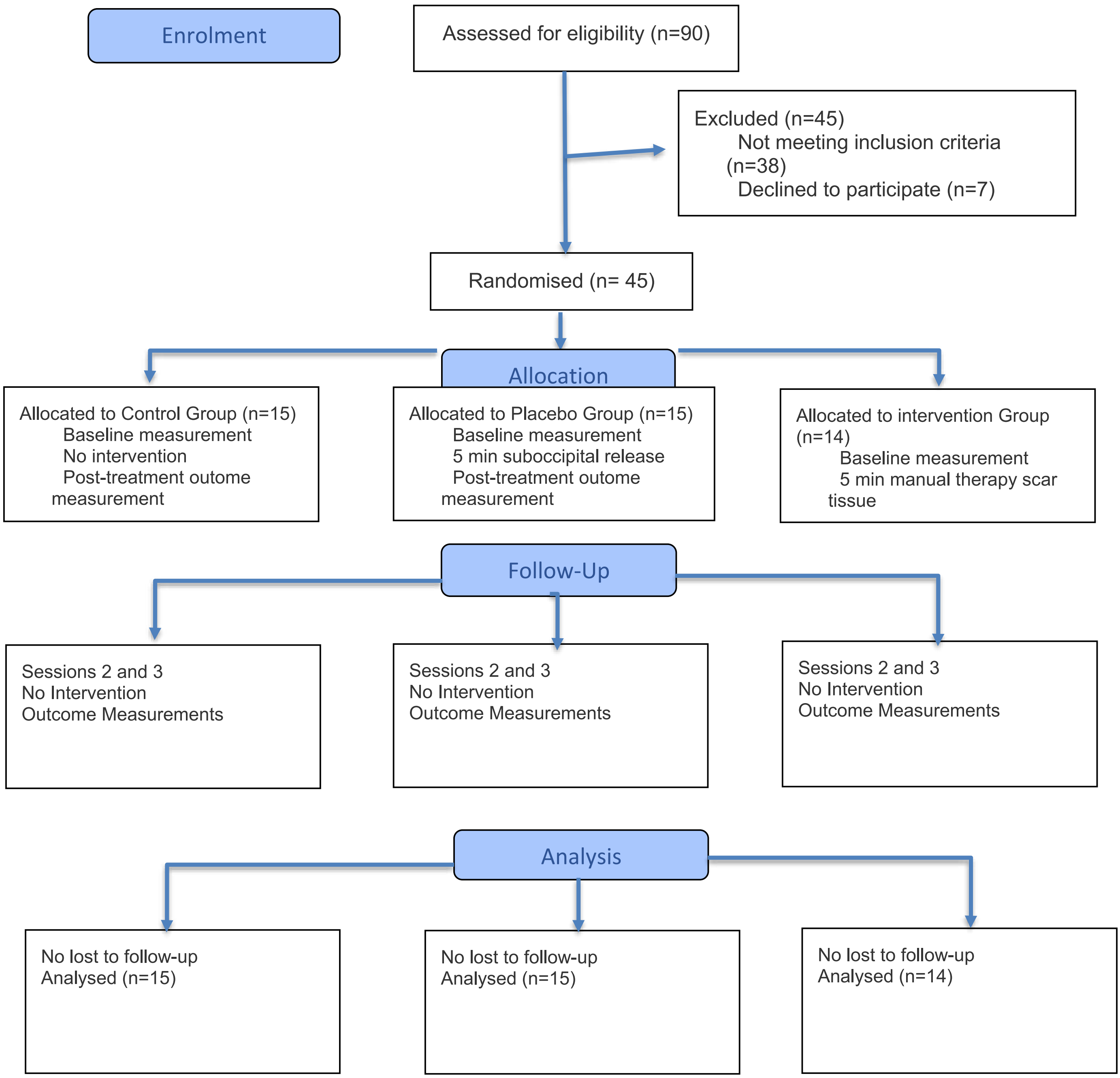

Fig. 1. CONSORT 2025 Flow diagram.

2.3.3. Intervention group: Manual Therapy in Scar Tissue

In the Scar Group (Intervention Group – IG), participants were positioned in a supine position with hips in neutral alignment and knees flexed at approximately 90°, to allow proper access to the lower abdominal region where the surgical scar was located. The intervention consisted of **Manual Therapy in Scar Tissue**, performed by a physiotherapist with over 10 years of clinical experience.

The manual therapy procedure was standardized and involved gentle, sustained mobilization of the scar using the pulp of the second and third fingers of both hands. The technique focused on applying **light to moderate pressure**, combined with multidirectional tissue stretching in the **longitudinal, transverse, and oblique planes**, according to individual tissue resistance. This mobilization did **not involve ischemic digital compression**, nor any rapid or deep manipulation. Instead, the therapist maintained **slow and sustained contact** to assess tissue tension and guide the application of subtle tensioning strategies to improve fascial glide and local tissue compliance (Fig. 4).

Each session lasted **10 min**, with **equal distribution of time along the upper and lower segments of the scar**, and targeted pressure was maintained for **approximately 60 to 90 s** in areas of identified restriction or densification. The aim was to promote viscoelastic adaptation of the scar tissue without eliciting pain or discomfort in the participant. All details of the three groups are shown in Table 1, including the control group, placebo group and manual scar intervention group.

Additionally, the therapist recorded whether the resistance was predominantly felt on the right or left side of the scar. This qualitative data was later correlated with the results of the blinded evaluator, who assessed pain sensitivity and tenderness across vertebral segments, to explore possible segmental or somatotopic patterns related to chronic

Fig. 2. Representation of the positioning of the control group.

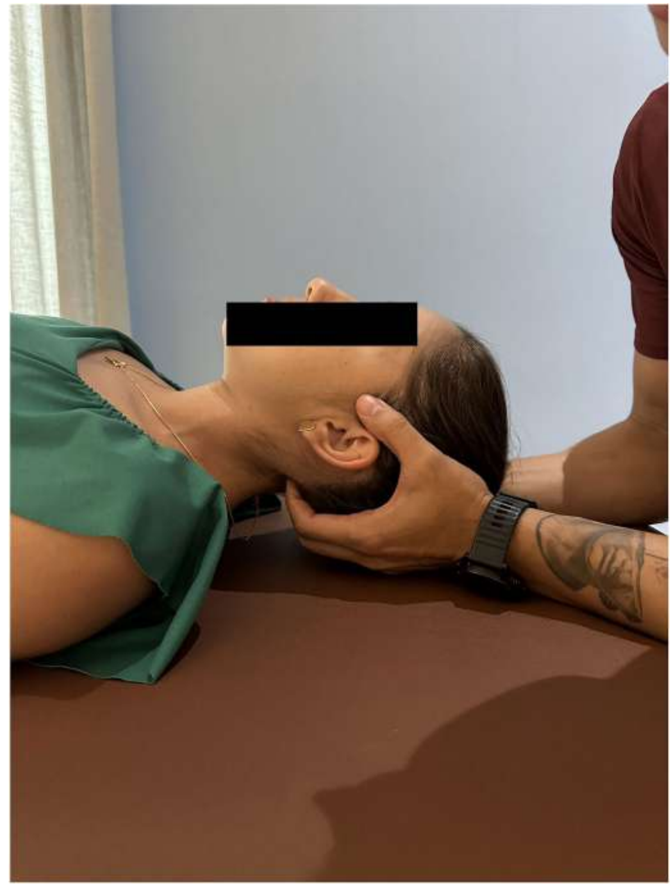

Fig. 3. Representation of the positioning and technique applied in the placebo group.

low back pain.

All manual interventions were performed under the same environmental conditions, with participants instructed to avoid vigorous activity before and after each session to standardize response variability.

2.4. Outcomes – measurements

The primary outcomes of this research aimed to measure pain intensity and pressure pain thresholds immediately after the interventions. Secondary outcomes included tracking the same data, in addition to assessing the range of motion of the spine and lower limbs, through interaction with pain and disability questionnaires, 10 and 20 days post-intervention.

Five measurement instruments were employed for the research, namely: 1-Visual Analog Scale for pain (VAS); 2-Algometer; 3-Roland-Morris Disability Questionnaire (RMDQ); 4-Oswestry Disability Index (ODI); and 5-Wells Bench. Three of these instruments (VAS, algometer, and Wells Bench) were administered at four time points during the study: T0-prior to the first intervention; T1-immediately after the intervention; T2-10-day follow-up after the intervention; T3-20-day follow-up after the intervention. The other two instruments (RMDQ and ODI) were applied at T0, T2, and T3.

2.4.1. Pain

The perception of pain was assessed using the visual analog scale (VAS) (Fig. 5); at the commencement of each session, participants were instructed to verbally express a numerical rating on a scale from 0 to 10, where 0 corresponds to "no pain" and 10 represents "the greatest possible pain" (Boonstra et al., 2008). Furthermore, the VAS assisted in all measurements alongside algometry to enhance data interpretation and patient comprehension.

2.4.2. Pressure pain threshold

The pressure pain threshold was measured using algometry, employing the MEDDOR algometer model (Jerez-Mayorga et al., 2020) (Fig. 6). It was applied to the spinous process at the vertebral level (Araujo et al., 2018), specifically the most sensitive level (L1-S3, as determined by the evaluator beforehand). Additionally, the algometer was applied 2 cm lateral to the spinous process on both sides (Aspinall et al., 2020) in the bilateral paravertebral mass at the same level (Fig. 7B), perpendicular to the skin. Pressure with the algometer was applied until the patient reported a pain level of VAS 7. Patients were instructed to verbalize "PAIN" upon reaching this VAS level. The evaluator marked the most sensitive level with a demographic pencil to minimize error in T1 (Fig. 7A). For a more robust data analysis, three measurements were taken, and the average of these measurements was utilized.

2.4.3. Pain and disability scales

To assess pain levels and their impact on disability, the Roland-Morris Disability Questionnaire (RMDQ) (Monteiro et al., 2010) (scores ranging from 0 to 24) and the Oswestry Disability Index (ODI) (Vigatto et al., n.d.) (scores ranging from 0 to 100) were utilized. These questionnaires were adapted and validated in the Portuguese language (see Appendices 2 and 3). The participants completed the questionnaires before the intervention and during the follow-up reevaluation periods at 10 days and 20 days post-intervention.

The RMDQ comprises 24 common statements that individuals report when experiencing back pain, with scoring based on the sum of these statements. On the other hand, the ODI consists of 10 sections that address how back pain interferes with or has affected the participant's daily life, such as in activities of daily living. If needed, the evaluator

Fig. 4. Representation of the positioning and technique applied in the scar intervention group.

could provide assistance in case of doubt or difficulty in interpreting the questionnaires.

Participants who scored lower than 14 % on the ODI (Vibe Fersum et al., 2013; O'Keeffe et al., 2020) continued in the project to avoid bias from the researcher performing the intervention; however, their data were not considered at the end of the study.

2.4.4. *Flexibility of the spine and leg*

To measure the flexibility of the spine and legs, we utilized the Wells Bench (BW) (Wells and Djllo~, n.d.), wherein the patient was instructed to sit with legs fully extended and feet supported on the equipment. During the measurement, the patient, with overlapping hands and extended arms, attempted to reach as far as possible with the third finger from the measuring tape (Fig. 8). Three measurements were taken at all study time points, and the final result for each assessment was the average of the three measurements.

2.4.5. *Statistical analysis*

All statistical analyses were conducted using Jamovi software. The Shapiro–Wilk test was used to assess the normality of data distribution, and Levene's test was applied to assess variance homogeneity.

Variables with a normal distribution and homogenous variance — such as Visual Analog Scale (VAS), Pressure Pain Threshold (PPT) (spinous and paravertebral), and Wells Bench test — were analyzed using a two-way repeated-measures ANOVA (time × group). When significant effects were found, Tukey's post-hoc test was used for pairwise comparisons.

For outcome variables with non-normal distributions or ordinal structure — such as Roland-Morris Disability Questionnaire (RMDQ) and Oswestry Disability Index (ODI) — the Kruskal–Wallis test was applied, followed by Dunn's post-hoc test with Bonferroni correction when appropriate.

Effect sizes were calculated for clinical interpretation:

- For ANOVA: eta squared (η^2)
- For Kruskal–Wallis: Rosenthal's r

A 95 % confidence interval and a significance level of $p < 0.05$ were adopted throughout.

3. Results

Ninety-one volunteers responded to the study selection process, with forty-four ultimately being chosen to participate (other volunteers were either ineligible or did not agree with the informed consent form (ICF)). There were no dropouts during the study (all volunteers completed the four stages of the study), resulting in a final number for analysis, n = 44 (Image 1).

Assuming that individuals were randomly assigned to receive the scar technique (Group 3) or suboccipital technique (Group 2) or be in

Table 1
Intervention protocol with dosimetry parameters.

Parameter	Manual Therapy in Scar Tissue (IG)	Placebo Group (PG)	Control Group (CG)
Patient position	Supine, knees flexed 90°	Supine, knees flexed 90°	Supine, knees flexed 90°
Therapist position	Beside patient, seated	At head of table, seated	–
Technique	Gentle, sustained scar mobilization with 2nd–3rd fingertips; multidirectional (longitudinal, transverse, oblique); emphasis on areas of greatest restriction	Suboccipital release (pressure + slight traction, 90° MCP joint)	No intervention
Pressure intensity	Light to moderate, adjusted to tissue resistance	Constant light pressure	–
Duration total	10 min, mobilizing the entire scar with emphasis on points with greater restriction	5 min total	5 min total (rest)
Dosimetry (per point)	60–90s sustained mobilization at restriction areas	Constant for 5 min	–
Number of sessions	Single session	Single session	Single session
Therapist experience	>10 years in manual therapy/osteopathy	>10 years in manual therapy/osteopathy	–
Additional instructions	Contact should not produce pain or discomfort perceived as very painful or preventing execution of the technique	Same	Same

The baseline characteristics of participants were homogeneous among the three groups, as detailed in Table 2. There were no significant differences in age, sex distribution, or duration of low back pain.
Statistically significant difference from T0 ($p^* < 0.05$).
† Statistically significant difference from Control group ($p < 0.05$).

Fig. 5. EVA - Visual Analog Scale adapted for Brazilian population.

the control group (Group 3), with a total of 44 individuals. A descriptive analysis of quantitative variables was conducted, indicating mean and standard deviation, with a confidence interval 95 % with upper and lower limits in Table 2, depending on whether the variables exhibited a normal distribution or not.

3.1. Visual Analogue Scale (VAS)

When analyzing the Visual Analog Scale (VAS), a significant alteration between groups at different study time points was demonstrated, as depicted in Table 3. Group 1 exhibited a difference before intervention with Groups 2 and 3 immediately post-intervention ($p = 0.038$ and $p = 0.029$) and at the 20-day follow-up compared to Group 3 ($p = 0.05$). In Group 2, a statistically significant difference was observed between post-treatment at 10 days and 20 days follow-up with Group 1 ($p =$ 0.017 and 0.022). There was a statistically significant difference between post-treatment in Group 3 and 10- and 20-day follow-ups in Group 1 ($p = 0.017$ and 0.039, respectively). Finally, there was a difference between the 20-day follow-up in Group 1 compared to the 20-day follow-up in Group 3 ($p = 0.029$). The Effect Size was moderate when comparing Groups 2 and 3 to Group 1 immediately after the intervention, as well as at the 20-day follow-up, as shown in Table 4 - EFFECT SIZE VAS.

3.2. Sclerotomes pressure pain threshold

In the analysis of the sclerotome, there was no statistically significant difference ($p = 0.114$), as shown in Table 5 with the mean, standard deviation, and 95 % CI. However, interesting results were observed when analyzing the effect size (Table 6 - EFFECT SIZE PPT). Pressure thresholds on the spinous process obtained in GI and GP were higher in acute effect (immediate post/T1) compared to GC, with a moderate effect size for GP (ES = 0.792) and a high effect size for GI (ES = 1.190). However, the comparison between groups showed a low effect size (ES = 0.205).

3.3. Paravertebral pressure pain threshold

In Table 7 the mean values, standard deviation, and 95 % CI of pressure pain thresholds for the right and left sides are presented, with no significant differences observed ($p = 0.171$ and 0.276, respectively). However, upon analyzing the Effect Size, the pressure thresholds in the paravertebral region obtained in GI and GP were higher at T1 compared to GC bilaterally. GP exhibited a moderate bilateral effect size (ES = 0.638 right, ES = 0.542 left). On the other hand, GI demonstrated a high bilateral effect size (ES = 1.111 right, ES = 0.989 left). Analysis between groups revealed a low bilateral effect size (ES = 0.398 right, ES = 0.423 left) (Table 8 - EFFECT SIZE).

3.4. Roland-morris disability questonnaire and oswstry disability index (RMDQ and ODI)

Regarding the levels of disability and pain obtained from the ODI and RMDQ questionnaires, no significant differences were observed between the groups ($p = 0.390$ and $p = 0.529$) (Table 9).

3.5. Wells Bench (WB)

When analyzing the flexibility levels of the spine and lower limbs with the Wells Bench (BW), significant changes were observed; however, interestingly, they were for the worse, especially when analyzed at T2, with GI showing deterioration compared to the other groups ($P > 0.05$) (Table 10 - BW).

4. Discussion

Up to the present moment, this study represents the first investigation into the immediate effects and 10- and 20-day follow-ups of manual mobilization of infraumbilical abdominal surgical scars in patients with nonspecific chronic low back pain (CLBP). The study adhered to the CONSORT statement (Schulz et al., 2010) and was registered in the Brazilian Clinical Trials Registry (ReBEC) under the code RBR-2cxwvcy. Tools previously validated by other authors (Boonstra et al., 2008; Araujo et al., 2018; Aspinall et al., 2020; Monteiro et al., 2010; Vigatto et al., n.d.; Wells and Djllo~, n.d.) were employed. All outcome measurements were performed by a blinded assessor.

The aim of this study was to analyze the effects of a single 5 min technique on infraumbilical abdominal scars in patients with nonspecific CLBP, considering the somatic dysfunction (SD) concept or sensitive metameric levels, and comparing with two other intervention groups—placebo and control. The neural pathway proposed by Still, known as osteopathic lesion and updated with the term SD (Fryer, 2016), allows us to relate abdominal scars to the symptoms of our patients, in this case, nonspecific CLBP. Signs of these dysfunctions arise from tissue and/or neurologic factors related to a cycle of tissue injury and/or functional alterations driven by receptors present in the tissues, potentially triggering spinal sensitization and generating responses in any tissues that share that metamere. To complement this perspective, Tozzi in 2015 proposed the neurofasciogenic model, aiming to incorporate the neural aspects previously explored by relating fascial tissue to

Fig. 6. Model of Algometer used in our research, validated by Jerez-Mayorga et al. (2020).

the formation and maintenance of SD (Tozzi, 2015a,b).

Based on these presented principles, it is possible to relate the injury/cutting processes performed by surgeries in this fascial system, which may lead to local repercussions and affect the receptors present. One possible assessment pathway to relate SDs to scars is through inhibitory touch. This test involves analyzing factors that may participate in and influence the sensitization process at the metameric level and, consequently, in the formation of a potential SD, contributing to the patient's symptoms (Bicalho et al., 2020).

Analyzing the findings of the current study, it was possible to demonstrate that manual therapy approaches on abdominal scars elicited acute responses, i.e., immediately post-intervention, concerning PAIN and PPT levels, with similar findings to the release of the suboccipital region. In the measurements obtained at FU10 and FU20, there were not as significant responses, analyzed through the 95 % confidence interval ($P < 0.05$) or Effect Size ($ES > 0.80$) (Coe, 2002).

The outcomes indicated a certain plausibility in relating more sensitive vertebral levels through VAS and PPT with abdominal surgeries corresponding to the same medullary level in patients with CLBP (Considering that patients showed a significant acute response after scar manipulation). However, suboccipital release also presented an interesting acute response, especially when evaluating PAIN levels (not so much in the PPT of the most sensitive vertebral level).

One justification for this finding is that in chronic patients, as in the case of this study, there may be a coexistence of sensitization processes in tissues adjacent or corresponding to the medullary level (metameric or peripheral sensitization) with processes of central sensitization (Woolf, 2011; Woolf, 2018; Harte et al., 2018; D'Alessandro et al., 2016; Kirkpatrick et al., 2015). This aligns with previous studies in which suboccipital muscle release yielded interesting results, such as decreased salivary cortisol, increased heart rate variability, decreased pain levels and perception, as well as improved overall spine range of motion (Giles et al., 2013; Silva et al., 2020; Silva et al., 2021; Jiang et al., 2019; Hasaneen et al., 2018).

Thus, the proposed placebo treatment can already be considered a possible tool to improve some symptoms in chronic patients. However, we must emphasize how challenging it is to select a placebo treatment involving manual therapy in clinical and randomized studies, as isolated touch activates neurophysiological responses that can positively or negatively interfere with the results (D'Alessandro et al., 2021; Karas et al., 2018; Vigotsky and Bruhns, 2015).

The responses obtained regarding the scars can be justified based on some findings prior to this study. It has already been demonstrated that scars with limited mobility, due to tissue adhesions, can lead to various symptoms, including myofascial pain syndromes (Gilbert et al., 2022). These adhesions, considered fibrotic scars between two tissues, formed after injury, infection, or surgeries, can contribute to pain processes and its chronicity, whether at the local level or in adjacent tissues (Okabayashi et al., 2014; Wasserman et al., 2016; Bordoni and Zanier, 2013; Wasserman et al., 2019; Kelly et al., 2019; Fan et al., 2020). It is worth noting that abdominal surgeries in general, whether performed through open or robotic surgery, have a high incidence of adhesions, with some studies indicating this occurrence in up to 100 % of cases (Okabayashi et al., 2014; Ouaïssi et al., 2012; Foster et al., 2020).

Manual therapy (MT) mobilization can intervene and consequently reduce adhesion formation when performed in the pre-surgical period (Bove and Chapelle, 2012) as well as post-surgically (Hedley, 2010; Okabayashi et al., 2014; Bove et al., 2017; Fan et al., 2020), contributing to symptom improvement (Lewit and Olsanska, 2004; Martins et al., 2013). Moreover, it has been shown that the activity of paravertebral and abdominal muscles, analyzed by electromyography, changes after manual mobilization over scars with low tissue mobility (Valouchová and Lewit, 2009), justifying one of the possible reasons for scar mobilizations yielding positive results in PPT in the paravertebral mass as demonstrated in this research.

Through the changes demonstrated in our research, as well as those mentioned earlier, the mechanisms of manual therapy extend beyond the biomechanical pathway, being better explained by the interaction of this pathway with others, such as neural pathways described by Bialosky et al. (2009), 2018, influenced by the therapist-patient interaction process (Fuentes et al., 2014; McParlin et al., 2022), and contextual factors (Rossettini et al., 2018; Thomson and Rossettini, 2021; Sherriff et al., 2022).

This study had some limitations. For example, the non-inclusion of the inhibitory touch test as an inclusion factor for study participants (Bicalho et al., 2020), since if the test were positive, we could better

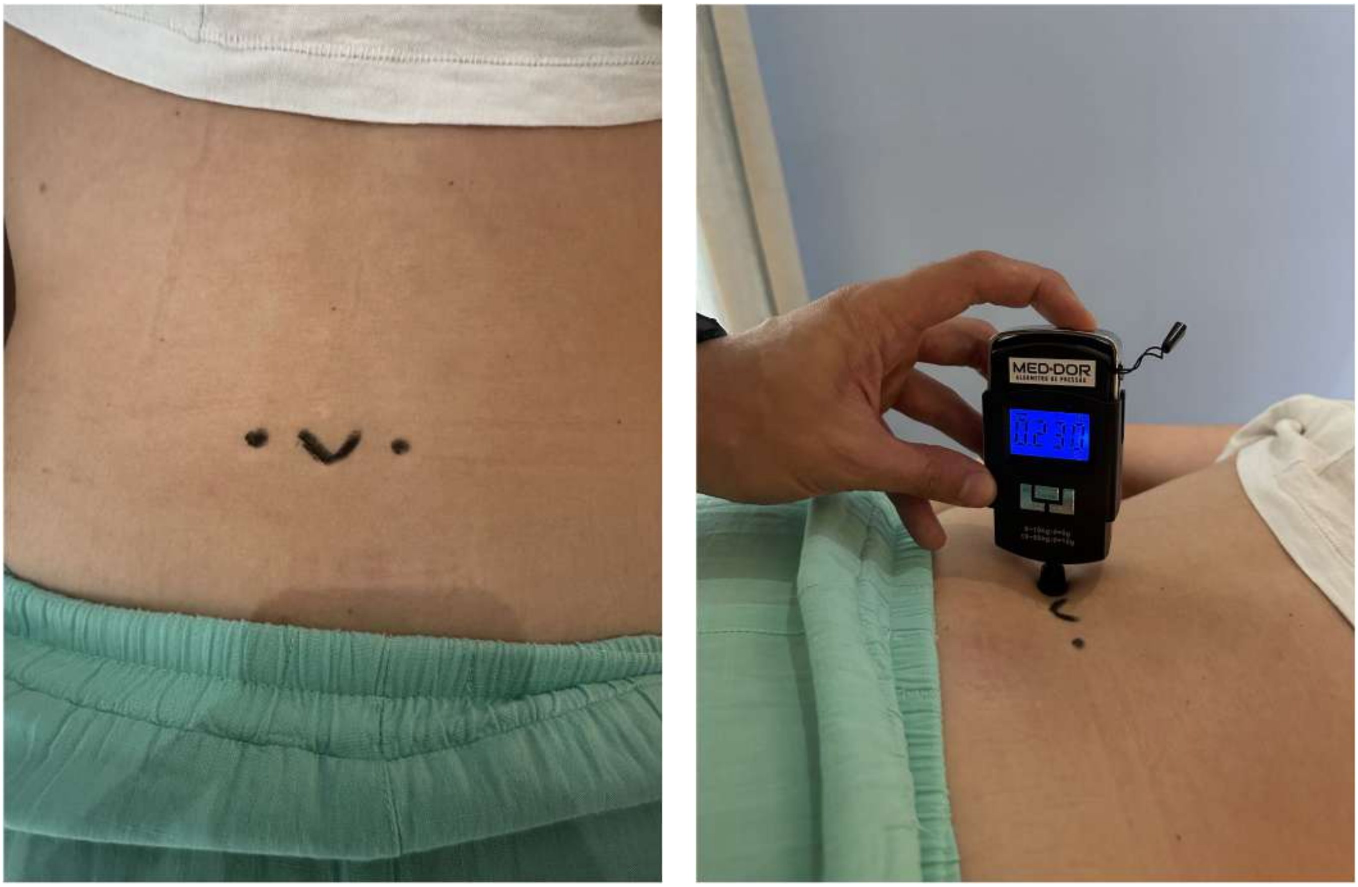

Fig. 7. A - Markings made on the transverse and spinous processes of the lumbar vertebrae for evaluation with the algometer; B - Demonstration how we use the algometer in the marked regions.

Fig. 8. Wells bench test realized in our research.

correlate SD (Consorti et al., 2023). That is, if the evaluator, by touching the scar, obtains an improvement in sensitivity in the spinous process and/or paravertebral mass of the previously more sensitive level, as well as some improvement in range of motion, we could have two possible interesting discussions:

1 Validation and Applicability of Inhibitory Touch through a Clinical and Randomized Study:
2 Increased potential to confirm or refute the relationship between surgical abdominal scars and sensitization of corresponding medullary levels.

The sample size was not as initially anticipated, which was a

Table 2
Baseline characteristics of participants.

Group	Sample Size (n)	Age (mean ± SD)	Gender (M/F)	Pain Duration (months)
Control (CG)	15	42.3 ± 5.1	6/9	18.2 ± 7.5
Placebo (PG)	15	41.7 ± 4.8	5/10	17.9 ± 6.9
Scar Therapy (IG)	14	43.0 ± 5.6	7/7	19.5 ± 6.7

Analysis of pain scores through the Visual Analog Scale (VAS) revealed significant reductions in the placebo and scar therapy groups when compared to the control group at immediate, 10-day, and 20-day follow-ups ($p < 0.05$). These results are shown in Table 2.
Statistically significant difference from T0 ($p^* < 0.05$).
† Statistically significant difference from Control group ($p < 0.05$).

Table 3
Pain scores (VAS) – mean ± SD [95 % CI].

Group	T0 (Pre)	T1 (Post)	T2 (10 days)	T3 (20 days)
CG	6.40 ± 2.29 [5.10–7.70]	6.00 ± 2.56 [4.45–7.55]	6.20 ± 2.76 [4.53–7.87]	6.50 ± 2.44 [5.01–7.99]
PG	6.20 ± 2.10 [5.02–7.38]	4.30 ± 2.10† [3.12–5.48]	4.00 ± 2.00 [2.88–5.12]	3.80 ± 1.90* [2.75–4.85]
IG	6.10 ± 2.00 [4.92–7.28]	3.90 ± 1.95† [2.80–5.00]	3.70 ± 2.05 [2.52–4.88]	3.60 ± 1.85*† [2.56–4.64]

P-value (group × time interaction): <0.001.
Legend: Significant difference from T0 ($p < 0.05$); † Significant difference from Control group at same time point ($p^* < 0.05$).
Statistically significant difference from T0 ($p^* < 0.05$).
† Statistically significant difference from Control group ($p < 0.05$).

Table 4
Effect Size between the experimental groups when analyzing the Visual Analogue Scale at different times after the intervention.

	Group 1 x Group 2	Group 1 x Group 3	Group 2 x Group 3
Between Groups T1	0,630	0,750	0,001
Between Groups T2	0,512	0,229	0,302
Between Groups T3	0,732	0,693	0,059

T1 – immediately after the intervention; **T2 –** 10 days after the intervention; **T3 –** 20 days after the intervention. **Group 1** – Control; **Group 2 –** Placebo; **Group 3 –** Intervention.
Scar mobilization (IG) yielded greater changes in pressure pain threshold (PPT) at the spinous process and bilateral paravertebral regions, with high effect sizes at T1 compared to baseline. These are presented in Tables 4 and 6
Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 5
Pressure pain threshold – spinous process.

Group	T0	T1	Effect Size (T1 vs T0)
CG	3.20 ± 0.85 [2.68–3.72]	3.25 ± 0.80 [2.76–3.74]	–
PG	3.30 ± 0.78 [2.82–3.78]	4.00 ± 0.70* [3.58–4.42]	0.79 (Moderate)
IG	3.35 ± 0.81 [2.83–3.87]	4.45 ± 0.65*† [4.02–4.88]	1.19 (High)

Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 6
Effect Size between the experimental groups when analyzing algometry on the spinous process at different moments after the intervention.

	Group 1 x Group 2	Group 1 x Group 3	Group 2 x Group 3
Between Groups T1	0,792	1190	0,205
Between Groups T2	0,528	0,545	0,014
Between Groups T3	0,688	0,720	0,189

T1 – immediately after the intervention; **T2 –** 10 days after the intervention; **T3 –** 20 days after the intervention. **Group 1** – Control; **Group 2 –** Placebo; **Group 3 –** Intervention.
Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 7
Pressure pain threshold – paravertebral region.

Group	Side	T0	T1	Effect Size
CG	Right	2.90 ± 0.70	2.95 ± 0.75	–
PG	Right	3.00 ± 0.68	3.60 ± 0.66*	0.63 (Moderate)
IG	Right	2.95 ± 0.72	4.10 ± 0.64*†	1.11 (High)
CG	Left	2.88 ± 0.68	2.92 ± 0.70	–
PG	Left	2.97 ± 0.69	3.52 ± 0.65*	0.54 (Moderate)
IG	Left	2.90 ± 0.70	4.00 ± 0.63*†	0.99 (High)

Although no statistically significant group × time interactions were found for the disability questionnaires, only the scar therapy group showed relevant clinical improvements at day 20, especially in ODI and RMDQ, as seen in Table 8.
Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 8
Effect Size between experimental groups when algometry of bilateral paravertebral mass was analyzed at different moments after the intervention.

	Group 1 x Group 2	Group 1 x Group 3	Group 2 x Group 3
Between Groups T1 Right and Left	0,638 - 0,542	1111 - 0,989	0,398 - 0,423
Between Groups T2 Right and Left	0,459–0,425	0,264 - 0,462	0,170 - 0,017
Between Groups T3 Right and Left	0,640 - 0,721	0,722 - 0,719	0,242 - 0,146

T1 – immediately after the intervention; **T2 –** 10 days after the intervention; **T3 –** 20 days after the intervention. **Group 1** – Control; **Group 2 –** Placebo; **Group 3 –** Intervention.
Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 9
Disability scores (ODI %) and roland-morris questionnaire (RMDQ).

Group	ODI T0	ODI T3	RMDQ T0	RMDQ T3
CG	36 ± 10 [30–42]	33 ± 9 [28–38]	10.2 ± 2.5 [8.9–11.5]	9.5 ± 2.3 [8.3–10.7]
PG	35 ± 9 [29–41]	28 ± 7 [24–32]	9.9 ± 2.4 [8.6–11.2]	8.3 ± 1.8 [7.4–9.2]
IG	36 ± 8 [31–41]	27 ± 6† [23–31]	10.1 ± 2.3 [8.9–11.3]	7.9 ± 1.7 [7.0–8.8]

Finally, flexibility assessed by the Wells Bench showed a decline in the scar group at T2 and T3 compared to baseline and control (Table 6).
Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

Table 10
Wells bench flexibility test (cm).

Group	T0	T2 (10 days)	T3 (20 days)
CG	21.0 ± 5.0	21.3 ± 4.8	21.2 ± 5.1
PG	20.5 ± 5.1	20.1 ± 5.0	20.3 ± 5.2
IG	21.2 ± 5.2	19.1 ± 5.6	18.8 ± 5.9†

Statistically significant difference from T0 (p* < 0.05).
† Statistically significant difference from Control group (p < 0.05).

limitation of this study. However, considering various exclusion factors and the short duration of the research, the analyzed data were sufficient for an initial proposal for a randomized clinical trial. Additionally, the lack of prior research on this subject does not contribute significantly to the clinical evidence base; nevertheless, it is hoped that the topic will attract more attention, leading to further research based on this study proposal, thereby enriching and facilitating more in-depth discussions in the future.

The results of this study should be interpreted critically as only a single intervention was conducted, and not a complete treatment to improve the symptoms of these patients. Although the measurement of PPT is scientifically validated through other studies, this was the first study attempting to correlate PPT with sensitive medullary levels identified by the assessor. It is also the first study to use PPT on the spinous processes of vertebral bodies. Therefore, this study was pioneering in various aspects, opening the door for numerous subsequent studies with the aim of either reinforcing or diverging from the findings of this group of researchers.

5. Conclusion

Based on the results obtained in the present study, the mobilization of abdominal scars in patients with nonspecific chronic low back pain (CLBP) for 5 min showed a high effect size compared to the control group. However, it did not demonstrate a significant difference compared to the release of suboccipital muscles for 5 min. Therefore, manual mobilization for 5 min over abdominal scar tissues in patients with nonspecific CLBP may be a proposed acute approach in managing pain intensity, similar to the release of suboccipital muscles. This effect does not extend into the follow-up periods of 10 and 20 days after the technique. However, due to the high Effect Size, manual mobilizations over the scar may be a better decision. Nevertheless, one of the factors for future studies is to consider the use of inhibitory touch to assess whether the scar is related to the participating patients.

6. Clinical relevance

6.1. Easy evaluation

A significant number of patients who come to the clinic may have undergone some type of surgery during their lifetime. The evaluation of abdominal scars, relating them to symptoms such as pain and range of motion in patients with nonspecific chronic low back pain (NCLBP), through inhibitory touch proposed in this study and described in a 2020 review, provides an easy way to assess and correlate the scar as a contributing factor to NCLBP.

6.2. Independent treatment response

Despite inhibitory touch not being an inclusion criterion for this study, participants in the intervention group (IG) showed interesting results compared to the other groups, especially the control group (CG). This suggests that mobilizing the scar can acutely contribute, even if the scar does not have a "direct" relationship in clinical tests.

6.3. Ease and acute response to treatment

In the study, scar mobilization was performed for a short duration (5 min) in a simple and highly reproducible manner by any other healthcare professional. It yielded acute results with a high effect size immediately after, and a moderate response in the 10-day follow-up, in terms of pain levels (DOR) and pressure pain threshold (PPT).

CRediT authorship contribution statement

Daniel Kenji Makita: Writing – review & editing, Writing – original draft, Resources, Methodology, Conceptualization. **Caroline Razera Ferreira:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Investigation, Formal analysis, Conceptualization. **Leonardo Sette Vieira:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Conceptualization. **Cristiano Guimarães:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Conceptualization. **Bruno Luis Amoroso Borges:** Writing – review & editing, Writing – original draft, Supervision, Software, Project administration, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Eu, Daniel Kenji Makita, venho por meio desta declarar meu interesse em submeter o manuscrito intitulado " The effect of manual release on abdominal scars in patients with nonspecific chronic low back pain - a double-blind, randomized, and controlled study " para avaliação e possível publicação na Journal of Bodywork and Movement Therapies. Este trabalho representa uma contribuição significativa para a compreensão do papel das cicatrizes em pacientes que apresentam dor lombar crônica inespecífica e espera-se que possa enriquecer o conhecimento existente na comunidade científica.

Meu interesse em publicar na Journal of Bodywork and Movement Therapies baseia-se no reconhecimento da reputação desta revista como um veículo respeitado na disseminação de conhecimento científico de alta qualidade. Acredito que os resultados deste estudo são pertinentes ao escopo e à audiência da revista, oferecendo uma perspectiva valiosa sobre como a terapia manual pode intervir positivamente em cicatrizes de pacientes que apresentam dor lombar crônica inespecífica.

Ressalto que este manuscrito não foi submetido a nenhuma outra revista para avaliação simultânea e que todos os coautores estão cientes e concordam com esta submissão. Além disso, declaro que não há conflitos de interesse relevantes que possam influenciar a imparcialidade na revisão e publicação deste artigo.

Agradeço antecipadamente pela consideração deste manuscrito e estou à disposição para fornecer informações adicionais ou esclarecimentos, conforme necessário.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jbmt.2025.09.041.

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