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Section: Original Research Report

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ABSTRACT

Context: Taken into account the complex structure of the diaphragm and its important role in the postural chain, we were prompted to check the effects of a diaphragm technique on hamstring flexibility. **Objective:** The aim of this study was to evaluate the effects of the doming of the diaphragm technique on hamstrings flexibility and spine mobility. **Design:** Randomized placebo controlled trial. **Setting:** University laboratory. **Patients:** Sixty young adults with short hamstring syndrome were included in this randomized clinical trial using a between-group design. **Intervention:** The sample was randomly allocated to a placebo group (n = 30) or to an intervention group (n = 30). Duration, position, and the therapist were the same for both treatments. **Main outcome measures:** Hamstring flexibility was assessed using the forward flexion distance and the popliteal angle tests. The spinal motion was evaluated using the Modified Schober's test and the cervical range of movement. **Results:** Two-way ANOVA afforded pre-to-post intervention statistically significant differences ($p<0.001$) in the intervention group compared to the placebo group for hamstrings flexibility measured by the forward flexion distance (mean change 4.59±5.66 intervention group vs 0.71±2.41 placebo group) and the popliteal angle tests (mean change intervention group 6.81± 8.52 vs. placebo group 0.57± 4.41). Significant differences ($p<0.05$) were also found in the modified Schober test (mean change intervention group -1.34±3.95 vs. placebo group 1.02±3.05) and the cervical range of movement. Significant between-groups differences ($p<0.05$) were also found in all the variables measured. **Conclusions:** The doming of the diaphragm technique provides a sustained improvement on hamstrings flexibility and spine mobility. Key words: clinical trial, kinesiology, physical-therapy, posture.

INTRODUCTION

The length of the hamstrings is important in human posture and in the efficiency of daily human movements, such as walking and running[1], but limited hamstrings flexibility is very common in the general population[2]. Many studies have been conducted in order to clarify the risk factors and impact of previous injuries for short hamstring syndrome[3,4]. Poor hamstring flexibility has been previously reported to impact on normal biomechanical patterns affecting balance, functionality and sport performance and leading to impaired mobility, postural deviations, pain and increased risk of injury[5]. According to the effects of hamstring flexibility on the spine, clinical observations suggested short hamstring muscles to be associated with specific disorders of the lumbar spine[6,7], but this has not been widely explored in the literature[8-10]. However, it has been reported that the limited flexibility of hamstring muscles provokes reduced pelvis mobility, disturbing the distribution of pressures in the spine, altering the lumbar curve, causing compensatory movement patterns of the lumbar spine, and subsequently increasing stress on the spinal soft tissues[11].

Manual techniques like stretching[12], massage[13] and myofascial release[14] have been used to increase the lower limbs range of motion when applied to hamstring muscles with controversial results.

It has been suggested that the shortening of a muscle creates compensation in adjacent and also in distant muscles[15]. Other authors examined the hamstring elasticity taken into account the restrictions of the postural muscles, including the diaphragm[16]. From an anatomical viewpoint, the diaphragm is a muscle with a central trefoil-shaped tendon that blends superiorly with the fibrous pericardium. The origins of the diaphragm are placed in the crura from bodies of lumbar vertebrae, the arcuate ligaments, the costal margins and the xiphoid[17].

The doming of diaphragm (DD) technique is used to restore the normal movement of the diaphragm and to improve its function(18). Kinetic chain approaches are based on movement patterns, the body works as a dynamic unit rather than as isolated segments(19). Therefore, the biomechanical relationship between the diaphragm and other structures support that a diaphragm technique can have a repercussion in others distant structures(15) such as the hamstring muscles. To our knowledge, no previous studies have evaluated the effects of a diaphragm technique on hamstring length and spine mobility. Taken into account the complex structure of the diaphragm and its important biomechanical role in the postural chain(15), our hypothesis is that a normalization technique of the diaphragm can have an effect on the posterior muscle chain. The outcomes were flexibility of the hamstring muscles assessed using the forward flexion distance and the popliteal angle tests and spinal mobility evaluated using the Modified Schober's test and the cervical range of movement. It was expected an improvement on hamstrings flexibility and an increase in the spinal range of motion. Thus, the aim of this study was to test the effects of the DD technique on patients with short hamstring syndrome.

METHODS

Design

Randomized placebo controlled trial, with a single blinded design. It was completed in a laboratory in the Health Sciences Faculty.

Participants

Email and word of mouth were used to recruit a non-probabilistic convenience sample of 68 subjects from the staff and student body of the Health Sciences Faculty, as well as their friends and relatives (Figure 1). Subjects were given all information about exclusion criteria at the time of recruitment and they were reminded of the relevant criteria 24 to 36 hours before their arranged time of participation.

Subject inclusion was limited to individuals between 18 and 40 years old. The inclusion criteria were as follows: willingness of the subjects to participate in the study (written informed consent signature), popliteal angle test (PAT) value of 15° or more and forward flexion distance (FFD) test of more than 5 cm.

Participants were excluded if they exhibited history of neck trauma, history of fracture in any part of the body, history of neck or low back pain, herniated disk or lumbar protrusion, symptoms in the lower extremity, some muscle tendon injury of the hamstring muscles, or regular use of analgesic or anti-inflammatory drugs. Those who were pregnant, reported experiencing major psychological stress, or had consumed caffeinated food and/or beverage products within the previous 24 hours were excluded from the study. Subjects were also excluded if they had received manual therapy within the previous month.

Approval for the study was obtained from the University Ethics Committee and each participant signed a written informed consent.

Procedures

Outcome measures

The study assessor who collected the outcome measures was blinded to study hypotheses and group allocation. After all the baseline measures were taken, subjects were led to another room where they received the diaphragmatic technique or the placebo intervention. Subjects were then taken back to the first room for the post-intervention measures. Main outcome measures were collected immediately after the session.

Anthropometric measures

All subjects completed the same battery of tests before and after the intervention. For descriptive purposes, anthropometric measurements were taken at baseline. Weight was measured in kilograms (kg) to the nearest 0.1 kg on a calibrated digital medical scale (Seca 843, Switzerland) with participants dressed in standard T-shirts and shorts. Height was measured in centimeters (cm) to the nearest 0.5 cm via a standard wall-mounted stadiometer.

Hamstring flexibility was assessed using the FFD test and the PAT. In the FDD test, the subject, standing on an anthropometric box, performed a maximum and progressive anterior flexion of the trunk, maintaining the knees straight and lengthening the arms with the palms parallel and the fingers extended[20].The therapist used a metric tape to determine the distance from the distal part of the fingers to the box on a millimeter ruler placed on the vertical side of the box[21]. This test has been reported to have good validity and reliability[10]. The PAT started out from the supine position, with the hip and knee flexed at 90°. From this position and with the axis of the goniometer placed on the lateral condyle of the femur, the subject was asked to perform extension of the knee, without modifying the flexion of the hip and avoiding pelvic movements. The angle remaining for full extension of the knee reflected the degree of hamstring shortening[22,23].

The spinal motion was evaluated using the Modified Schober's test and the cervical range of movement. According to the description of the modified Schober's test[24], an anchor is established at the L5 level of the lumbar spine, from which marks at 10 cm above and 5 cm below are placed, with the patient standing upright. The distance between the superior and inferior mark is measured and recorded[25]. The cervical range of movement was assessed using a full-circle goniometer[26,27]. Three measurements were made alternatively for each direction (flexion, extension, and lateral flexions) and the mean value was considered for the analysis.

Interventions

Subjects were randomly allocated into one of two groups (intervention and control) by choosing a sealed envelope, after which they received the diaphragm technique or the placebo intervention. The doming of the diaphragm is a technique designed to relax the resting state of the diaphragm, enhancing its contraction and relaxation functions. It is designed to create a greater pressure gradient between the thorax and the abdomen, augmenting the expiration phase[18]. It was performed by a therapist with more than seven years of experience.The patient position is seated and relaxed. The therapist stands behind the subject and puts his hands around the thoracic cage, introducing the fingers beneath the costal margins (Figure 2). The thorax is then carefully rotated to the left and to the right to determine which direction offers the greatest degree of freedom and ease of motion. The thorax is eased in the direction in which it rotates more freely. This position is held for 5 minutes, and the hands are used to support and to follow the tissues as a slow releasing. Disconnected ultrasound was applied distal the xyphoid process for 5 minutes as placebo treatment (Figure 3). The duration of the intervention, the position of the patient and the therapist and the therapist who performed the intervention were the same for both groups.

Statistical Analyses

The sample size was set at a minimum of 28 patients in each group based on an expected improvement of 7.5±6.2º in the intervention group (mean±standard deviation) in the popliteal angle test[28], an α value set at 0.05 (type I error), and β at 0.20 (type II errors). Thus, a priori, we intended to include 60 patients in expectation of a number of dropouts.

The statistical distribution of the data was analyzed with the Kolmogorov-Smirnov test. The distribution of the quantitative variables was normal. Qualitative variables are presented as percentage (%) (sex) and quantitative variables (antropometric measures, hamstrings flexibility and spinal movement) as mean±standard deviation. The demographic data and initial assessment results were compared with T-tests and the χ^2 test using SPSS (Statistical Package for the Social Sciences) software, version 20.0 (SPSS Inc., Chicago, IL, USA). The data were analyzed with the 2-way analysis of variance ANOVA using unrepeated measure factor to analyze within group values and repeated measure factor to compare pre- to post-intervention between groups measures. The alpha level was set at 0.05.

RESULTS

Sixty-eight participants were recruited for the study, and 8 of them were excluded because they did not meet the inclusion criteria. The flow diagram[29] of participants through the trial is shown in Figure 1.

Baseline characteristics (Table 1) of both groups were similar, although the intervention group had comparatively fewer men – 10 (34.9%), vs. 13 (40.7%) –. Body mass index (BMI) values were extremely similar (mean 23.26 ± 3.3 vs. mean 23.02 ± 3.36).

Baseline characteristics of both groups in the outcome measures are presented in Table 2, showing no significant differences between groups in all the variables.

Intervention (Table 3) showed significant changes between measures in the technique group. By contrast, the placebo group did not show pre -to post differences ($p>0.05$) in any measure. Significant pre – to post intervention differences ($p<0.001$) were found in the intervention group compared to the placebo group for hamstrings flexibility measured by the forward flexion distance (mean change 4.59±5.66 intervention group vs 0.71±2.41 placebo group) and the popliteal angle tests (mean change intervention group 6.81± 8.52 vs. placebo group 0.57± 4.41). Significant differences ($p<0.05$) were also found in the modified Schober test (mean change intervention group -1.34±3.95 vs. placebo group 1.02±3.05) and all cervical movements (mean change intervention group vs. control group: flexion -7.09 vs. 0.33, extension -4.57 vs. 0.863, right lateral flexion -4.28 vs. -0.27 and left lateral flexion -4.29 vs. -0.53)

Between groups differences ($p<0.05$) were also found in hamstrings flexibility and spine mobility (table 3).

DISCUSSION

The main purpose of the current study was to analyze the effects of an indirect doming of the diaphragm technique on hamstrings flexibility and spinal mobility in participants with limited flexibility of hamstring muscles. The results of this study showed a significant improvement on hamstrings flexibility ($p<0.001$) and in the cervical and lumbar range of motion ($p<0.05$) after the technique whilst no significant changes occurred in placebo group.

The sample of subjects included in both placebo and intervention groups did not present significant differences at baseline. This decreases the chances of having confounding variables that could have affected the value of our results.

The hamstrings are primarily hip extensors and secondarily knee flexors; they have a mechanical advantage at the hip. However, they also play an important role in the stance and swing phases during gait as they stabilize the knee at initial contact and decelerating the shank in terminal swing[30]. The interventions on hamstring muscles are important because disturbed length of the muscles can affect muscular efficiency and it has reported to be a frequent condition due to the sedentary life style. It has been previously reported that hamstring muscles tend to become short and tight because of sedentary activities [31].

Our theoretical approach is that the application of the DD technique would result in an activation of core stabilizing muscles and a normalization of the aberrant motor control strategies displayed by the subjects with short hamstring syndrome[32], with consequent improvements in hamstrings flexibility and spinal movement. Previous studies have investigated the effects of different techniques on hamstrings flexibility. Some authors explore the effects of long distances techniques on hamstrings elasticity.

Aparicio et al.[10] identify the effects of the suboccipital muscle inhibition technique performed during 2 minutes in patients with short hamstring muscle, modifying the elasticity and also the pressure algometry of the semimembranous muscle. They reported an increase in the FDD test and in the PAT after the suboccipital muscle inhibition technique. In our study, the subjects showed higher values of change after performing the DD technique; the experimental group obtained an increase in FDD test and in the PAT. Pollard and Ward[8] compared two techniques, a suboccipital muscle contraction-relaxation technique and a contraction-relaxation technique on the hamstring muscles. They used the straight leg raise test as an outcome measure, showing a significant improvement in the experimental group after the technique. Taylor et al.[9] used a cervical spine contract-relax technique with a contraction of 3 to 5 seconds and a stretching repeated 3 times, showing no evidence supporting the effectiveness of this technique to increase hamstring extensibility.

Numerous studies focus on techniques on the hamstrings such as stretching [2, 12] or deep stripping massage [5] that increase the muscle flexibility. They established a program to increase the flexibility, but in our study significant differences were found as immediate effects pre-to post-doming of the diaphragm technique. In the study of George et al.[31], it is reported to increase hamstring flexibility in only one session with active release technique in asymptomatic male participants. Aparicio et al.[10] also obtained immediate improvements on hamstring flexibility after a suboccipital technique.

To our knowledge, no studies have used a diaphragm technique in order to obtain an effect on hamstring flexibility and/or spine mobility.

Some limitations and strengths of this study should be noted. One weakness is the absence of knowledge about how long the benefits of the technique last. Another limitation is the use of an ultrasound procedure as placebo to be compared to a hands-on technique. Noll et al.[34] recommended that investigators use deferred or no treatment control group in addition to a sham control. A randomized clinical trial in manual medicine should ideally include three arms: an active treatment group, a sham group and a no-treatment group. However, such a study design is more costly and requires a large number of participants to achieve adequate statistical power. Additionally, previous studies have compared a manual therapy technique to this procedure [35,36]. Other limitations are that this study only shows immediate effects of the technique and the lack of follow-up.

Despite this, the trial has the strength of being based on a randomized controlled design. This is also the first study that shows a significant improvement on hamstring flexibility and spine mobility after a short diaphragm technique. Moreover, the population of the study is quite representative of patients suffering from short hamstrings syndrome, thus makes this research a realistic base for future studies in this field. It is evidenced that obtaining and maintaining the range of motion is very important and a key factor in injury prevention. According to that, the technique proposed of doming the diaphragm is useful, safe and well-tolerated with an immediate significant effect.

CONCLUSIONS

Patients with short hamstring syndrome who underwent doming of the diaphragm technique significantly improved pre- to post technique hamstring flexibility and the spinal range of motion, with no significant changes in the placebo group. Doming of the diaphragm technique can be used as an effective therapeutic tool with an immediate response in short hamstrings. The results of this study provide new and additional data to assist the therapeutic approaches.

Conflict of interest:

The authors state that there are no conflicts of interest with this work.

REFERENCES

1. Gajdosik RL, Giuliani CA, Bohannon W. Passive compliance and length of the hamstring muscles of healthy men and women. *Clin Biomech*. 1990;5(1):23-29.

2. Ayala F, Sainz de Baranda P. De Ste Croix M, Santonja F. Comparison of active stretching technique in males with normal and limited hamstring flexibility. *Phys Ther Sport*. 2013;14(2):98-104.

3. Turl SE, George KP. Adverse neural tension: a factor in repetitive hamstring strain? *J Orthop Sports Phys Ther*. 1998;27(1):16-21.

4. Verrall GM, Slavotinek JP, Barnes PG, Fon GT, Spriggins AJ. Clinical risk factors for hamstring muscle strain injury: a prospective study with correlation of injury by magnetic resonance imaging. *Br J Sports Med*. 2001;35(6):435-439.

5. Forman J, Geertsen L, Michael E, Rogers ME. Effect of deep stripping massage alone or with eccentric resistance on hamstring length and strength. *J Bodyw Mov Ther*. 2014;18(1):139-144.

6. Raftry SM, Marshall PW. Does a 'tight' hamstring predict low back pain reporting during prolonged standing? *J Electromyogr Kinesiol*. 2012;22(3):407-411.

7. Biering-Sorensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. *Spine*. 1984;9:106-119.

8. Pollard H, Ward G. A study of two stretching techniques for improving hip flexion range of motion. *J Manipulative Physiol Ther*. 1997;20(7):443–447.

9. Taylor D, Fryer GB, McLaughlin P. The effect of cervical spine isometric contract-relax technique on hamstring extensibility. *Australas Chiropr Osteopathy*. 2003;11:21–26.

10. Aparicio EQ, Quirante LB, Blanco CR, Sendín FA. Immediate effects of the suboccipital muscle inhibition technique in subjects with short hamstring syndrome. *J Manipulative Physiol Ther*. 2009;32(4):262-269.

11. Da Silva Dias R, Gómez-Conesa A. Síndrome de los isquiotibiales acortados. *Fisioterapia*. 2008;30(4):186–193.

12. Fox M. Effect on hamstring flexibility of hamstring stretching compared to hamstring stretching and sacroiliac joint manipulation. *Clinical Chiropractic*. 2006;9(1):21-32.

13. Crosman L, Chateauvert S, Weisberg J. The effects of massage to the hamstring muscle group on range of motion. *J Orthop Sports Phys Ther*. 1984;6(3):168–172.

14. Hemmings BJ. Physiological, psychological, and performance effects of massage therapy in sport: a review of the literature. *Phys Ther Sport*. 2001;2(4):165–170.

15. Hamaouoi A, Le Bozec S, Poupardb L, Bouisset S. Does postural chain muscular stiffness reduce postural steadiness in a sitting posture? *Gait Posture*. 2007; 25:199-204.

16. Kuchera M, Kuchera W. General postural considerations. In: Ward R (ed.) *Foundations for Osteopathic Medicine*. Baltimore: Lippincott Williams & Wilkins; 1997.

17. Downey R. Anatomy of the normal diaphragm. Thorac Surg Clin 2011;21(2):273-279.

18. Whittaker, D. Multidisciplinary approaches to breathing pattern disorders. *Australas Chiropr Osteopathy*. 2002;10(2):111.

19. Souchard P-E, Meli O, Sgamma D, Pillastrini P. *Rieducazione posturale globale*. Paris: EMC Elsevier Masson SAS; 2009.

20. Buckup K. *Pruebas clínicas para patología ósea, articular y muscular: Exploraciones, signos, síntomas*. Barcelona: Masson; 2002.

21. Esparza F. *Manual Cineantropometría*. Madrid: Femede; 1993.

22. Gajdosik L. Hamstring muscle tightness. Reliability of an active-knee-extension test. *Phys Ther*. 1983;63:1085-1090.

23. Worrell TW, Perrin DH. Hamstring muscle injury: the influence of strength, flexibility, wam-up, and fatigue. *J Orthop Sports Phys Ther*. 1992;16(1):12-18.

24. Macrae IF, Wright V. Measurement of back movement. *Ann Rheum Dis*. 1969;28: 584–589.

25. Miller MH, Lee P, Smythe HA, Goldsmith CH. Measurements of spinal mobility in the sagittal plane: new skin contraction technique compared with established methods. *The J Rheumatol*. 1984;11(4):507–511.

26. Tucci SM, Hicks JE, Gross EG, Campbell W, Danoff J. Cervical motion assessment: a new, simple and accurate method. *Arch Phys Med Rehabil*. 1986;67(4):225-230.

27. Zachman ZJ, Traina AD, Keating JC, Bolles ST, Braun-Porter L. Interexaminer reliability and concurrent validity of two instruments for the measurement of cervical ranges of motion. *J Manipulative Physiol Ther*. 1989; 12(3):205-210.

28. O'Hora J, Cartwright A, Wade CD, Hough AD, Shum GL. Efficacy of static stretching and proprioceptive neuromuscular facilitation stretch on hamstrings length after a single session. *J Strength Cond Res*. 2011;25(6):1586-1591

29. Schultz KF, Altman DG, Moher D. CONSORT 2010 Statement: Updated guidelines for reporting parallel randomized trials. *BMC Med*. 2010;8(1):18.

30. Stewart C, Postans N, Schwartz MH, Rozumalski A, Roberts AP. An investigation of the action of the hamstring muscles during standing in crouch using functional electrical stimulation (FES). *Gait Posture*. 2008;28(3):372-377.

31. Owen BD. Personal characteristics important to back injury. *Rehab Nurs*. 1986;11(4):12-16.

32. O'Sullivan PB, Beales DJ. Changes in pelvic floor and diaphragm kinematics and respiratory patterns in subjects with sacroiliac joint pain following a motor learning intervention: a case series. *Man Ther*. 2007;12(3):209-218.

33. George JW, Tunstall AC, Tepe RE, Skaggs CD. The effects of active release technique on hamstring flexibility: a pilot study. *J Manipulative Physiol Ther*. 2006;29(3):224-227.

34. Noll DR, Degenhardt BF, Stuart M, McGovern R, Matteson M. Effectiveness of a sham protocol and adverse effects in a clinical trial of osteopathic manipulative treatment in nursing home patients. *J Am Osteopath Assoc*. 2004;104:107-113.

35. Arroyo-Morales M, Olea N, Martínez M, Moreno-Lorenzo C, Díaz-Rodríguez L, Hidalgo-Lozano A. Effects of myofascial release after high-intensity exercise: a randomized clinical trial. *J Manipulative Physiol Ther*. 2008;31(3):217-223.

36. Toro-Velasco C, Arroyo-Morales M, Fernández-de-las-Peñas C, Cleland JA, Barrero-Hernández FJ. Short-term effects of manual therapy on heart rate variability, mood state and pressure pain sensitivity in patients with chronic tension-type headache: a pilot study. *J Manipulative Physiol Ther*. 2009;32(7):527-535

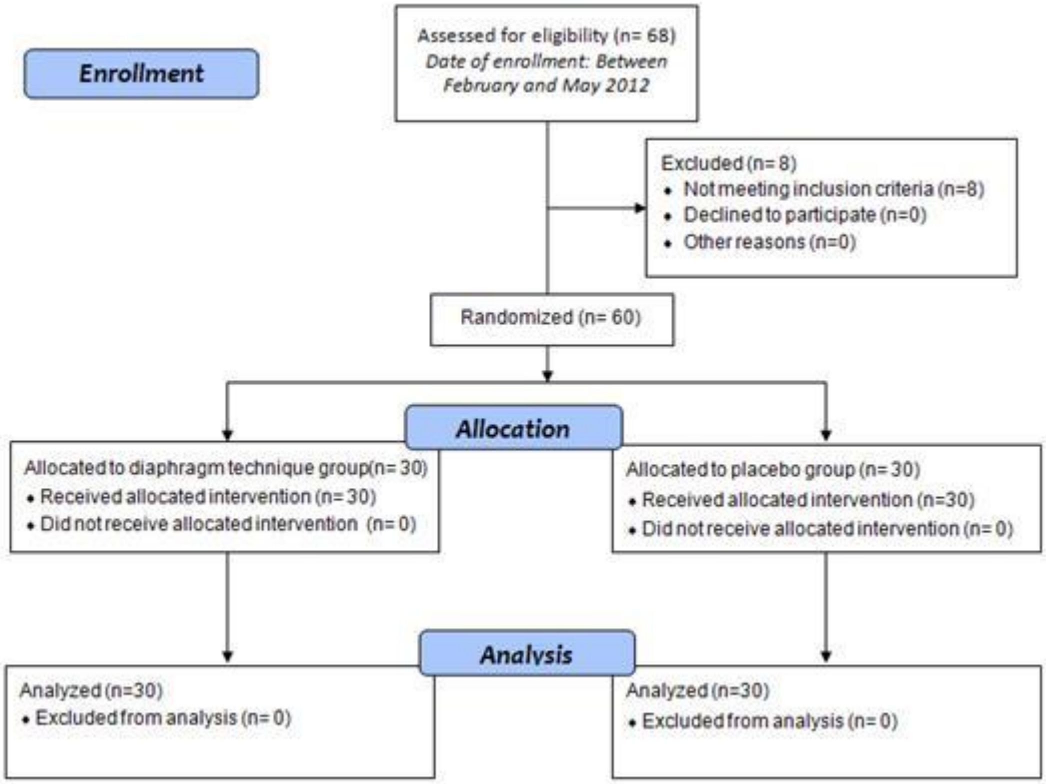

Figure 1. Flow diagram of the progress through the phases of a parallel randomised trial of two groups.

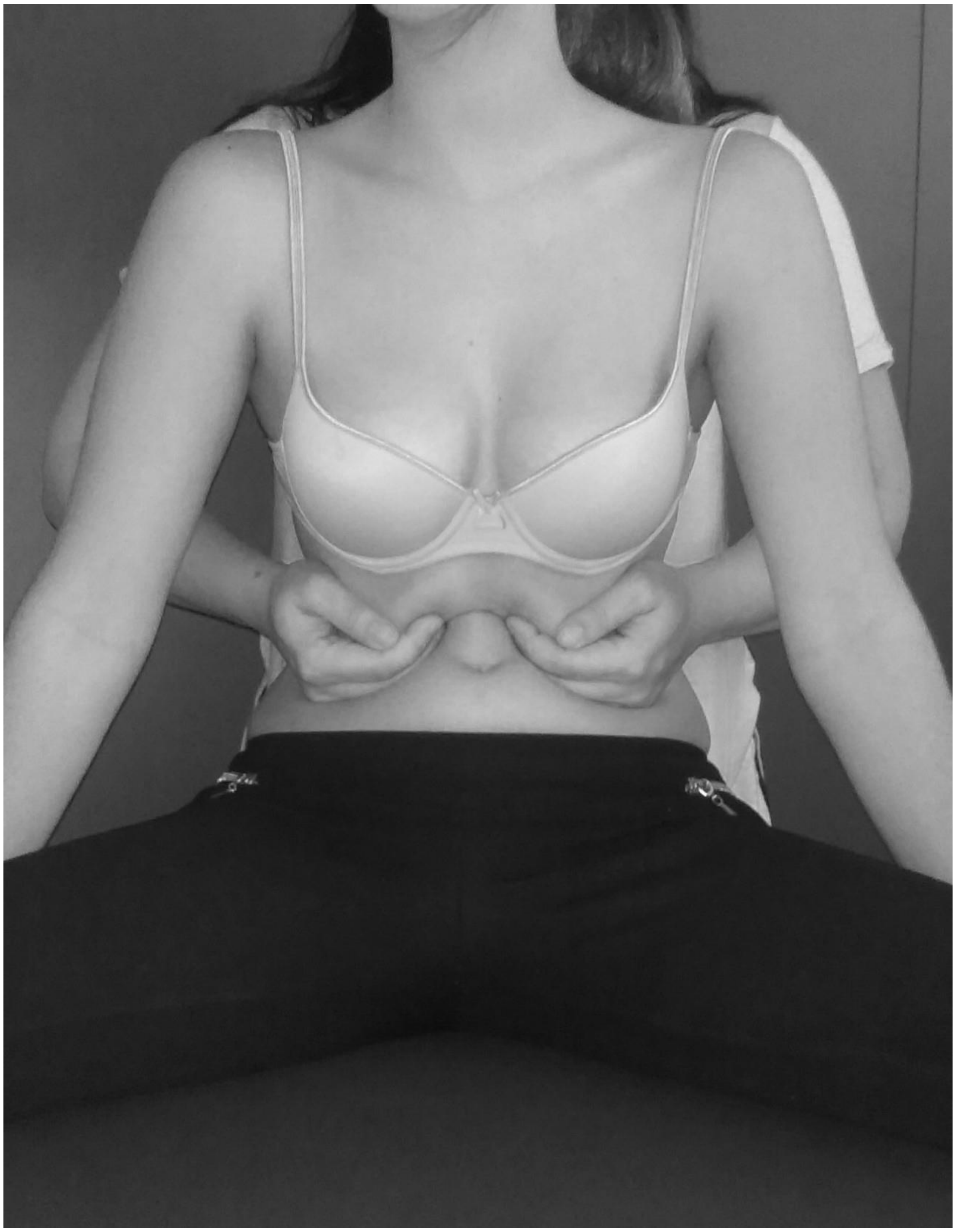

Figure 2. Doming of the diaphragm technique.

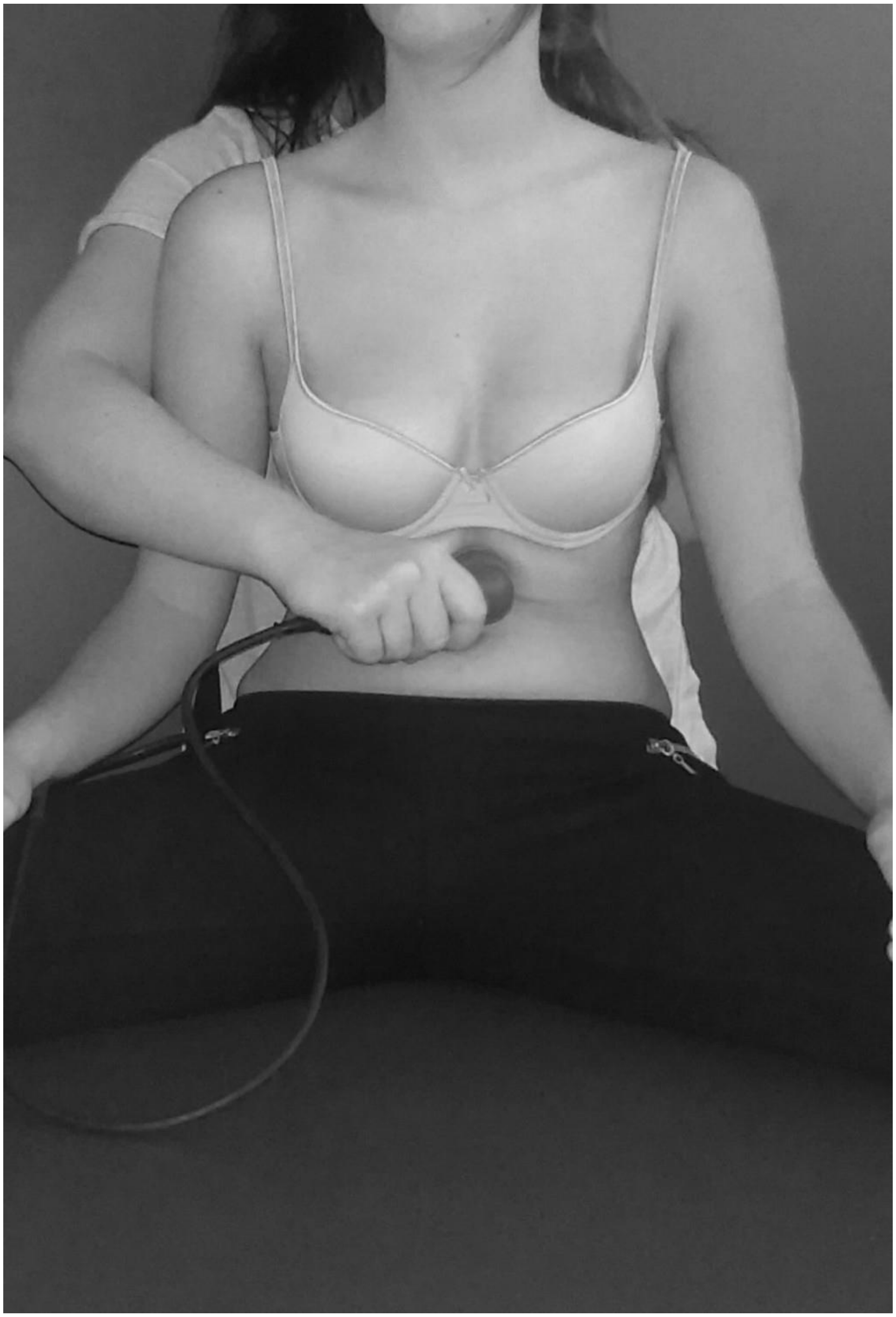

Figure 3. Placebo intervention.

Table 1. Descriptive data of the sample included in the study (n=60).

	Intervention group (n=30)	Control group (n=30)	P-value
Sex (% males)	34.9	40.7	0.404
Age (years) (Mean±SD	22.33±4.90	23.40±5.80	0.856
Height (cm) (Mean±SD)	167±0.83	169±0.99	0.226
Weight (Kg) (Mean±SD)	65.22±12.59	66.50±12.10	0.676
BMI (kg/cm^2) (Mean±SD)	23.26±3.30	23.02±3.36	0.764

SD: standard deviation; BMI: body mass index; n: number of participants.

Table 2. Pre-intervention values in the different tests performed.

	Intervention group (n=30)	Control group (n=30)	p-value
Hamstring muscles flexibility			
Forward Flexion Distance Test (cm)	21.97±7.75	23.17±7.99	0.610
Popliteal angle test (degrees)	32.98±11.58	34.28±12.36	0.432
Spine Mobility			
Schober Test (cm)	2.11±1.30	2.19±1.32	0.351
Modified Schober test (cm)	5.83±3.93	5.64±6.57	0.401
Cervical range of movement (degrees)			
Flexion	63.79±8.43	64.53±8.39	0.171
Extension	61.61±11.43	61.143±11.68	0.407
Right lateral flexion	47.16±8.79	47.85±9.61	0.471
Left lateral flexion	48.23±8.86	48.72±8.57	0.165

Table 3. Pre- to post-intervention values in the participants of the study (n=60).

	Intervention group (n=30)	Within group p-value	Control group (n=30)	Within group p-value	Between groups mean difference±SD (95% CI)	Between groups p-value
Hamstring flexibility						
Forward Flexion Distance Test (cm)	17.38±9.78	p<0.001**	22.45±7.60	0.190	-5.07±2.63 (-7.41, -2.19)	p<0.001**
Popliteal angle test (degrees)	26.16±14.56	p<0.001**	33.71±11.41	0.559	-7.41±4.57 (-8.45, -3.81)	p<0.001**
Spine Mobiliy						
Modified Schober test (cm)	6.49±1.95	0.049*	4.63±1.21	0.142	-1.34±3.95 (0.05, 2.68)	p<0.001**
Cervical range of movement (degrees)						
Flexion	70.88±10.29	p<0.001**	64.20±8.45	0.201	-7.10±8.57 (-9.99, -4.20)	p<0.001**
Extension	66.18±10.79	0.005*	60.28±12.59	0.147	-4.57±9.17 (-7.67, -1.46)	p<0.001**
Right lateral flexion	51.44±9.36	0.015*	48.12±8.23	0.329	-4.28±10.09 (-7.69, -0.87)	0.032*
Left lateral flexion	52.52±7.84	0.004*	49.25±9.33	0.356	-4.28±8.34 (-7.10, -1.46)	0.029*

*p<0.05; **p<0.001; CI: confidence interval; SD: standard deviation; n: number of participants.