Effects of High-Velocity, Low-Amplitude Spinal Manipulation on Strength and the Basal Tonus of Female Pelvic Floor Muscles

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Abstract

Objective: Spinal manipulation with high-velocity and low-amplitude (HVLA) manipulation is frequently used for the treatment of lumbopelvic pain; however, the effect on the pelvic floor has been poorly studied in the past. The objective of this study was to quantify the intravaginal pressure (IVP) and the basal perineal tonus (BPT), measured in terms of pressure, before and after the HVLA manipulation in patients without neuromuscular and skeletal dysfunctions.
Methods: In this experimental, noncontrolled, nonrandomized study, IVP was obtained through a perineometer introduced into the volunteers' vagina while in dorsal horizontal decubitus. Forty young, healthy university volunteer women with no history of vaginal delivery participated. All voluntary contractions of the perineal muscles were measured in 3 different ways: phasic perineal contraction (PPC), tonic perineal contraction, and perineal contraction associated to accessory muscles. New pressure measurements were obtained immediately after the HVLA manipulation on the volunteers' sacrum. The pressures were registered and transcribed directly to a personal computer with specific software.
Results: The average IVPs obtained in millimeters of mercury before and after the HVLA manipulation were 56.01 (±25.54) and 64.65 (±25.63) for PPC, 445.90 (±186.84) and 483.14 (±175.29) for tonic perineal contraction, and 65.62 (±26.56) and 69.37 (±25.26) for perineal contraction associated to accessory muscles, respectively. There was significant statistical variation only for PPC (P = .0020) values. The BPT increased regardless of the type of contraction ($P < .05$).
Conclusion: High-velocity and low-amplitude manipulation of the sacrum was associated with an increase of PPC and of BPT in women who had no associated osteoarticular diseases. These preliminary discoveries could be helpful in the future study of the treatment of women with perineal hypotony. (J Manipulative Physiol Ther 2010;33:109-116)
Key Indexing Terms: *Pelvic Floor; Perineum; Manipulation, Spinal; Muscle Tonus; Muscular Contraction*

Chronic lumbar and pelvic pain may be one of the main causes that make women seek medical aid and may be the most important cause of absenteeism from work.[1,2] Several treatment options have been used with the purpose of relieving chronic spinal pain, such as drug-based treatments, acupuncture, postural orientation (back school), and spinal manipulation (SM), among several others. In addition, diseases such as stress urinary incontinence (SUI), overactive bladder, vulvodynia, and irritable bowel syndrome have not yet been appropriately studied in terms of the perineal muscles and will probably need physiotherapy techniques to stabilize the functional dynamics.

Spinal manipulation is a therapeutic procedure that is frequently used in the treatment of patients with cervical, lumbar, or pelvic pain. Some studies suggest that SM presents superior results to those of acupuncture and of drug-based treatments in chronic pain syndromes of the spine.[3] According to Ferreira et al,[4] treatments with SM for chronic lumbar pain bring about improvement in the short term, but not in the medium and long term.

Other studies carried out on individuals with sacroiliac chronic pain suggest that the treatment with back school could provide greater efficiency in pain control; however, SM would have the advantage of improving the amplitude

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Paper submitted February 21, 2009; in revised form August 11, 2009; accepted September 25, 2009.
0161-4754/$36.00

doi:10.1016/j.jmpt.2009.12.007

of muscular movement.[5] Spinal manipulation can be done in different ways. One of them would be through articulation mobilization with high-velocity and low-amplitude (HVLA) stimulus (thrust) on the vertebral segment that has mobility restriction (HVLA manipulation); another form can be through articulation mobilization without thrust.[6,7] The thrust can release a cracking articulation noise, but this does not seem to be related to its efficiency.[8-10] Studies with electromyography demonstrate an increase of the activity of the brachial biceps muscle, bilaterally, immediately after the HVLA manipulation on the C5/C6 articulation to the right, notwithstanding the presence of articulation noise.[11]

Summarizing, Shekelle[12] describes 4 hypotheses for the effects of the HVLA manipulation: liberation of the sinovial membrane; decrease of muscular hypertony for abrupt muscular stretching, rupture of articulate or periarticulate adherences, and correction of the movement of articulation segments. However, there seems to be 2 different actions for SM: a mechanical and a neurophysiologic action, where the "mechanical" intraarticulate effect seems to be independent of the neurophysiologic effect, which is associated to the caption of the articulate fluid, which is an indicator of sudden united alterations. *Cavitation* is the term used to describe the formation of bubbles inside the articulations due to the decrease of synovial fluid pressure areas and may be associated with a popping noise.[13]

The beneficial effects of SM promote a decrease in pain, increase in articular mobility, normalization of muscular tonus, and restoration of the articulation function.[14-19] Studies carried out on a force platform demonstrate that patients with a decrease in sacroiliac mobility present improvement of asymmetry while walking after SM[16,20]; and other studies report a decrease of muscular inhibition of the quadriceps muscle after manipulation, with an increase of the moment of muscular force (torque) in patients with previous knee pain.[21,22]

High-velocity and low-amplitude manipulation on the sacrum aims at restoring the articular mobility and normalizing the muscular tonus of this metamere (pelvic floor). Despite this manipulation having been proven as efficient for other segments of the spine, there is still doubt on how the HVLA manipulation acts on the pelvic floor muscles. The pelvic floor, specifically in women, has great relevance in physiologic processes throughout life, such as maintaining the stability of the pelvis, pelvic organ continence (bladder, uterus, intestines), sexual performance and the passage of the fetus during childbirth,[23,24] and especially the adequate maintenance of the urogenital and pelvic diaphragm, which will determine urinary continence.[24]

Studies suggest that the muscular contraction of the pelvic floor can be mainly related to pelvic instability, suggesting the need for more studies regarding patients that have lumbar pain, vulvodynia, dyspareunia, and SUI.[23,25-27]

Techniques that can interfere favorably in the tonus of the pelvic floor muscles could contribute with invaluable help to improve SUI symptoms, vulvodynia, dyspareunia, and lumbar pains.

The objective of this study was to investigate if HVLA manipulation of the sacrum can modify the strength and the basal tonus of the pelvic floor muscles.

Methods

A nonrandomized clinical experimental study was carried out on 40 female university volunteers of reproductive age (20-40 years), without any hormonal problems, who were nulliparous or who had not undergone vaginal deliveries and who presented no significant neuromusculoskeletal alterations in the lumbopelvic area (scoliosis, or accidents or pathologies involving the pelvis). Furthermore, only women who never presented known changes in the pelvic floor such as urinary incontinence or other conditions related to the pelvic floor and who had similar lifestyles, educational levels, professions, physical activity, and ethnic origin were selected. These women were recruited at the clinic of general gynecology at the State University of Campinas, São Paulo, Brazil. The funding source for this project was provided for by the authors' own resources.

Although SM has been tested in various situations,[7,11,12,20,21] there are no studies to assess the changes that occur in the perineal muscles after the application of SM, despite the importance that these muscles have in the maintenance of pelvic stability. Because of this lack of information, we carried out a preliminary study to determine possible changes in the values of the perineal muscle tonus before and after SM. The study was performed with the first 40 female volunteers who met the specifications required because of the difficulty in finding healthy women who were willing to participate in a perineal manipulation study.

All of the patients, after being informed of the procedures, filled out a questionnaire related to the study and signed an informed consent form. The questionnaire was set up with the objective of identifying the volunteers' profile. The questionnaire contained questions related to lifestyle that could influence the contractive state of the perineal muscles, such as number of offspring, type of work (seated, nonseated, or demanding physical effort), frequent practice of physical activity at least 3 times a week at the time of the study or in the past, and history of lumbar pain. To minimize the variations of the vaginal pressures due to a lack of the volunteers' understanding of how to carry out the contractions, each one of the volunteers was requested to practice contractility movements 3 consecutive times after orientation before the first intravaginal pressure (IVP) measurement. This practice was useful to give women a better understanding of how to perform the requested contractions and thus help toward its implementation, but the aim was not to change the strength of contraction of the perineal muscles.

The measurement of the IVPs was carried out using a perineometer, which is a pressure electromyograph that registers muscular contractions of the pelvic floor.[28] Kegel perineometer, modified by Sabatino et al,[29] is a pressure measurement system made up of a semirigid 10-cm–long and 3.5-cm–diameter rubber tube, with a round and closed distal part. The device was assembled in the laboratory of clinical physiology of the Physical Education Faculty, the State University of Campinas, using an NPI 19A electric sensor (General Electric Company, Billerica, Mass) capable of identifying existing pressures inside the perineometer. This system, once inside the vagina, adapts to the walls of the vagina in all its extension.[29] The patients were put in dorsal horizontal decubitus on an adequate-height hard-surfaced osteopathy stretcher and requested to relax during the intravaginal placement of the perineometer, according to the Bo and Finckenhagen[30] study. The perineometer was properly adjusted for each patient, connecting the perineometer to a conventional mercury manometer, to identify the minimum (0 mm Hg) and maximum (150 mm Hg) values, before being introduced into the vagina. The calibration was carried out aiming at creating a standard deviation as a reference for the values found during contractions performed by the volunteers. After the introduction of the perineometer and before any contraction was required, that is, during rest, the values varied and not all started at zero. This state of rest was considered to be the muscle basal tonus; and graphically, this state was named *baseline*. To define a value for this line, an average between these values with a standard deviation of 10% was established.

The perineometer, which was introduced into the vaginal canal, was submitted to the pressures of the relaxed vaginal walls and, after that, to voluntary contractions of the perineal muscles in 3 different ways, according to the *Perfect* outline proposed by Bo et al,[31] at 3-minute intervals. The first method consisted of a fast or phasic contraction of the anus-elevating muscles (PPC), when the muscular force of the pelvic floor, formed mainly by type II muscular fibers (fast or phasic), can be evaluated. In the second method, a persistent contraction of the anus-elevating muscles or tonic contraction (TPC) was requested and maintained for 10 seconds, when the "endurance" (maintenance of the contraction) carried out by type I muscular fibers (slow) can be evaluated. The third method entails evaluating the contraction of the anus-elevating muscles simultaneously with the gluteus; transverse of the abdomen; and adduction muscles (APC). Immediately after the measurement of the 3 types of perineal contraction, the patient was placed in the lateral decubitus position; and the HVLA manipulation was carried out on the sacrum. Immediately after the accomplishment of the HVLA manipulation, the perineal pressure was measured again.

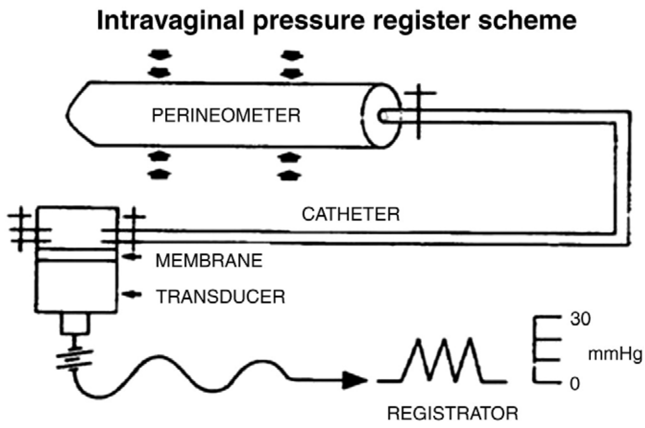

Fig 1. *Simplified scheme of the IVP register.*

The pressures that were measured by the transductor of the perineometer (Fig 1) were transmitted by electric pulses to the computer for data registration. The information of the pressure was transformed into electric signs through a bridge amplifier (model SCXI 1321; National Instruments, Austin, Tex) and a digital-to-analog conversion plate (model 6032 Y, National Instruments). The electric signs were decoded by the LabVIEW software (National Instruments, http://www.ni.com/labview/), which enabled the registration, with the possibility of setting a database for each patient (Fig 2).

Once the vaginal pressure measurements were attained, 6 volunteers were excluded because of technical problems. The measurements of the vaginal pressure were calculated differently according to the purpose of each type of contraction. For PPC and APC, the maximum value in a single contraction carried out by the volunteer was registered by the device, aiming at measuring the maximum pressure that the volunteer is capable of exerting. For TPC, the integral value of the measured pressure values was calculated throughout this interval of time, aiming at measuring the endurance.

To determine the basal perineal tonus represented by the baseline, the minimum value of the baseline plus 10% of the difference between the minimum and maximum value of baseline found was considered, that is, an average between these values with a standard deviation of 10%. It is important to note that these calculations were carried out to compare the perineal basal tonus between the subjects of this study and not to calculate the precise values of perineal basal tone for each subject.

Appropriate statistical tests (paired Student *t* and Wilcoxon test) were used for the analysis of the data. The protocol was reviewed and approved by the institution's Research Committee Ethics (775/2007).

Results

The average age of the 40 voluntary women was 33.58 years (SD = 5.37). The medium height and weight found

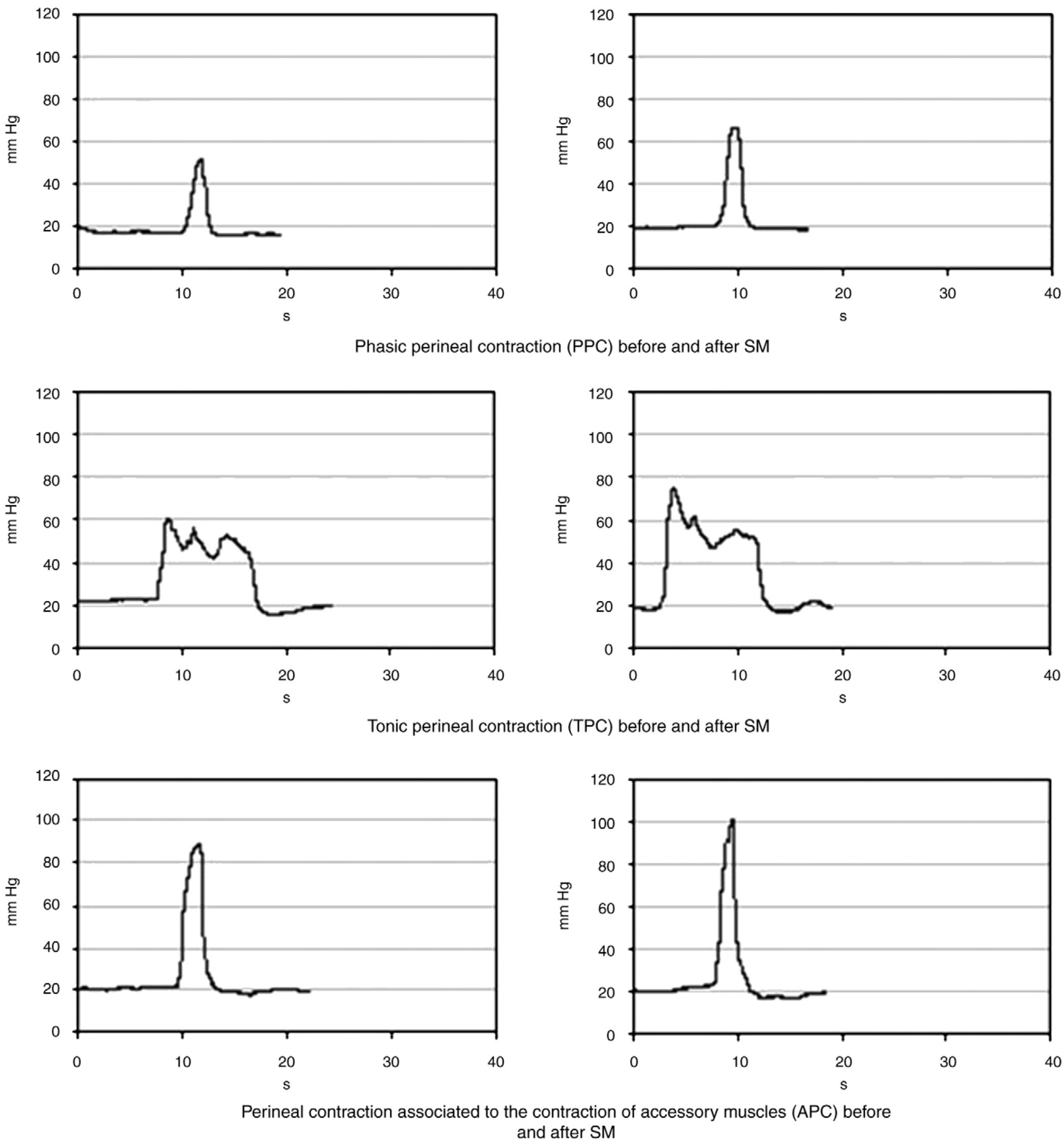

Fig 2. *Example of a graph of the perineal pressure curves obtained from the 3 types of contraction before and after SM of a volunteer.*

were 164 cm (SD = 0.07) and 60 kg (SD = 11.17), respectively. Nineteen (47.50%) women were nulliparous, 12 (30%) had experienced childbirth once, and 9 (22.50%) had 2 childbirths, all via cesarean delivery. The registration of the professional activity shows that 16 (40%) fulfilled activities that demand physical effort, 10 women (25%) had professional activities that did not demand physical effort, 14 women (35%) worked seated, 26 (65%) carried out physical activity, and 38 (95%) had practiced physical activity in the past.

According to the inclusion criteria, no woman reported lumbar pain during the experiment; however, 30 among the 40 studied women reported lumbar pain in the past. With regard to the history of lumbar pain during pregnancy, 15 (71.50%) out of the 21 women that had been through childbirth had pain during pregnancy; and 10

Table 1. *General characteristics of the studied population sample (N = 40)*

Variable	Distribution
Age (y) $\overline{X}$ (SD)	33.6 (5.37)
Height (m) $\overline{X}$ (SD)	1.64 (0.7)
Weight (kg) $\overline{X}$ (SD)	60.8 (11.4)
No. of childbirths	
None	19 (47.5%)
1	12 (30%)
2	09 (22.5%)
Posture at work	
Standing	10 (25%)
Standing performing physical effort	16 (40%)
Sitting	14 (35%)
Sports activity–current	29 (65%)
Sports activity–past	38 (95%)
Lumbar pain history	30 (75%)

(66.67%) stated that the lumbar pain began at the onset of pregnancy (Table 1).

The results of the pressure measurements presented normal distribution. The average IVPs obtained in millimeters of mercury before and after the HVLA manipulation were 56.01 (±25.54) and 64.65 (±25.63) for PPC, 445.90 (±186.84) and 483.14 (±175.29) for TPC, and 65.62 (±26.56) and 69.37 (±25.26) for APC, respectively. There was a statistically significant variation only for the PPC values (P = .0020) (Table 2).

The baseline values, interpreted as basal perineal tonus of the phasic perineal contraction (PPC-BL), presented normal distribution; however, the baselines for the tonic contraction (TPC-BL) and for the perineal contraction associated with the contraction of accessory muscles (APC-BL) did not present normal distribution. The average IVPs obtained in millimeters of mercury Hg before and after the HVLA manipulation were 24.41 (±10.51) and 30.07 (±9.22) for the PPC-BL, 27.29 (±10.07) and 30.40 (±9.12) for the TPC-BL, and 29.55 (±9.76) and 31.44 (±9.38) for the APC-BL, respectively, There were significant increases for all types of contraction after the HVLA manipulation (PPC-BL, P = .0001; TPC-BL, P = .0090; APC-BL, P = .0480) (Table 3).

Table 2. *Summary of the average values obtained for the perineal pressure before and after SM*

		PPC	TPC	APC
n		34	34	34
Before	Average	56.01	445.90	65.62
	SD	25.54	186.84	26.56
	Median	53.13	420.79	63.51
	P10%	24.97	221.73	33.57
	P90%	85.54	702.93	101.45
After	Average	64.65	483.14	69.37
	SD	25.63	175.29	25.26
	Median	67.01	472.82	64.20
	P10%	33.49	242.37	40.95
	P90%	93.71	665.99	100.37
P		.0020	.0680	.2190

PPC, phasic perineal contraction; *TPC*, tonic perineal contraction; *APC*, perineal contraction associated to accessory muscles; *P10*, 10% of the sample presents contraction up to this value and 90% above this value (smaller 10%); *P90*, 90% of the sample presents contraction up to this value and 10% above this value (greater 90%).

Table 3. *Summary of the baseline values before and after SM*

		PPC	TPC	APC
n		34	34	34
Before	Average	24.41	27.29	29.55
	SD	10.51	10.07	9.76
	Median	22.69	24.68	27.46
	P10%	12.74	17.48	19.23
	P90%	36.31	41.01	42.71
After	Average	30.07	30.40	31.44
	SD	9.22	9.12	9.38
	Median	30.94	30.93	32.73
	P10%	17.57	17.80	20.03
	P90%	40.64	43.95	43.59
P		<.0001	.0090 [a]	.0480 [a]

PPC, phasic perineal contraction; *TPC*, tonic perineal contraction; *APC*, perineal contraction associated to accessory muscles; *P10*, 10% of the sample presents contraction up to this value and 90% above this value (smaller 10%); *P90*, 90% of the sample presents contraction up to this value and 10% above this value (greater 90%).

[a] Wilcoxon signed rank test.

Discussion

The detailed knowledge of the perineal functionality and biodynamics is still not clear probably because of the anatomical complexity and also because of the social-cultural and sexual aspects that are involved in the handling of this area. It was possible, in this work, to identify modifications in the perineum pressures of healthy women submitted to HVLA manipulation.

The values of the perineal pressure found in relation to the 3 types of contraction obtained normal statistical distribution, with a great part of the values found close to average (Fig 3). The perineal pressure only significantly increased after the HVLA manipulation for PPC (P = .0020), which was not observed in the case of APC (P = .0680). This result suggests that the SM when carried out on the sacrum bone only affects the related metamere, in other words, the pelvic floor, increasing the contraction force of the perineum (pressure).

The contraction of the accessory muscles could minimize the differences encountered. The increase in IVP after the HVLA manipulation is in agreement with the literature, where it was found that SM acts on the activity of the α motor neurons, regulating the muscular tonus and causing an increase in the muscular contraction force.[14-19] According to Suter et al,[21,22] the decrease in muscular inhibition after HVLA manipulation produces an increase of the moment of muscular force (torque). This effect can be explained by the incentive that the HVLA manipulation causes on the γ system enabling the normalization of the muscular tonus, which as a result improves during muscular force or torque.

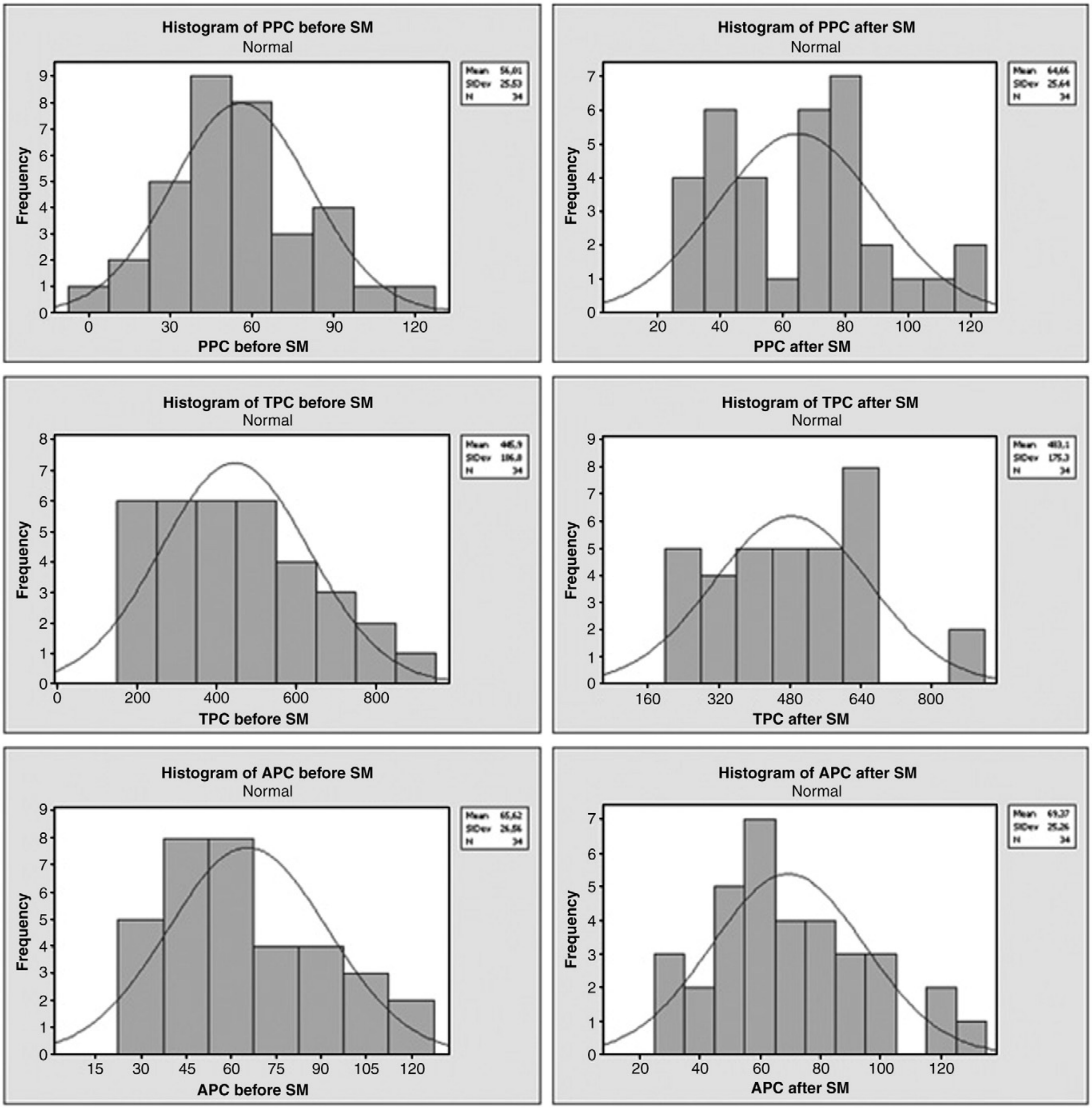

Fig 3. *Histograms that present normal PPC, TPC, and APC distribution.*

When the effect of the HVLA manipulation on the slow-action fibers (type I), through TPC, was studied, no significant result (P = .0680) could be found. This result can suggest that the HVLA manipulation would have a smaller effect on type I or slow fibers; however, it would not be in agreement with the significant results of an increase of basal tonus found after the HVLA manipulation. These data suggest that more studies should be carried out to define at which exact moment the slow fibers of the perineal muscles begin to be activated. According to the literature, the pelvic floor is made up of slow-contraction or type I and fast-contraction or type II muscular fibers; and 70% of those are the slow type and are responsible for the maintenance of the tonus. The other 30% are fast-contraction and low-resistance fibers.[32] In this work, based on the protocol of the *Perfect* outline,[28] PPC was carried out to detect the presence and the intensity of the perineal contraction; and TPC was used to study muscular resistance through the recruitment of type I or slow-contraction muscular fibers. Despite trying in this study to identify the effect of the HVLA manipulation for the different types of muscular fiber, based on the protocol used and literature that shows that the voluntary contraction of the pelvic floor acts more specifically on type II fibers,[33] the results found suggest that more studies could be carried out to investigate the exact time in which type I or slow fibers are recruited, so that other protocols for the pelvic floor can be used. In addition, the maintenance of the contractility for a long period may demand a recruitment of the accessory muscles, minimizing the differences encountered.

The increase of the basal tonus after the HVLA manipulation disagrees with literature that reports a decrease of the muscular hypertonicity after SM. This effect of the HVLA manipulation on the force and tonus of the muscles of the pelvic floor can be beneficial in the treatment of individuals with pelvic floor dysfunction such as SUI and lumbar pains, thus increasing the force and the hypotonic perineal tonus; and because of this, more studies should be carried out in this sense. Still, the results suggest that it would be interesting to develop more research and other treatment protocols with and without the use of the SM technique to observe the immediate and lasting effects on the functionality of the muscles of the pelvic floor, in terms of normality and pathology. Another interesting study might be to compare SM therapy with a placebo in a randomized trial of asymptomatic subjects.

Limitations

The limitations of this study include that the patients were asymptomatic; thus, those with musculoskeletal or visceral problems may not necessarily respond in a similar manner. The study participants were recruited from a college campus clinic; therefore, the findings may not necessarily be applicable to other populations.

Conclusion

The HVLA manipulation applied on the sacrum causes modifications in the muscular response, increasing the perineal force or pressure. The basal perineal tonus increased after the application of the HVLA manipulation. These preliminary discoveries may be helpful in the future study of the treatment of women with perineal hypotony.

Practical Applications

- The HVLA manipulation applied on the sacrum causes modifications in the muscular response, increasing the perineal force or pressure.
- The basal perineal tonus increased after the application of the HVLA manipulation.
- These preliminary findings could possibly favor the treatment of women with perineal hypotony.

Funding Sources and Potential Conflicts of Interest

No funding sources or conflicts of interest were reported for this study.

References

1. Lebouef-Yde C, Lauritsen JM. The prevalence of low back pain in the literature. Spine 1995;20:2112-8.
2. Pereira APB, Souza LAP, Sampaio RF. Back school: um artigo de revisão. Rev Bras Fisioter 2001;5:1-8.
3. Giles L, Muller G. Chronic spinal pain syndromes: a clinical pilot trial comparing acupuncture, a nonsteroidal anti-inflammatory drug, and spinal manipulation. J Manipulative Physiol Ther 1999;22:376-81.
4. Ferreira ML, Ferreira PH, Latimer J, et al. Comparison of general exercise, motor control exercise and spinal manipulative therapy for chronic low back pain: a randomized trial. Pain 2007;131:31-7.
5. Herzog W, Conway PJ, Willcox BJ. Effects of different treatment modalities on gait symmetry and clinical measures for sacroiliac joint patients. J Manipulative Physiol Ther 1991;14:104-9.
6. Maitland G. Vertebral manipulation. London: Butterworths; 1986.
7. Dishman JD, Bulbulian R. Comparison of effects of spinal manipulation and massage on motoneuron excitability. Electromyogr Clin Neurophysiol 2001;41:97-106.
8. Flynn TW, Fritz JM, Wainner RS, Whitman JM. The audible pop is not necessary for successful spinal high-velocity thrust manipulation in individuals with low back pain. Arch Phys Med Rehabil 2003;84:1057-60.
9. Cleland JA, Flynn TW, Childs JD, Eberhart S. The audible pop from thoracic spine thrust manipulation and its relation to short-term outcomes in patients with neck pain. J Man Manipulative Ther 2007;15:143-54.
10. Teodorczyk-Injeyan JA, Injeyan HS, McGregor M, Harris GM, Ruegg R. Enhancement of in vitro interleukin-2 production in normal subjects following a single spinal manipulative treatment. Chiropr Osteopat 2008;16:5.
11. Dunning J, Rushton A. The effects of cervical high-velocity low-amplitude thrust manipulation on resting electromyographic activity of the biceps brachii muscle. Man Ther 2009;14:508-13.
12. Shekelle PG. Spinal manipulation. Spine 1994;19:858-61.
13. Evans DW. Mechanisms and effects of spinal high-velocity, low-amplitude thrust manipulation: previous theories. J Manipulative Physiol Ther 2002;25:251-62.
14. Cibulka MT, Dellitto A, Koldehoff RM. Changes in innominate tilt after manipulation of the sacroiliac joint in patients with low back pain. An experimental study. J Manipulative Physiol Ther 1988;68:1359-63.
15. Herzog W, Nigg BM, Robinson RO, Read LJ. Quantifying the effects of spinal manipulations on gait, using patients with low back pain: a pilot study. J Manipulative Physiol Ther 1987;10:295-9.
16. Herzog W, Nigg BM, Read LJ. Quantifying the effects of spinal manipulations on gait using patients with low back pain. J Manipulative Physiol Ther 1988;11:151-7.
17. Herzog W, Scheele D, Conway PJ. Eletromyographic responses of back and limb muscles associated with spinal manipulative therapy. Spine 1999;24:146-52 discussion 153.
18. McMorland G, Suter E. Chiropractic management of mechanical neck and low-back pain: a retrospective, outcome-based analysis. J Manipulative Physiol Ther 2000;23:307-11.

19. Osterbauer PJ, De Boer KF, Widmaier R, Petermann E, Fuhr AW. Treatment and biomechanical assessment of patients with chronic sacroiliac joint syndrome. J Manipulative Physiol Ther 1993;16:82-90.
20. Robinson RO, Herzog W, Nigg BM. Use of force platform variables to quantify the effects of chiropractic manipulation on gait symmetry. J Manipulative Physiol Ther 1987;10:172-6.
21. Suter E, McMorland G, Herzog W, Bray R. Decrease in quadriceps inhibition after sacroiliac joint manipulation in patients with anterior knee pain. J Manipulative Physiol Ther 1999;22:149-53.
22. Suter E, McMorland G, Herzog W, Bray R. Conservative lower back treatment reduces inhibition in knee-extensor muscles: a randomized controlled trial. J Manipulative Physiol Ther 2000; 23:76-80.
23. Pool-Goudzwaard A, Van Dijke GH, Van Gurp M, Mulder P, Snidjers C, Stoeckart R. Contribution of pelvic floor muscles to stiffness of the pelvic ring. Clin Biomech (Bristol, Avon) 2004; 19:564-71.
24. Moore KL, Dalley AF. Anatomia orientada para a clínica. 4th ed. São Paulo: Guanabara Koogan; 2001.
25. Reid R. MO clinical review: vulvodynia update. Medical Observer 2003:36-7.
26. Smart OC, Maclean AB. Vulvodynia. Curr Opin Obsted Gynecol 2003;15:497-500.
27. Bachmann GA, Rosen R, Pinn VW, et al. Vulvodynia: a state of the art consensus on definitions, diagnosis and management. J Reprod Med 2006;51:447-56.
28. Amaro JL, Oliveira Gameiro MO, Padovani CR. Treatment of urinary stress incontinence by intravaginal electrical stimulation and pelvic floor physiotherapy. Int Urogynecol J Pelvic Floor Dysfunct 2003;14:204-8.
29. Sabatino H, Salinas M, Marques MLN, Fragnito HL. Análise quantitativa de Pressões Intravaginais em Gestantes Normais. Rev Bras Ginec Obstet 1995;17:819.
30. Bo K, Finckenhagem HB. Is there any difference in measurement of pelvic floor muscle strength in supine and standing position? Acta Obst Gynecol Scand 2003;82: 1120-4.
31. Bo K, Kvarstein B, Hangen R, Larsen S. Pelvic floor muscle exercises for the treatment of female stress urinary incontinence: II. Validity of vaginal pressure measurements. Neurourol Urodyn 1990;9:479-87.
32. Hollinshead HW. Anatomia. 4ª ed. Rio de Janeiro: Interlivros; 1991. p. 625-71.
33. Bernardes NO, Peres RF, Souza E, Souza OL. Métodos de Tratamento Utilizados na Incontinência Urinária de Esforço Genuína: um Estudo Comparativo entre Cinesioterapia e Eletroestimulação Endovaginal. RBGO 2000;22: 49-54.