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Title:

Changes in Pain Perception after Pelvis Manipulation in Women with Primary Dysmenorrhea: A Randomized Controlled Trial

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Abstract

Objective. This study aims to evaluate the immediate effect of a global pelvic manipulation (GPM) technique, bilaterally applied, on low back pelvic pain in women with primary dysmenorrhea (PD).

Design. A prospective, randomized, double-blind, controlled trial.

Setting. Faculty of Nursing, Physiotherapy and Podiatry. University of Sevilla, Spain.

Methods. The sample group included 40 women (30 ± 6.10 years) that were divided into an experimental group (EG) (N = 20) who underwent a bilateral GPM technique and a control group (CG) (N = 20) who underwent a sham (placebo) intervention. Evaluations were made of self-reported low back pelvic pain (visual analog scale), pressure pain threshold (PPT) in sacroiliac joints (SIJs), and the endogenous response of the organism to pain following catecholamines and serotonin release in blood levels.

Results. The intragroup comparison showed a significant improvement in the EG in the self-perceived low back pelvic pain (P = 0.003) and in the mechanosensitivity in both SIJs (P = 0.001). In the between group comparison, there was a decrease in pain perception (P = 0.004; F(1,38) = 9.62; R2 = 0.20) and an increase in the PPT of both SIJs, in the right side (P = 0.001; F(1,38) = 21.29; R2 = 0.35) and in the left side (P = 0.001; F(1,38) = 20.63;R2 = 0.35). There were no intergroup differences for catecholamines plasma levels (adrenaline P = 0.123; noradrenaline P = 0.281; dopamine P = 0.173), but there were for serotonin levels (P = 0.045; F(1,38) = 4.296; R2 = 0.10).

Conclusion. The bilateral GPM technique improves in a short term the self-perceived low back pelvic pain, the PPT in both SIJs, and the serotonin levels in women with PD.

It shows no significant differences with a sham intervention in catecholamines plasma levels.

Key Words. Primary Dysmenorrhea; Manipulation Spinal; Pelvic Pain; Pain Threshold; Serotonin; Catecholamines.

Introduction

Primary dysmenorrhea (PD) is a common gynecological disorder in women of childbearing age [1,2]. PD is defined by several symptoms that precede menstruation, in the absence of any organic pathology, and lasting around 48–72 hours [2]. The most common symptom is pain in the lower abdomen that radiates to both thighs or to the lumbar-sacral region. Pain is usually accompanied by less frequent signs and symptoms, such as tiredness, headache, nausea, constipation, and diarrhea [3,4]. The prevalence of PD varies between 45% and 95% of women of childbearing age [4,5]. It is a common cause of absenteeism from work or school, thus interfering with daily life and with many social costs arising from this [5].

There have been many proposals for interventions for PD in the scientific literature. As pelvic pain seems to be mediated by prostaglandin factor 2Å~ [6], the most common therapeutic approach has been medical treatment that usually involves the administration of nonsteroidal anti-inflammatory drugs (NSAIDs) or oral contraceptives [7]. On one hand, NSAIDs are peripheral inhibitors of prostaglandin synthesis [8]. On the other hand, oral contraceptives inhibit ovulation and, consequently, the endometrium reduces in thickness thereby diminishing prostaglandin synthesis [7].

The efficiency of these treatments varies between 17% and 95% [4]. However, pharmacological treatment may involve some adverse side effects, like gastrointestinal bleeding, which increases their intolerance for some patients [4,9]. Hence, it is common for women to demand new and alternative therapeutic tools with less perceived associated risks [10].

Previous research has analyzed the effects on pelvic pain perception arising from PD through alternative therapies such as: 1) continuous low-level topical heat at hypogastric level [11]; 2) acupuncture [12–14]; 3) transcutaneous electrical nerve stimulation (TENS) and interferential current [15]; 4) homeopathy [16]; 5) Chinese herbal medicine [17]; 6) acupressure [18,19]; and even 7) low fat diets [20,21]. Many of these therapies have proven to have a positive impact on pain. However, these results are not conclusive enough to recommend their use routinely, due to poor methodological designs in some cases [10,22].

Several studies have evaluated the efficacy of spinal manipulative techniques on women with PD [23–26]. Spinal manipulation (SM) has proven to have some influence on pain perception and menstrual cramps, and also on plasma levels of some chemical mediators of pain [26–28]. Even though there are no conclusive observations to prove a positive effect of SM on pain associated with PD, there is a lack of agreement on which spinal region needs to be manipulated and on the techniques that may be most effective. Hence, there is some need to develop new studies in this field [29]. Holtzman et al. [25]. proposed that SM should be directed to specific restrictions in the lumbar-sacral spine (L5-S1) to alleviate pain associated with PD.

Hypothesis

The global pelvic manipulation (GPM) technique, bilaterally applied in women suffering from PD, improves pain perception on low back pelvic region and has a positive impact on the endogenous response of the organism to pain (catecholamines and serotonin release in blood levels).

Objective

Based on the neurophysiologic effects of SM techniques [30], the main aim of the study is to assess the immediate effects of a GPM technique in low back pelvic pain perception and in several nociceptive biomarkers in subjects with PD.

Materials and methods

Design and Randomization Procedure

A randomized, by means of a randomized number table designed by an Internet website (http://www.randomized.org), and double-blind controlled clinical trial was conducted. The randomization sequence was guarded by an external consultant who guaranteed its concealment from all participants in the study: subjects, evaluators and therapist in charge of the interventions.

Participants

One hundred (N = 100) participants who had a history of low back pain and medical diagnosis of PD by a gynecologist, excluding any other gynecological pathology, were recruited for the study. The clinical records were selected from the main researcher's practice. Sixty women (N = 60) were excluded from the study; 37 (N = 37) did not meet the inclusion/exclusion criteria, 14 women (N = 14) refused participation, and nine (N = 9) of them were excluded for reasons related mainly to fear to blood extraction or home address changes. During the allocation phase, 40 (N = 40) subjects who enrolled the study were distributed into two groups (N = 20). No losses to follow-up were recorded during data collection and analysis phases [31] (Figure 1). Established inclusion criteria were: 1) age between 18 and 50 years old; 2) diagnosis of PD according to the Primary Dysmenorrhea Consensus Guideline [32]; 3) regular

menstrual cycle (28 ± 7 days); 4) menstrual pain of moderate or severe intensity (over 50 mm in the visual analog scale [VAS]); and 5) subjects who gave the informed consent.

Exclusion criteria were the following: 1) to have an intrauterine device; 2) being diagnosed as suffering from secondary dysmenorrhea; 3) previous gynecological interventions; 4) contraindications to the GPM technique; 5) having received previous manipulative treatment within the 2 months before the beginning of the study; and 6) showing any stress or fear of SM.

Sampling Process and Sample Size

The subjects were selected according to nonprobabilistic convenience sampling techniques. The sample size was based on a pilot study [33], using the software "tamaño de la muestra 1.1"® (Hospital Universitario San Ignacio, Bogotá, Colombia). Taking into account a one-tailed hypothesis, the intergroup difference being of 20%, for an α value of 0.05, a variability of 15%, a desired power of 90%, and for an expected average of 25% in the experimental group (EG) and of 5% in the control group (CG), a sample size of 20 subjects per group was necessary. The final sample group consisted of 40 women with PD with a mean age of 30 ± 6.10 years (19–48). They were divided into an EG (N = 20) and a CG (N = 20). The study received approval and was designed conformed to the guidelines of the Institutional Ethical Committee. It has been registered in the Australian and New Zealand Clinical Trials Registry with registration number ACTRN12611001195943.

Blinding

All participants were informed of the general aspects of the study with the informed consent form (possible benefits, risks, precautions and side effects of the assessments,

and the interventions). They were told before randomization that different types of treatments will be compared in the study. Subjects and evaluators who collected or analyzed data remained unaware of the treatment allocation group and the specific aims of the study to guarantee participant and outcome assessor blinding. The therapist in charge of the manipulation (interventor) did not participate in the assessment protocol. Measures were also taken to ensure that the interventor remained unaware of the treatment allocation group (interventor blinding).

Study Protocol

Subjects were contacted by phone. Once it was confirmed that they qualified under the inclusion/exclusion criteria and their willingness to participate, they were referred to the study setting the first day of the menstrual cycle. Then, the subject completed the informed consent paper, which was prepared in accordance with the Declaration of Helsinki (version 2008), and filled the personal and clinical data form. The measurement protocol took place in a room equipped with a treatment table and a steady temperature between 18°C and 21°C. All evaluations were performed in both groups before and after the intervention in the following order.

Assessment of Low Back Pelvic Pain

A VAS was used to measure self-reported pain. VAS is considered to be a validated, effective, accurate, sensitive, easy to use, and reproducible method to assess acute and chronic pain [34]. The subject marked on the VAS the current intensity of low back pelvic pain. The result was expressed in millimeters (mm), ranged from 0 mm to 100 mm.

Assessment of Pressure Pain Threshold (PPT) in Sacroiliac Joints (SIJs)

PPT is defined as the minimum amount of pressure needed to evoke discomfort or pain [35]. A digital dynamometer (PCE, FM model 200, Meschede, Germany) was used to

quantify the PPT. Assessment protocol followed the guidelines described in the pilot study [33]. Measurements were made three consecutive times in each side, with a resting period of 30 seconds between them, taking the mean as the reference value [36].

Blood Extraction

Blood extraction was performed by an experienced nurse. The first blood extraction (preintervention) was made from subject's right arm. Blood was distributed in two different tubes, marked with the subject's folder number. Catecholamines (A1) and serotonin (B1) levels were evaluated. The second blood extraction (postintervention) was made 30 minutes later from subject's left arm also to measure catecholamines (A2) and serotonin (B2) levels. Blood samples (the four tubes) were centrifuged for 10 minutes to separate plasma and serum. A1 and A2 tubes were frozen at −3°C until used, whereas B1 and B2 tubes were refrigerated at 4°C. These tubes were insulating from light with aluminum, because light may influence serotonin levels. Catecholamines and serotonin were analyzed in plasma by high-performance liquid chromatography [37].

Pelvis Manipulation and Dysmenorrhea

Bilateral GPM Technique in the EG The GPM technique was carried out by a therapist with more than 10 years of manual therapy experience. The GPM technique is a semi-direct high-velocity low amplitude (HVLA) thrust procedure that achieves a global opening of the SIJ and of the facet joint of the fifth lumbar vertebra (L5) over the first sacrum vertebrae (S1). The maneuver has been described as follows [38]. The subject is placed in lateral position. The lower limb remains extended and in contact with the treatment table, whereas the lumbar spine must be in neutral position. Then, the therapist adds a slight trunk rotation and the subject places her hands to the side. After that, the therapist flexes the lower-top limb of the patient until perceiving some tension at the second sacral vertebra level. One therapist's hand is placed on the pectoral

region to exert a slight trunk rotation and to control the patient's upper body. The caudal forearm contacts the SIJ and the iliac crest to bring tension to L5 and to the longer and lower arm of the SIJ. Then, the slack reduction is done in three stages: 1) for the lumbar-sacral facet, the therapist's hand increases trunk rotation until perceiving tension in L5; 2) for the SIJ lower arm, the caudal forearm pushes toward the lower arm to form a fold in this side; and 3) for the SIJ longer arm, the forearm pushes the bottom part of the SIJ toward the therapist's trunk. These three reductions are maintained while the therapist adds compression to open the SIJ. The therapist's knee is placed over the subject's flexed knee to achieve the "kick" contact. A thrust is performed increasing all parameters and compressing toward the ground (Figure 2).

Intervention in the CG

For the CG, the sham (placebo) intervention consisted in placing the participant in the same position as previously described but without any tension applied or thrust intention. The therapist placed her hands on the hypogastric region of the subject, just above the pubic symphysis. The subject was kept in the position for 2 minutes (estimated time for the bilateral GPM technique).

Statistical Analysis

The statistical analysis was performed using the PASW Advanced Statistics 18.0 (SPSS Inc., Chicago, IL, USA). The mean, standard deviation, and 95% confidence interval were calculated for each variable. The Kolmogorov–Smirnov test showed a normal distribution of all quantitative variables ($P > 0.05$). Baseline aspects in both groups were compared using the Student's t-test for quantitative variables and chi-square ($\chi 2$) for categorical variables. An analysis of variance for repeated measures was performed using time (pre- and postintervention) as intrasubject variable and group (CG or EG) as intersubject variable. In those variables in which statistically significant between groups

differences were found at baseline measurements, the preintervention value was included as a potential covariable (analysis of covariance) to adjust the effect. The clinical effect was assessed with Cohen's test. The statistical analysis was conducted considering statistically significant P value <0.05.

Results

Table 1 shows the baseline characteristics of the study sample. There were statistically significant differences in the between-group comparison for the self-perceived pain through the VAS (P = 0.003), the PPT of the left SIJ (P = 0.016), and the serotonin levels (P = 0.002). In regard to the score differences after intervention, Table 2 indicates the intragroup comparison results. There was a significant decrease in the self-perceived low back pelvic pain in the EG (P = 0.003). The EG also observed a significant increase in the PPT of the SIJ in both sides (SIJ right side; P = 0.001) (SIJ left side; P = 0.001). On the other hand, the CG showed a decrease in the PPT of the left side (P = 0.044). Concerning the concentration of catecholamines and serotonin in plasma, there were higher levels post-intervention in the EG for adrenaline, serotonin, and dopamine while the noradrenaline concentration levels diminished (Table 2). Table 3 lists the intergroup comparison of differences from postintervention to preintervention values. There were significant changes for pain perception [P = 0.004; F(1,38) = 9.62; R2 = 0.20], PPT in right SIJ [P = 0.001; F(1,38) = 21.29; R2 = 0.35], PPT in left SIJ [P = 0.001; F(1,38) = 20.63; R2 = 0.35] and serotonin plasma level [P = 0.045; F(1,38) = 4.296; R2 = 0.10].

Discussion

The bilateral GPM technique appears to exert a short-term improvement in the low back pelvic pain in women with PD, by means of an increase in the serotonin blood levels, in the PPT of the SIJ, and a decrease of the self-perceived pain.

Hondras et al. [24] performed SM maneuvers in the fixed vertebral levels between the 10th thoracic vertebra and L5, and in the SIJ region in women with PD. Even though women reported a lower lumbar pain and a decrease in the prostaglandin plasma level (measured through plasma concentration of hormone $KDPGF_{2\alpha}$) after SM, there were no differences with the CG. Proctor et al. [29]. concluded, in a systematic review, that there is no enough evidence to support SM in PD, although all therapeutic approaches that involve active movement in the vertebral spine seem to be more effective than no treatment. It is not scientifically proven yet that these techniques may have more effect that sham (placebo) intervention [29]. SM has been recently described as an ineffective treatment for managing some pain conditions [39]. Nevertheless, as suggested, most studies of SM have failed to either employ CGs with sham intervention or use blinded designs and sample sizes based on power calculations [39]. The present study has controlled these aspects to increase internal validity.

Previous works have found similar results to the present study in regard to pelvic pain perception after SM [23,25,26]. Kokjohn et al. [26] concluded that SM is a useful therapeutic tool to decrease, at least in the short term, the distress associated with PD. They observed a reduction in pain perception and in the prostaglandin plasma concentration after SM, although a decrease in prostaglandin levels was also found in the CG. We observed a similar pattern in both groups for adrenaline and dopamine but not for serotonin and noradrenaline. Boesler et al. [23] stated that SM reduces low back

pelvic pain (measured by electromyography of the lumbar musculature) associated with menstrual cramps. Holtzman et al. [25] observed similar findings after a lumbar-sacral manipulation. Nevertheless, the different intervention protocols and measurement tools makes difficult to compare among studies.

The minimum detectable change (MDC) to report a true difference in the VAS after intervention in subjects with low-back pain has been determined in 18–19 mm in regard to a pretreatment mean score of 64 mm [40]. According to this, a 29.65% improvement in the VAS can be considered as clinically meaningful. In the present trial, the VAS score change in the EG (11.39 mm) did not surpass the established MDC. It is also under the mean change immediately found after electrotherapy in PD (13.9 mm in the TENS group and 24.4 mm after interferential current) [15]. However, taking into consideration the low baseline VAS score in the EG, the difference represented a 29.89% improvement after SM. This value is also similar to the difference observed in a recent meta-analysis in the VAS after acupressure compared with no treatment (10.11 mm) [41]. Therefore, the effect of the GPM technique seems to have a clinical impact on pain relief.

SM has been correlated with a positive change in the PPT of trigger points in different pathologies and in asymptomatic subjects [42,43]. Based on those findings, the PPT in the SIJ was included as a new outcome measure that has not been formerly evaluated in PD. The positive results on the PPT can be explained by the effect of SM on pain central processing mechanisms [30,44]. The influence of SM on activation of the endogenous opioid system has also been assessed in regard to the release of B-endorphins [45], and a possible opioid effect on the peripheral nervous system [46]. The improvement in PPT levels in the EG surpassed the standard error of measurement

(0.01 kg/cm2) reported for mechanosensitivity in the lumbar spine in low-back pain patients [47]. SM appears to have a greater impact on improving PPT levels than other manual therapy approaches, and its effect is not dependent on the patient's pain state [48]. This may explain why results were still positive in the EG although the baseline mechanosensitivity values were higher than in the CG. The pain relief model on the mechanisms of SM is based on a chain of neurophysiological responses related to the central and peripheral nervous systems [49]. The hypoalgesic effect linked with SM is suggested to be associated with both, a spinal cord, and a supraspinal mediated mechanisms [48]. Therefore, the results of the present study seems to support the understanding of SM as a nonspecific technique acting on the pain modulating system, even though the mechanisms still remain elusive [48]. Unlike other treatments for PD, no adverse side effects have been described for lumbar SM, except for a slight burning sensation in the lumbar region [24]. A certain trend toward worsening of PPT in both SIJ after the sham maneuver was observed in the CG (Table 2). These findings may be a consequence of the placebo technique itself. The subject was kept in a static lateral position, with all the body weight resting on the side. Hence, the subject's body weight may be a plausible reason for the local sensitization of the SIJ.

Women were asked about their perceived global low-back pelvic pain, but the PPT evaluations were limited to the SIJ joints. The referral pain sites for lumbar-sacral pain interfere with the anatomical location of the pelvic and SIJs [50]. Therefore, it is not clear if the observed pain relief was mostly related to the lumbar or the pelvic area. It is difficult to state as well if the results are a definite or a transient short-term outcome because low-back pain seems to be stable whether pelvic pain may increase, at least during pregnancy [50]. In any case, pain perceived in PD is quite complex due to its subjective and multidimensional nature. There is also a huge variability among patients,

which makes it difficult to find solid conclusions.

In regard to plasma levels of nociceptive biomarkers, Degenhardt et al. [27] found no significant changes for serotonin levels after osteopathic manual therapy (OMT) in subjects with low back pain. This result suggests that the effects of the OMT without applying HVLA techniques may not be mediated by the serotonergic pathway but probably by endogenous opioids and cannabinoids. On the contrary, Skyba et al. [28] demonstrated in an animal model that joint manipulation augments the serotonin concentration, which can produce analgesia through the descending inhibitory pathway. When comparing between-groups, we observed a significant increase of serotonin concentration in the EG. It may be reasonable to state that this result is due to the decrease found in the serotonin level in the CG (14.93 Å} 36.58 ng/mL), because the increase in the EG level was small (4.98 ± 22.51 ng/ mL). We find no definite explanation for these results in the CG. Some studies have shown no statistical changes on nitric oxide concentration blood levels after alternative therapies (yoga and acupressure) in women with PD [51,52]. It remains an issue for future studies to complement the present evaluations with the assessment of nitric oxide levels after SM. It may help to get a better understanding of the clinical effect of manipulative techniques in PD.

Limitations

The study has certain limitations. First, the subject's intake of NSAIDs and/or cyclo-oxygenase-2 specific inhibitors was not controlled. This could be a plausible explanation to understand the baseline intergroup differences in the perceived pain. It could be also argued that the intake of oral contraceptives, which has been related to pelvic pain alleviation [7], was higher in the EG (25% of subjects).

Low-back pelvic pain seems to be associated with hypermobility, strain of the joints, and body mass index [50]. Participants' height and weight were not measured in this trial. Unlike previous research [23,25], no evaluation of specific lumbar-sacral motion restrictions was performed either. Second, the findings must be cautiously interpreted because the study has only assessed immediate effects. Long-term results should be evaluated in future studies [53]. Finally, the measurement of catecholamines and serotonin plasma level is complex because it is influenced by food intake, stress, and patient position, and it shows a circadian rhythm [54]. Subjects were always placed during measurements in a sitting position, and they were at rest between each blood extraction. The study was always performed between 8:00 PM and 9:00 PM to avoid influencing the baseline levels. However, if any woman had a fear of SM or blood extraction and failed to report such feeling, catecholamines levels may have been altered in the postintervention evaluation.

Conclusions

The GPM technique, bilaterally applied to women with PD, appears to increase significantly the PPT in the SIJ and reduce the self-reported low–back pelvic pain in a short term.

Regarding the plasma levels of chemical modulators of pain (catecholamines and serotonin), the GPM technique increases serotonin levels, with a small effect size. It shows no statistical significance in comparison with a sham (placebo) intervention for catecholamines plasma levels.

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Figure 1. Flowchart diagram according to CONSORT statement for the report of randomized controlled trials.

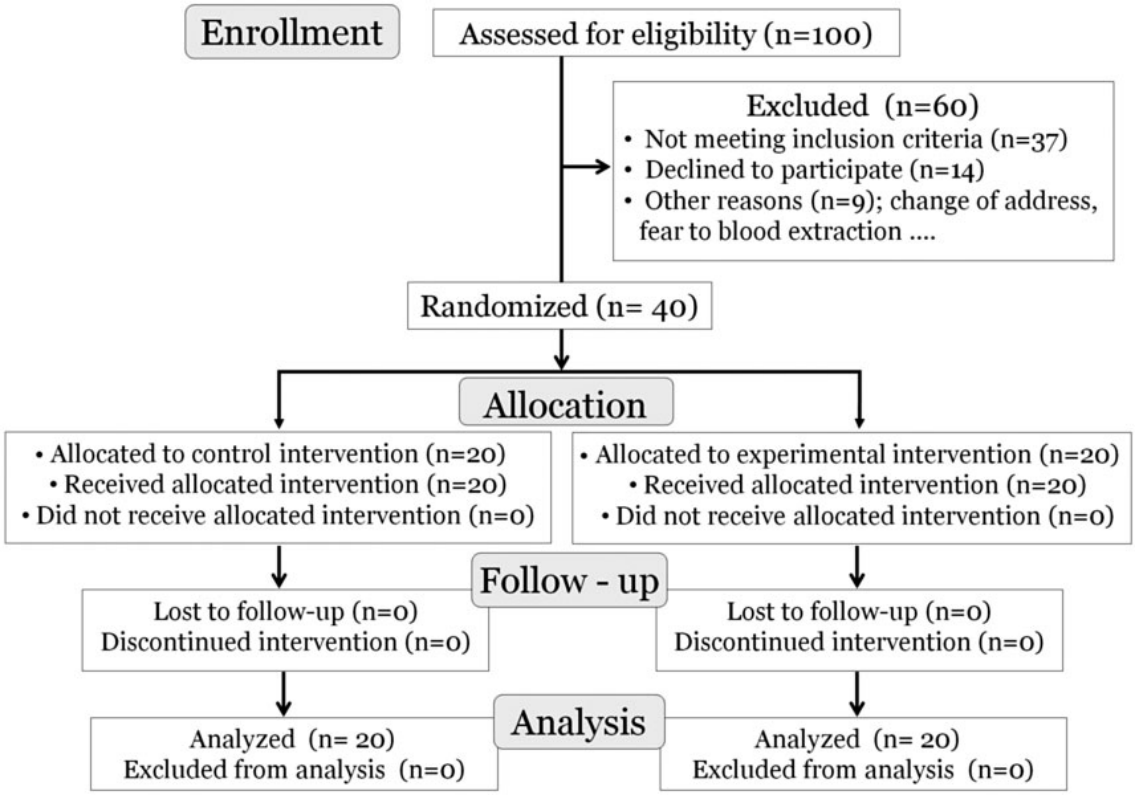
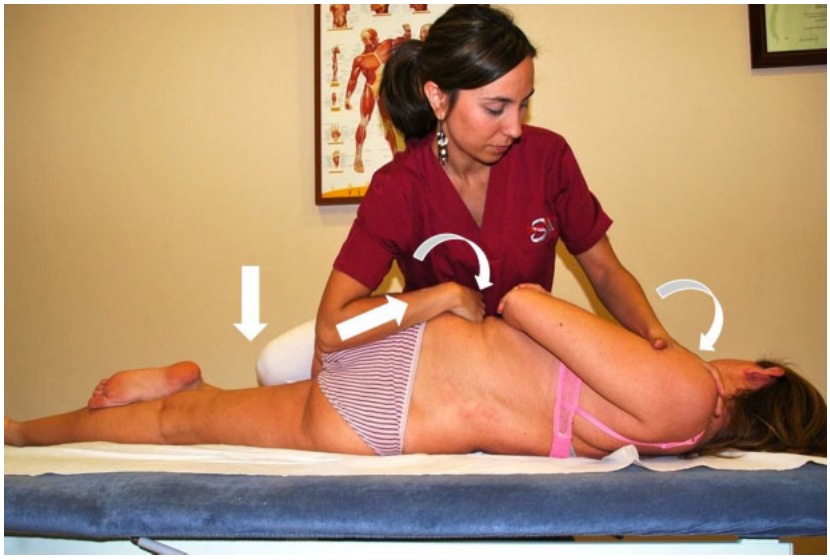


Figure 2. Global pelvic manipulation technique.



White arrows indicate the impulses' direction.

Table 1 Physical and clinical characteristics of the studied sample

	Control Group	Experimental Group	Diff.
Age (years)	30 ± 5.83	30 ± 6.63	0.860
Age of menarque (years)	13 ± 1.13	12 ± 1.23	0.597
Pain in the last menstruation (VAS)	7.45 ± 1.27	7 ± 1.45	0.304
Contraceptives intake (yes)	15% (3/20)	25% (5/20)	0.695
Primary dysmenorrhea	50% (10/20);	75% (75/20);	0.213
(Grades I and II; Grade III)	50% (10/20)	25% (5/20)	
Low-back pelvic pain (VAS) (mm)	61.5 ± 24.72	38.1 ± 23.02	0.003
PPT right SIJ (kg/cm^2)	1.32 ± 0.51	1.58 ± 0.65	0.174
PPT left SIJ (kg/cm^2)	1.40 ± 0.45	1.85 ± 0.65	0.016
Adrenaline plasma level (ng/mL)	44.1 ± 6.34	43.18 ± 10.74	0.743
Noradrenaline plasma level (ng/mL)	184.96 ± 40.43	177.74 ± 97.37	0.761
Dopamina plasma level (ng/mL)	78.4 ± 17.91	72 ± 27.95	0.394
Serotonin plasma level (ng/mL)	104.53 ± 50.24	60.04 ± 34.76	0.002

Data are reported as mean Å} SD or in percentages (%).

Diff: statistical significance of the between-group difference.

VAS = visual analogue scale; PPT = pressure pain threshold; SIJ = sacroiliac joint.

Table 2 Pre- and postintervention values and intragroup differences in each group (control and experimental)

	Control Group			Experimental Group		
	Preintervention	Postintervention	*P*	Preintervention	Postintervention	*P*
LBP	61.50 ± 24.72	61.35 ± 25.92	0.904	38.1 ± 23.02	27.72 ± 24.32	0.003
PPT right SIJ	1.32 ± 0.51	1.30 ± 0.52	0.381	1.58 ± 0.65	1.91 ± 0.84	0.001
PPT left SIJ	1.40 ± 0.45	1.32 ± 0.44	0.044	1.85 ± 0.65	2.02 ± 0.72	0.001
AD PL	44.1 ± 6.34	45.77 ± 7.69	0.385	43.18 ± 10.74	47.36 ± 15.58	0.123
NAD PL	184.96 ± 40.43	199.96 ± 66.13	0.219	177.74 ± 97.37	158.47 ± 99.94	0.281
DP PL	78.4 ± 17.91	86.30 ± 26.27	0.133	72 ± 27.95	81.25 ± 22.64	0.173
ST PL	104.53 ± 50.24	89.60 ± 43.64	0.084	60.04 ± 34.76	65.02 ± 37.64	0.335

P value: intragroup comparison between pre- and postintervention results.

LBP = low-back pelvic pain; PPT = pressure pain threshold; SIJ = sacroiliac joint; AD = adrenaline; NAD = noradrenaline;

DP = dopamine; ST = serotonin; PL = plasma level.

PPT is expressed in kg/cm2; Plasma level values are expressed in ng/mL.

Table 3 Between-group comparison of the differences from post- to preintervention

	Control Group	Experimental Group	*P*
LBP	–0.15 ± 5.47 (2.41/–2.71)	–11.39 ± 12.03 (–3.69/–14.95)	0.004
PPT right SIJ	–0.016 ± 0.08 (0.02/–0.05)	0.33 ± 0.33 (0.49/0.18)	0.001
PPT left SIJ	–0.08 ± 0.16 (–0.01/–0.16)	0.16 ± 0.18 (0.25/0.08)	0.001
AD PL	1.67 ± 8.40 (5.60/–2.26)	4.18 ± 11.59 (9.61/–1.24)	0.437
NAD PL	15 ± 52.73 (39.68/–9.67)	–19.27 ± 77.72 (17.10/–55.65)	0.111
DP PL	7.90 ± 22.53 (18.44/–2.64)	9.25 ± 29.22 (22.92/–4.42)	0.871
ST PL	–14.93 ± 36.58 (2.19/–32.05)	4.98 ± 22.51 (15.51/–5.55)	0.045

Data are reported as mean ± SD and (95% confidence level-CI). P value: intergroup comparison between pre- and postintervention values (ANOVA).

LBP = low back pelvic pain; PPT = pressure pain threshold; SIJ = sacroiliac joint; AD = adrenaline; NAD = noradrenaline; DP = dopamine; ST = serotonin; PL = plasma level.

PPT is expressed in kg/cm2; Plasma level values are expressed in ng/mL.