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Effectiveness of an Osteopathic Abdominal Manual Intervention in Pain Thresholds, Lumbopelvic Mobility, and Posture in Women with Chronic Functional Constipation

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Abstract

Objectives: To assess the effect of an osteopathic abdominal manual intervention (AMI) on pressure pain thresholds (PPTs), mobility, hip flexibility, and posture in women with chronic functional constipation.

Design: Randomized, double-blind placebo-controlled trial.

Setting/Location: Subjects were recruited for the study by referral from different gastroenterology outpatient clinics in the city of Madrid (Spain).

Subjects: Sixty-two patients suffering from chronic functional constipation according to the guidelines of the Congress of Rome III.

Interventions: The experimental group ($n = 31$) received an osteopathic AMI, and the control group ($n = 31$) received a sham procedure.

Outcome measures: PPTs at different levels, including vertebral levels C7, T3, T10, T11, and T12, trunk flexion range of motion (ROM), hip flexibility, and posture, were measured before and immediately after the intervention. A comparison between the difference between the pre- and postintervention values using the Student's *t* test for independent samples or nonparametric *U*-Mann–Whitney test depending on the distribution normality of the analyzed variables was perfomed.

Results: In the intergroup comparison, statistically significant differences were found in PPT at T11 ($p = 0.011$) and T12 ($p = 0.001$) and also in the trunk flexion ROM ($p < 0.05$). Moreover, women showed no adverse effects with acceptable pain tolerance to the intervention.

Conclusion: The application of an osteopathic AMI is well tolerated and improves pain sensitivity in areas related to intestinal innervation, as well as lumbar flexion.

Keywords: abdominal massage, constipation, pain threshold, posture, range of motion, articular

Introduction

CHRONIC CONSTIPATION (CC) IS very frequently a presenting digestive complaint.[1] According to Rome III Diagnostic Criteria for Functional Gastrointestinal Disorders,

functional constipation is present when symptom onset is more than 6 months before the diagnosis, with the following criteria fulfilled for the past 3 months: Loose stools rarely present without the use of laxatives, insufficient criteria met to establish a diagnosis of irritable bowel syndrome (IBS),

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and two or more of a set of criteria. These criteria are as follows: Less than three defecations per week, manual maneuvers necessary to facilitate at least 25% of defecations (e.g., digital evacuation and support of the pelvic floor), lumpy or hard stools in at least 25% of defecations, sensation of incomplete evacuation for at least 25% of defecations, sensation of anorectal obstruction/blockage for at least 25% of defecations, or straining during at least 25% of defecations.[2] Its prevalence varies from 2.6% to 26.9%, and the most frequently associated factors are female sex and advanced age.[3]

This condition is a major economic burden for society[4] and has great impact on patients' quality of life.[5,6] It has been proposed as a marker of cardiovascular risk in postmenopausal women,[7] and enteric nervous system abnormalities found in constipated patients play a pivotal role in the genesis of symptoms, with important trophic and immunologic implications.[8]

In addition, it has been shown that the number of gastrointestinal symptoms, including CC, was significantly associated, after adjustment for confounding factors, with an increased risk of developing back pain among all age cohorts.[9] In another longitudinal cohort study, it has been demonstrated that women with preexisting and/or newly developed gastrointestinal symptoms, including constipation, had a significant increased risk for the development of back pain.[10]

Some nonpharmacologic interventions have been carried out for CC, such as diet modification, bowel training, and abdominal manual intervention (AMI).[11,12] The effectiveness of various kinds of manual interventions to alleviate or mitigate different symptoms related to visceral dysfunctions has been demonstrated, such as the use of manipulation techniques for the improvement of pressure pain thresholds (PPTs) at the level of the spinous processes of the vertebrae related to the autonomic innervation of the kidney in subjects suffering from renal lithiasis[13] or for low back pain and PPTs in the sacroiliac joints in women with primary dysmenorrhea[14] or even in the improvement of the function of the lower esophageal sphincter in patients with gastroesophageal reflux.[15]

AMI has shown improvements in gastrointestinal symptoms[12] and additional benefits in other conditions such as central neurologic diseases[16,17] or intellectual disability,[18] improving gastric emptying in patients with pneumonia,[19] in patients receiving enteral nutrition through a nasogastric tube,[20] and in patients with IBS.[21]

Although AMI has been found to decrease the severity of constipation and abdominal pain, some patients experience increased abdominal pain during the first few minutes of the application of the procedure. This resolves by the end of the massage period.[22] This fact could be a barrier for some patients to receive this intervention, and a deeper knowledge on intensity and tolerance to pain related to this intervention is needed. In addition, the effect of AMI at the somatic and functional level is little known, to the point that, in the case of constipation, there are no studies that assess this effect.

Therefore, the objective of this study was to assess the effect of an osteopathic AMI on PPTs and, furthermore, on trunk flexion range of motion (ROM), hip flexibility, posture, and adverse events to the intervention in subjects with chronic functional constipation.

Materials and Methods

Design

Parallel group, randomized, double-blind placebo-controlled trial.

Study participants

Subjects were recruited for the study by referral from different gastroenterology outpatient clinics in the city of Madrid. Those subjects who matched the selection criteria and agreed to participate were selected consecutively for their randomization.

The inclusion criteria for participants were as follows: (a) symptom-based diagnostic criteria of functional constipation according to the guidelines of the Congress of Rome III[2] and, additionally, the patient should consider values 1 or 2 on the Bristol Scale regarding the type of stool[23] (b) female sex (c) aged between 18 and 50 years.

Criteria (b) and (c) are justified because CC is more frequent in females, and it is considered that the pathophysiologic mechanisms involved and, therefore, their association with low back pain, may differ by sex due to various factors[5] and also because in women over 50 years this condition is usually associated with other comorbid conditions that could act as confounding factors for the results of this study.

Patients with any of the following characteristics were excluded: (a) those having undergone abdominal and/or lumbar surgery, (b) ongoing pregnancy, (c) suffering from rheumatism, spinal stenosis, or infectious, carcinogenic, and/or neurologic diseases, (d) having suffered injuries in the thoracic or abdominal cavity in the last 6 months, (e) having taken medications in the last 72 h that may interfere with necessary measurements, and (f) presenting some kind of inability to perform different assessments or any other medical indication that prevents the performance of the study technique.

Accepting an α risk of 0.05 and a β risk of 0.2 in a two-sided contrast, 31 subjects were required in each group to detect a difference equal to or greater than 1.39 U in the primary endpoint, which was the PPT. It is assumed a common standard deviation (SD) of 1.85. A rate of loss of 10% was estimated. To calculate the sample size, Granmo software v7.12 (Hospital del Mar, Barcelona, Spain) was used.

Randomization, blinding, and allocation

Randomization was undertaken using a computerized randomization system (randomized.com) that guaranteed allocation concealment. An outside coworker safeguarded the sequence for those participating in the study. Subjects and evaluators who collected or analyzed data remained unaware of the aims of the study and the treatment allocation group, to ensure participant blinding and outcome assessor blinding, respectively.[24] The clinician in charge of the intervention did not participate in the assessment protocol and did not know what the objectives of the study were.

Study protocol

Participants received both the evaluation and intervention protocols in one session. Both the therapist and the evaluator

were physical therapists and osteopaths with over 6 years of experience in the field of manual therapy.

The evaluator carried out the preintervention measurements, the therapist later carried out the assigned intervention, and, after 10 min, the evaluator repeated the postintervention measurements. All ratings were made in a clinic with a stable temperature between 20°C and 23°C and in the morning.[25]

The sequence of all the measurements was performed in the same way for both the experimental group (EG) and for the control group (CG).

Before the collection of the measurements for the preintervention variables, the evaluator collected the variables: age, height, weight, and weekly physical activity. A significant relationship between body mass index and daily physical activity has been shown, such that body mass index has been inversely associated with constipation, and women who report daily physical activity have a lower prevalence of constipation.[26]

Primary outcome: PPT

PPT measurements were made with an algometer (Baseline Dolorimeter, Baseline, USA)[27] at the tips of the spinous processes at vertebral levels C7, T3, T10, T11, and T12. PPTs were also made bilaterally in patellar tendon, anterior tibialis muscle, and ulnar nerve. For the patellar tendon and anterior tibialis muscle, measurements were performed in the supine position following the procedure used by other authors.[28,29] The vertebral algometry and ulnar nerve algometry were performed in the prone position.[29] Algometry has proved to be a reliable instrument for measuring pain thresholds under pressure.[30]

The algometer pointer was placed perpendicular to the point marked for evaluation. The pressing force was increased with a constant rate of $1 \, kg/cm^2/s$ uniformly and continuously until the perception of the sensitive point.[29] Each patient was asked to inform the evaluator when the feeling of pressure became a painful sensation, at which point the evaluator stopped exerting pressure, making the pertinent record.[31]

Three measurements were made at each point, leaving a period of 10 sec between each of them and 20 sec at switching point.[32] The average value of the three measurements (measured in kg) at each point was calculated.[33] The algometer range of values goes from 0 to 10 kg.

Secondary outcomes

Trunk flexion.   Trunk flexion movement was measured. The selection of this variable to assess back mobility is based on the systematic review by Steiger et al.[34] It can be seen that many of the studies on low back pain in which pain and disability related to mobility are studied, the variable that is usually analyzed is mobility in the sagittal plane, circumscribed exclusively to the flexion movement in a large number of them. This also occurs in other studies comparing different techniques of conservative treatment applied to nonspecific low back pain.[35] A double digital inclinometer,[36] Baseline model, validated by the company Fabrication Enterprises Incorporated, (New York), recommended by the American Medical Association Guide,[37] was used. It has been shown to have good inter- and intraexaminer reliability in evaluating column mobility.[36,38]

For measurement purposes, the procedure described by Prushansky et al.[39] was used, applying one inclinometer in

FIG. 1.   First phase of the abdominal manual intervention.

the spinous process of the 12th thoracic level and another in the first sacral level.

The evaluator did not see the display until the end of the measurement and then recorded the obtained value (measured in grades). Three measurements were made, taking the maximum value of the three as a reference,[40] allowing 30 sec between each of the assessments.[41]

Hip flexibility.   The sit and reach test was used with centimetric drawer rating (Baseline® Sit-and-reach Trunk Flexibility Box). This test has been shown to be reliable in women ($r = 0.61$ to 0.66) and has an intraclass correlation coefficient from 0.94 to 0.97, also being a comfortable and reproducible test.[42]

It is necessary that the patient holds the position for 2 sec before taking the measurement (in cm). Three measurements were made, taking the mean as the reference value.

Posture.   Photogrammetry was applied, using software para avaliaçao postural (SAPO) postural assessment software (v.0.68), whose use in clinical trials has been endorsed.[43]

The photographs were taken according to the recommendations of the SAPO software. The standardized procedure described by different authors to obtain different angular measurements in the (anterior) frontal plane and the (left) sagittal plane was followed.[43,44]

Adverse effects.   Subjects were interviewed at the end of the encounter to gather any instances of pain and other adverse reactions elicited by the interventions. These were recorded qualitatively.

Intervention in the EG

The patient was placed in Trendelenburg' supine position (30°) with a wedge under the knees.

The therapist was placed at the height of the patient's chest on the right or left side depending on the treatment area.

Abdominal mobilization maneuvers were applied in three phases. In the first, the therapist placed the ulnar borders of both hands on the lower abdominal region, asking the patient to undertake deep diaphragmatic breaths, in order that he pulls the visceral mass toward the head in the inspiratory phase (Fig. 1). In the second and third phases, the therapist took contact with both hands, respectively, in the patient's

FIG. 2. Second and third phase of the abdominal manual intervention[†].

FIG. 3. Manual intervention in the control group (placebo).

right and left iliac fossa and followed the procedure described above, pulling on the visceral mass to the left shoulder of the patient in the first case (second phase) and to the right shoulder in the second (third phase) (Fig. 2). Ten repetitions of each of these three phases were performed.

Intervention in the CG (placebo)

The therapist placed himself at the height of the patient's chest placing the whole hand in full contact on the epigastrium while accompanying the breathing of the patient. The pressure exerted during the execution of the maneuver was minimal to avoid any kind of therapeutic effect, although sufficient for the subjects to be convinced that it was a real procedure (Fig. 3). This is an intervention on the same principles as others previously used.[21]

Data analysis

The data were analyzed and processed by the statistical analysis program Statistical package for the social sciences 19.0 (SPSS, Inc. IBM Company, 2010).

A descriptive and exploratory analysis of the variables of interest was performed. The case of distribution normality with the Kolmogorov–Smirnov test was rated. An initial comparability of the baseline (preintervention) values between the two study groups was conducted, showing that they start from a comparable baseline situation. Then an intergroup comparison of the difference between the pre- and postintervention values (post minus pre) obtained in each group was performed. This intergroup comparison of the evolutions of the groups implies that the parameter on the final state in the groups is included. Regarding those variables that showed a non-normal distribution, the nonparametric U-Mann–Whitney test was applied. The effect size was estimated with Cohen's d.[45]

The statistical analysis was conducted, considering statistically significant p value <0.05, and in all statistical tests a confidence interval of 95% was applied. All the analyses were carried out from an intention to treat approach.

[†]This image corresponds to the second phase of the abdominal maneuver. The third phase would be executed identically to the second but beginning in the left iliac fossa and pulling the visceral mass to the right shoulder of the patient.

Ethical considerations and data protection

The study was conducted in accordance with the ethical standards of the Declaration of Helsinki,[46] and the confidentiality of patient data was respected.[47] The study was designed in accordance and received approval of the institutional ethics committee. All patients were informed in writing with regard to the objectives and procedures of the study and agreed to participate by signing a statement of informed consent.

Results

One hundred three patients were evaluated for their participation in the study, and sixty-two ($n = 62$) met the selection criteria and voluntarily signed informed consent. Patients were randomized into two groups as follows: EG and CG, each one of them with 31 patients. No loss to follow-up was recorded during the data collection or analysis phases. Flow diagram of patients in both groups through the trial is shown in Figure 4.

The total mean age was 37.2 years (SD = 9.48). It was 37.13 years (SD = 10.56) in the CG and 37.35 years (SD = 8.45) in the EG. The main characteristics of the patients are described in Table 1. Regarding the Bristol scale, no statistically significant differences between the experimental and CGs were found ($p = 0.799$).

No differences between groups at baseline in any of the collected variables were found, except for the vertical alignment of the body posturography parameter. Most of the variables followed a non-normal distribution.

Statistically significant differences in the comparison of the intragroup means in the EG in relation to the PPT variables in vertebral levels T10 ($p < 0.05$) and T11 and T12 ($p < 0.001$ in both cases) were found. Significant differences in the comparison of some of the secondary variables used in the study, specifically in the trunk flexion ROM values, as well as in the hip flexibility measurement (sit and reach test), were also found ($p < 0.001$). No difference was found in any of the analyzed variables in relation to CG or in the rest of the variables in the EG.

In relation to the intergroup comparison between the post- and preintervention difference (Table 2), only statistically significant differences were found in the PPT values at the vertebral levels T11 ($p < 0.05$) and T12 ($p < 0.05$) with
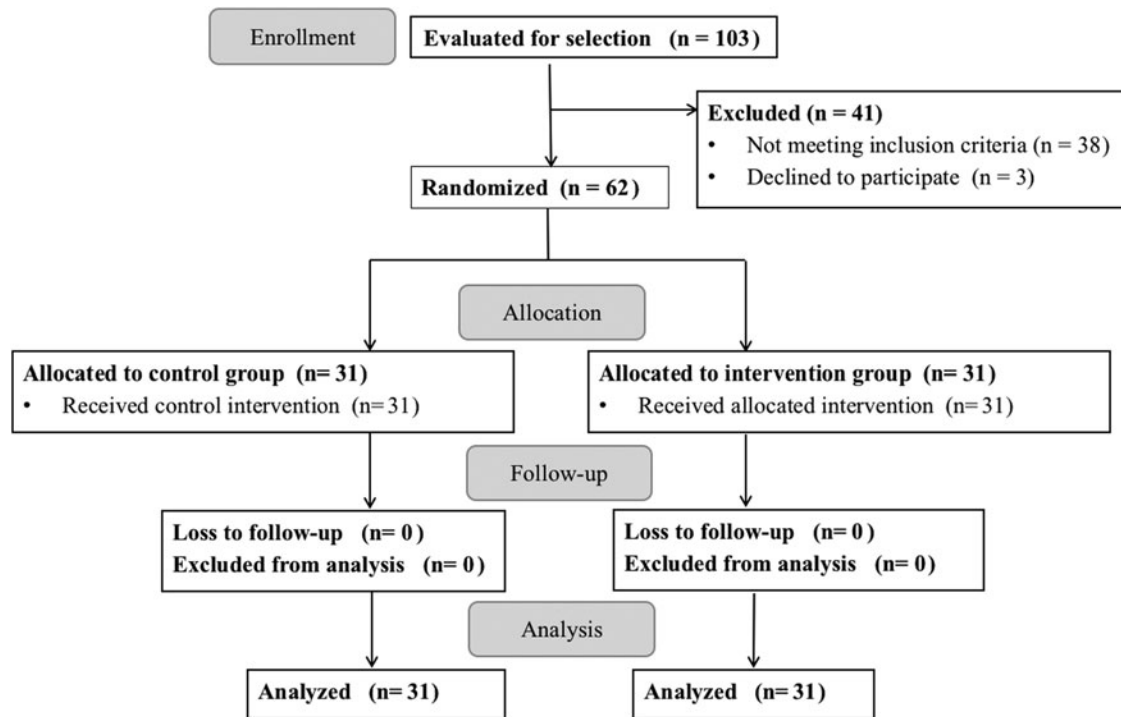
FIG. 4. Flowchart according to the CONSORT Statement for the Randomized Trial Report.

a d-Cohen close to 0.80 (large effect size). The authors also found significant differences in the trunk flexion ROM, with values of $p = 0.001$ in inclinometry T12-L1 (d-Cohen = 0.88, large effect size) and $p = 0.023$ in inclinometry L5-S1 (d-Cohen = 0.59, moderate effect size). There were no reports of the appearance of adverse events, with acceptable tolerance to pain during the study intervention in either group.

Discussion

The main aim of this study was to evaluate the effect of osteopathic AMI on PPT at different locations in subjects with CC. In addition, effects on trunk flexion mobility, hip flexibility, posture, and adverse effects to the intervention were also analyzed.

The results show that the application of this osteopathic AMI compared with a placebo in women with functional CC produces immediate changes in the PPT in the vertebral levels related to orthosympathetic nerve supply of the intestine, and it also seems that it is well tolerated by the patients. This kind of intervention also increases thoracolumbar and lumbosacral flexion; however, it has no effect on the analyzed variables related to posture.

Different studies have evidenced that AMI in patients with constipation improves their bowel function, helping to reduce the incidence of symptoms (discomfort and abdominal pain).[48,49] Some authors have suggested that this kind of intervention may help prevent the development of a range of disorders and/or symptoms associated with constipation, such as headaches and fatigue, feelings of bloatedness, and others.[50] Their results propose that those related to mobility and sensitivity to pain, such as back pain, could be included in this list. Moreover, these results clarify how the perception of pain is experienced during the intervention.

These results could be of great interest in women with CC because osteopathic AMI could prevent the frequent occurrence of low back pain associated with gastrointestinal disorders, decreasing both PPT in the aforementioned vertebral levels and improving lumbar and hip motion. There is a relationship between the presence of gastrointestinal symptoms, including those derived from the presence of CC, and back pain, in that the presence of one of them has been shown to be associated with the development of the other,[10] making it possible to hypothesize that improvement of PPT would also contribute to a decrease in gastrointestinal symptoms, such as abdominal pain. It has also been shown that the prevalence of anterior trunk pain (including that of abdominal origin due to gastrointestinal disorders such as constipation) in chronic low back pain is higher than in the general population. Statistically significant differences in pain intensity and degree of disability have been found between patients with low back pain and anterior trunk pain compared with those who did not have the latter symptom.[9]

There exist several possible mechanisms to explain the coexistence of gastrointestinal symptoms and back pain, although the authors may generically distinguish between neurophysiologic and mechanical factors. Among the first, could be mentioned the dynamic changes in cortical processing of visceral pain.[51] Among mechanical factors, increased spinal loading when straining during defecation should be included.[52] Nevertheless, changes in morphometry or activation of transversus abdominis following conservative treatments have shown no conclusive association with improvements in clinical outcomes related to back pain.[53]

There is a growing body of research, which may be drawn upon to help understand the mechanisms by which AMI exerts its effects.[54–56] However, there is a paucity of research investigating the possible effects of viscerosensory

TABLE 1. BASELINE CHARACTERISTICS OF THE EXPERIMENTAL AND CONTROL GROUP

Variable	Experimental (n=31) Median (IQR)	Control (n=31) Median (IQR)	p[a]
Age	36 (16)	32 (22)	**0.816**
Height (m)	1.63 (0.1)	1.63 (0.1)	0.877
Weight (kg)	65 (18)	60 (12.5)	0.320
Weekly physical activity (h)	2 (2.5)	2 (2)	0.606
Primary outcome			
Algometry C7 (kg)	3.2 (1.8)	3.1 (2.2)	**0.778**
Algometry T3 (kg)	3.8 (2.5)	3.9 (2.6)	**0.877**
Algometry T10 (kg)	4.3 (2.1)	4.8 (3.9)	0.989
Algometry T11 (kg)	4.2 (2.5)	4.7 (3.5)	**0.972**
Algometry T12 (kg)	4.7 (2.7)	4.6 (2.6)	0.899
Right ulnar nerve algometry (kg)	2.3 (0.8)	2.2 (0.9)	**0.773**
Left ulnar nerve algometry (kg)	2.3 (0.9)	2.2 (0.6)	**0.451**
Right patellar tendon algometry (kg)	4.9 (4.4)	4.4 (3.8)	**0.464**
Left patellar tendon algometry (kg)	4.2 (4.0)	4.4 (4.0)	**0.933**
Right tibial anterior muscle algometry (kg)	4.0 (3.9)	4.0 (3.5)	**0.741**
Left tibial anterior muscle algometry (kg)	3.8 (4.0)	3.7 (3.4)	**0.789**
Secondary outcomes			
Inclinometry T12-L1 (grades)	108 (16)	114 (20)	0.176
Inclinometry L5-S1 (grades)	58 (20)	58 (20)	0.849
Sit and reach (cm)	29 (8.5)	27.8 (12.5)	0.994
HAA[b] (grades)	11.7 (15.3)	6.3 (15.6)	0.349
VAHA[c] (grades)	1.5 (1.8)	1.6 (1.2)	**0.949**
AASIS[d] (grades)	2.6 (17.3)	8.1 (24.8)	0.607
HAASIS[e] (grades)	12.5 (22.8)	15.3 (23.8)	0.784
VTA[f] (grades)	−0.7 (0.5)	−0.7 (0.8)	**0.888**
HTLL[g] (grades)	−1.9 (1.2)	−2.8 (1.4)	**0.096**
VAB[h] (grades)	0.2 (0.2)	0.3 (0.4)	<0.05*
HAP[i] (grades)	−21.5 (47.6)	−19.6 (42.5)	0.699

[a]p-Values belonging to variables with non-normal distribution (based on Kolmogorov–Smirnov test results) have been included in bold.
[b]HAA (horizontal alignment of the acromions). This is measured from the line that joins both acromions with respect to a horizontal line.
[c]VAHA (vertical alignment of the head with the acromion). This is measured from the line that joins the tragus of the ear with the acromion with respect to a vertical line.
[d]AASIS (angle between the two acromions and the two anterior superior iliac spines). This is measured from the angle created between the two acromions and a horizontal line and between the two anterior superior iliac spines (ASIS) and a horizontal line.
[e]HAASIS (horizontal alignment of the anterior superior iliac spines). The intersection between the line created between both ASIS and a horizontal line is measured.
[f]VTA (vertical trunk alignment). This is measured from the line that joins acromion and greater trochanter with respect to a vertical line.
[g]HTLL (hip angle–trunk and lower limb). This is measured from the angle created between acromion, greater trochanter, and peroneal malleolus.
[h]VAB (vertical alignment of the body). This is measured from the line that joins acromion and peroneal malleolus with respect to a vertical line.
[i]HAP (horizontal alignment of the pelvis). This is measured from the line that joins the ASIS and the posterior superior iliac spine (PSIS) with respect to a horizontal line.
* indicates statistically significant difference.
IQR, interquartile range.

stimuli on somatic tissues, which means that they are still quite unknown, particularly in relation to hyperalgesia. To their knowledge, there is only one study that has analyzed the effect on the somatic level of implementation of an AMI (in particular, a sigmoid colon manipulation technique) and only in asymptomatic subjects.[57]

In the present study, the authors have observed statistically and clinically significant (based upon the d-Cohen results) increases in the PPT centered in the vertebral levels whose metameres are involved in vascular control of the lower limbs and in the autonomic control of abdominal organs such as the intestine. The authors might think that the AMI exerts a normalizing stimulus through identical neurophysiologic pathways that are put into play during the application of spinal manipulation at a low thoracic and/or lumbar level (viscerosomatic convergence).[58] This hypothesis is strengthened by the fact that, as was the case in the study of McSweeney et al.,[57] no change in measurements of the PPT was observed in other anatomical location at the vertebral level nor at the level of other peripheral tissues. One of the clinical manifestations of visceral dysfunction in the large intestine is the presence of taut bands in the paravertebral lumbar muscles.[59] It is possible that as a result of the applied treatment, there has been a decrease in its tone, which may explain the significant increase recorded in inclinometry, as well as in the closely significant values of the sit and reach test in the EG values compared with the CG.

To their knowledge there are no studies that have assessed the effect of this kind of intervention on posture. Significant differences between the two groups have not been observed in their study, suggesting that the technique does not generate postural changes.

TABLE 2. DIFFERENCES BETWEEN PRE- AND POSTINTERVENTION VALUES IN EACH STUDY GROUP, MEAN INTERGROUP DIFFERENCES WITH 95% CONFIDENCE INTERVAL, ANALYSIS OF THE EXISTENCE OF DIFFERENCES BETWEEN THEM AND EFFECT SIZE VALUES, STANDARDIZED BY COHEN'S d TEST (STATISTICALLY SIGNIFICANT p-VALUES)

Variable	Experimental (n=31) Mean (SD)	Control (n=31) Mean (SD)	Mean difference between pre and postvalues (CI 95%)	p^a	Cohen's d^b
Primary outcome					
Cervical spinous algometry 7 (kg)	0.068 (0.945)	0.052 (0.89)	−0.016 (−0.482 to 0.45)	**0.945**	
Thoracic spinous algometry 3 (kg)	0.368 (1.058)	0.031 (1.04)	−0.337 (−0.87 to 0.196)	**0.211**	
Thoracic spinous algometry 10 (kg)	0.691 (1.093)	0.236 (1.163)	−0.454 (−1.028 to 0.119)	0.120	
Thoracic spinous algometry 11 (kg)	0.995 (0.894)	0.201 (1.069)	−0.794 (−1.294 to −0.293)	<0.05*	0.80
Thoracic spinous algometry 12 (kg)	1.342 (1.449)	0.443 (0.992)	−0.899 (−1.53 to −0.268)	<0.001*	0.72
Right ulnar nerve algometry (kg)	0.056 (0.405)	0.003 (0.390)	−0.053 (−0.255 to 0.148)	**0.600**	
Left ulnar nerve algometry (kg)	−0.034 (0.549)	0.061 (0.575)	0.096 (−0.189 to 0.382)	**0.502**	
Right patellar tendon algometry (kg)	0.206 (1.08)	0.566 (1.071)	0.360 (−0.187 to 0.907)	**0.193**	
Left patellar tendon algometry (kg)	0.313 (1.135)	0.474 (0.801)	0.160 (−0.339 to 0.659)	**0.523**	
Right tibialis anterior muscle algometry (kg)	0.167 (1.002)	−0.041 (0.997)	−0.209 (−0.717 to 0.298)	**0.413**	
Left tibialis anterior muscle algometry (kg)	0.170 (0.775)	−0.061 (0.836)	−0.230 (−0.640 to 0.178)	**0.264**	
Secondary outcomes					
Inclinometry T12-L1 (grades)	8.71 (5.229)	4.613 (3.904)	−4.097 (−6.441 to −1.752)	**<0.001***	0.88
Inclinometry L5-S1 (grades)	6.355 (6.14)	2.871 (5.560)	−3.484 (−6.46 to −0.508)	**<0.05***	0.59
Sit and reach (cm)	2.328 (1.524)	1.791 (1.862)	−0.537 (−1.402 to 0.327)	0.067	
HAA (grades)	−1.226 (4.446)	−0.945 (5.234)	0.28 (−2.187 to 2.748)	**0.821**	
VAHA (grades)	−0.337 (1.1)	−0.247 (0.808)	0.09 (−0.409 to 0.59)	0.593	
AASIS (grades)	−0.268 (4.807)	1.187 (9.391)	1.455 (−2.335 to 5.245)	0.910	
HAASIS (grades)	−1.458 (5.695)	−0.645 (6.22)	0.813 (−2.217 to 3.842)	**0.866**	
VTA (grades)	−0.037 (0.342)	0.048 (0.271)	0.085 (−0.711 to 0.242)	**0.279**	
HTLL (grades)	0 (0.633)	0.271 (0.746)	0.271 (−0.08 to 0.623)	0.199	
VAB (grades)	−0.019 (0.276)	0.05 (0.219)	0.069 (−0.057 to 0.196)	0.684	
HAP (grades)	−1.013 (5.637)	−0.523 (6.363)	0.490 (−2.564 to 3.544)	0.349	

[a]Indicated in bold are those values that have been obtained by parametric Student's t test for independent samples (presenting a normal distribution). The rest of the significant values have been obtained by the U-Mann–Whitney nonparametric test.

[b]Only results of standardized effect size have been shown (Cohen's d) in those differences between values that have been shown to be statistically negative; considering that values around 0.20 are considered small scale effect; around 0.50 moderate; and 0.80 either superior or large (Cohen, 1988).

* indicates statistically significant difference.

AASIS, angle between the two acromions and the two anterior superior iliac spines; CI, confidence interval; HAA, horizontal alignment of the acromions; HAASIS, horizontal alignment of the anterior superior iliac spines; HAP, horizontal alignment of the pelvis; HTLL, hip angle–trunk and lower limb; SD, standard deviation; VAB, vertical alignment of the body; VAHA, vertical alignment of the head with the acromion; VTA, vertical trunk alignment.

In any case, these results must be confirmed in longitudinal studies on patients with specific characteristics (e.g., patients in long-term care settings and so on) and with different conditions (e.g., cancer, stroke, and so on).[60]

Limitations of the Study

There have been only immediate changes in outcome variables, which mean that it would be interesting for further studies to include a wider time frame to identify any lasting effects.

Conclusions

The application of the AMI in women with functional constipation is well tolerated in patients, and it increases pain thresholds in the lower thoracic spine, as well as lumbar ROM.

The application thereof in patients with functional constipation does not generate statistically significant postural changes.

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Authors' Contributions

A.O.P.V., F.R., and R.S.S.R. designed the study. A.O.P.V., R.S.S.R., J.C.F.D., and J.M.M.A. conducted the literature research. R.S.S.R., J.G.I., and F.R. were responsible for data acquisition. A.O.P.V., J.C.F.D., and J.G.I. were involved in data analysis. A.O.P.V., R.S.S.R., and J.C.F.D. were involved in writing the article. All authors were responsible for drafting the article and have read and approved the final version.

Author Disclosure Statement

No competing financial interests exist.

References

1. Chang JY, Locke GR, III, McNally MA, et al. Impact of functional gastrointestinal disorders on survival in the community. Am J Gastroenterol 2010;105:822–832.
2. Longstreth GF, Thompson WG, Chey WD, et al. Functional bowel disorders. Gastroenterology 2006;130:1480–1491.
3. Schmidt FM, Santos VL. Prevalence of constipation in the general adult population: An integrative review. J Wound Ostomy Continence Nurs 2014;41:70–76.
4. Nellesen D, Yee K, Chawla A, et al. A systematic review of the economic and humanistic burden of illness in irritable bowel syndrome and chronic constipation. J Manag Care Pharm 2013;19:755–764.
5. Tack J, Müller-Lissner S, Stanghellini V, et al. Diagnosis and treatment of chronic constipation—A European perspective. Neurogastroenterol Motil 2011;23:697–710.
6. Sánchez MI, Bercik P. Epidemiology and burden of chronic constipation. Can J Gastroenterol 2011;25 Suppl B:11B–15B.
7. Salmoirago-Blotcher E, Crawford S, Jackson E, et al. Constipation and risk of cardiovascular disease among postmenopausal women. Am J Med 2011;124:714–723.
8. Bassotti G, Villanacci V, Crețoiu D, et al. Cellular and molecular basis of chronic constipation: Taking the functional/idiopathic label out. World J Gastroenterol 2013;19: 4099–4105.
9. Panagopoulos J, Hancock MJ, Kongsted A, et al. Does anterior trunk pain predict a different course of recovery in chronic low back pain? Pain 2014;155:977–982.
10. Smith MD, Russell A, Hodges PW. The relationship between incontinence, breathing disorders, gastrointestinal symptoms, and back pain in women: A longitudinal cohort study. Clin J Pain 2014;30:162–167.
11. Lim SF, Childs C. A systematic review of the effectiveness of bowel management strategies for constipation in adults with stroke. Int J Nurs Stud 2013;50:1004–1010.
12. McClurg D, Lowe-Strong A. Does abdominal massage relieve constipation? Nurs Times 2011;107:20–22.
13. Oliva Pascual-Vaca Á, Punzano-Rodríguez R, Escribá-Astaburuaga P, et al. Short-term changes in algometry, inclinometry, stabilometry, and urinary pH analysis after a thoracolumbar junction manipulation in patients with kidney stones. J Altern Complement Med 2017;23:639–647.
14. Molins-Cubero S, Rodríguez-Blanco C, Oliva-Pascual-Vaca A, et al. Changes in pain perception after pelvis manipulation in women with primary dysmenorrhea: A randomized controlled trial. Pain Med 2014;15:1455–1463.
15. da Silva RC, de Sá CC, Pascual-Vaca ÁO, et al. Increase of lower esophageal sphincter pressure after osteopathic intervention on the diaphragm in patients with gastroesophageal reflux. Dis Esophagus 2013;26:451–456.
16. Coggrave M, Norton C. Management of faecal incontinence and constipation in adults with central neurological diseases. Cochrane Database Syst Rev 2014:CD002115.
17. McClurg D, Hagen S, Jamieson K, et al. Abdominal massage for the alleviation of symptoms of constipation in people with Parkinson's: A randomised controlled pilot study. Age Ageing 2016;45:299–303.
18. Robertson J, Baines S, Emerson E, et al. Constipation management in people with intellectual disability: A systematic review. J Appl Res Intellect Disabil 2017 [Epub ahead of print]; DOI: 10.1111/jar.12426.
19. Kahraman BB, Ozdemir L. The impact of abdominal massage administered to intubated and enterally fed patients on the development of ventilator-associated pneumonia: A randomized controlled study. Int J Nurs Stud 2015;52:519–524.
20. Uysal N, Eșer İ, Akpinar H. The effect of abdominal massage on gastric residual volume: A randomized controlled trial. Gastroenterol Nurs 2012;35:117–123.
21. Attali TV, Bouchoucha M, Benamouzig R. Treatment of refractory irritable bowel syndrome with visceral osteopathy: Short-term and long-term results of a randomized trial. J Dig Dis 2013;14:654–661.
22. Lämas K, Graneheim UH, Jacobsson C. Experiences of abdominal massage for constipation. J Clin Nurs 2012;21: 757–765.
23. Parés D, Comas M, Dorcaratto D, et al. Adaptation and validation of the Bristol scale stool form translated into the Spanish language among health professionals and patients. Rev Esp Enferm Dig 2009;101:312–316.
24. Chess LE, Gagnier J. Risk of bias of randomized controlled trials published in orthopaedic journals. BMC Med Res Methodol 2013;13:76.
25. Ensink FB, Saur PM, Frese K, et al. Lumbar range of motion: Influence of time of day and individual factors on measurements. Spine 1996;21:1339–1343.
26. Dukas L, Willett WC, Giovannucci EL. Association between physical activity, fiber intake, and other lifestyle variables and constipation in a study of women. Am J Gastroenterol 2003;98:1790–1796.

27. Potter L, McCarthy C, Oldham J. Algometer reliability in measuring pain pressure threshold over normal spinal muscles to allow quantification of anti-nociceptive treatment effects. Int J Osteopath Med 2006;9:113–119.

28. Fernández-Pérez AM, Villaverde-Gutiérrez C, Mora-Sánchez A, et al. Muscle trigger points, pressure pain threshold, and cervical range of motion in patients with high level of disability related to acute whiplash injury. J Orthop Sports Phys Ther 2012;42:634–641.

29. Fernández-de-las-Peñas C, de la Llave-Rincón AI, Fernández-Carnero J, et al. Bilateral widespread mechanical pain sensitivity in carpal tunnel syndrome: Evidence of central processing in unilateral neuropathy. Brain 2009;132(Pt 6):1472–1479.

30. Chesterson LS, Sim J, Wright CC, et al. Inter-rater reliability of algometry in measuring pressure pain thresholds in healthy humans, using multiple raters. Clin J Pain 2007;23:760–766.

31. Goulet JP, Clark GT, Flack VF, et al. The reproducibility of muscle and joint tenderness detection methods and maximum mandibular movement measurement for the temporomandibular system. J Orofac Pain 1998;12:17–26.

32. Frank L, McLaughlin P, Vaughan B. The repeatability of pressure algometry in asymptomatic individuals over consecutive days. Int J Osteopath Med 2013;16:143–152.

33. Marchuk C, Legal L. Repercusión de la maniobra lift de vejiga sobre el punto gatillo miofascial del músculo tibial anterior y de la apófisis espinosa de lumbar 5 [Repercussions of the urinary bladder lift manipulation on the myofascial trigger point of the tibialis anterior muscle and fifth lumbar spinous process]. Osteopat Científica 2010;5:56–63.

34. Steiger F, Wirth B, de Bruin ED, Mannion AF. Is a positive clinical outcome after exercise therapy for chronic nonspecific low back pain contingent upon a corresponding improvement in the targeted aspect(s) of performance? A systematic review. Eur Spine J 2012;21:575–598.

35. Garcia AN, Costa Lda C, da Silva TM, et al. Effectiveness of back school versus McKenzie exercises in patients with chronic nonspecific low back pain: A randomized controlled trial. Phys Ther 2013;93:729–747.

36. Kolber MJ, Pizzini M, Robinson A, et al. The reliability and concurrent validity of measurements used to quantify lumbar spine mobility: An analysis of Iphone® application and gravity based inclinometry. Int J Sports Phys Ther 2013;8:129–137.

37. American Medical Association. Guides to the Evaluation of Permanent Impairment, 5th ed. Chicago, IL: American Medical Association, 2001.

38. Kachingwe AF, Phillips BJ. Inter- and intrarater reliability of a back range of motion instrument. Arch Phys Med Rehabil 2005;86:2347–2353.

39. Prushansky T, Ezra N, Kurse N, et al. Reproducibility of sagittal pelvic tilt measurements in normal subjects using digital inclinometry. Gait Posture 2008;28:513–516.

40. Luomajoki H, Kool J, De Bruin ED, et al. Reliability of movement control tests in the lumbar spine. BMC Musculoskelet Disord 2007;8:1–11.

41. Macintyre NJ, Bennett L, Bonnyman AM, et al. Optimizing reliability of digital inclinometer and flexicurve ruler measures of spine curvatures in postmenopausal women with osteoporosis of the spine: An illustration of the use of generalizability theory. ISRN Reumatol 2011;2011:571698.

42. Hui SS, Yuen PY. Validity of the modified back-saver sit-and-reach test: A comparison with other protocols. Med Sci Sports Exerc 2000;32:1655–1659.

43. Souza JA, Pasinato F, Basso D, et al. Biofotogrametria confiabilidade das medidas do protocolo do software para avaliação postural (SAPO) [Biophotogrammetry: reliability of measurements obtained with a posture assessment software (SAPO)]. Rev Bras Cineantropom e Desempenho Hum 2011;13:299–305.

44. Figueiredo RV, Amaral AC, Shimano AC. Photogrammetry on the identification of postural asymmetries in cadets and pilots of the Brazilian air force academy. Rev Bras Fisioter 2012;16:54–60.

45. Cohen J. Statistical Power Analysis for the Behavioral Sciences, 2nd ed. New York: Academic Press, 1988.

46. Krleza-Jeric K, Lemmens T. 7th revision of the Declaration of Helsinki: Good news for the transparency of clinical trials. Croat Med J 2009;50:105–110.

47. Organic Law 15/1999, December 13, Personal Data Protection: B.O.E. number 298;1999.

48. McClurg D, Hagen S, Hawkins S, et al. Abdominal massage for the alleviation of constipation symptoms in people with multiple sclerosis: A randomized controlled feasibility study. Mult Scler 2011;17:223–233.

49. Sinclair M. The use of abdominal massage to treat chronic constipation. J Bodyw Mov Ther 2011;15:436–445.

50. Lämas K, Lindholm L, Stenlund H, et al. Effects of abdominal massage in management of constipation—A randomized controlled trial. Int J Nurs Stud 2009;46:759–767.

51. Brock C, Olesen SS, Valeriani M, et al. Brain activity in rectosigmoid pain: Unravelling conditioning pain modulatory pathways. Clin Neurophysiol 2012;123:829–837.

52. Coenen P, Kingma I, Boot CR, et al. Cumulative low back load at work as a risk factor of low back pain: A prospective cohort study. J Occup Rehabil 2013;23:11–18.

53. Wong AY, Parent EC, Funabashi M, et al. Do changes in transversus abdominis and lumbar multifidus during conservative treatment explain changes in clinical outcomes related to nonspecific low back pain? A systematic review. J Pain 2014;15:377.e1–e35.

54. Brumovsky P, Gebhart GF. Visceral organ crosssensitization—An integrated perspective. Auton Neurosci 2010;153:106–115.

55. Giamberardino MA, Affaitati G, Costantini R. Visceral referred pain. J Musculoskelet Pain 2010;18:403–410.

56. Giamberardino MA, Costantini R, Affaitati G, et al. Viscero-visceral hyperalgesia: Characterization in different clinical models. Pain 2010;151:307–322.

57. McSweeney TP, Thomson OP, Johnston R. The immediate effects of sigmoid colon manipulation on pressure pain thresholds in the lumbar spine. J Bodyw Mov Ther 2012;16:416–423.

58. Bolton PS, Budgell B. Visceral responses to spinal manipulation. J Electromyogr Kinesiol 2012;22:777–784.

59. Gerwin R. Myofascial and visceral pain syndromes: Visceral-somatic pain representations. J Musculoskelet Pain 2002;10:165–175.

60. Lämas K, Lindholm L, Engström B, et al. Abdominal massage for people with constipation: A cost utility analysis. J Adv Nurs 2010;66:1719–1729.

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