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Long-term effect of first childbirth on pelvic floor muscle function: cross-sectional study

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Summary

The aim of this study was to evaluate and compare the pelvic floor muscles (PFM) function of nulliparous and primiparous women with history of vaginal delivery and cesarean section. This study took place at the Women's Health Research Laboratory, in the Department of Physical Therapy at Federal University of São Carlos, Brazil. Sixty volunteers were included between 18 and 40 years-old; regarding the primiparous, the assessment was done strictly from one to three years postpartum. A sample of 20 participants in each group was determined: vaginal delivery group, cesarean group and nulliparous group. Procedures included vaginal palpation, vaginal manometry and surface electromyography of the PFM. Non-parametric variables were analyzed using Kruskal-Wallis test or Mann-Whitney test and parametric variables using One-way ANOVA. A significance level of 5% was adopted. No significant difference was found between groups in relation to the function of the PFM evaluated by digital palpation (p = 0.75), vaginal manometry (p = 0.25) and surface electromyography (p = 0.465). The function of the PFM was similar between primiparous and nulliparous.

Key words: Primiparous; Delivery; Pelvic floor muscle function; Electromyography; Vaginal manometry.

Introduction

Pelvic floor muscles (PFM) work along with bone structures, fascia and ligaments to promote support to the pelvic organs and maintain urinary and anal continence [1, 2]. Pregnancy and delivery may contribute to the occurrence of PFM disorders, such as pelvic organ prolapse and urinary incontinence (UI) [2]. However, the long-term effects of mode of delivery on PFM function remain inconclusive in the literature.

Typical pregnancy-related physiological, mechanical and hormonal changes, such as overloading of the pregnant uterus on the bladder and PFM, increased progesterone levels, smooth muscle relaxation and connective tissue remodeling, can compromise PFM function [3], being pregnancy considered a risk factor for UI [4]. During childbirth, the PFM performs marked distension to allow the passage of the fetal head through the birth canal [5]. In some cases, skeletal muscle fibers might reach their elastic limit culminating in trauma, which may occur within the muscle body or at the muscle insertion, being partial or complete [5].

Childbirth-related trauma in the PFM can manifest as an avulsion of the levator ani muscle or over-distension of levator hiatus [1], both associated with reduced contractile function assessed by vaginal palpation [6].

The function of PFM after delivery has already been investigated, and the results are contradictory. There are reports showing that cesarean section might present a protective effect to the pelvic floor [7] and that vaginal delivery is associated with greater PFM function loss when compared to cesarean [8, 9]. On the other hand, other studies demonstrate that parity compromises PFM function regardless of mode of delivery [10], and cesarean sections do not reduce the occurrence of pelvic floor dysfunction in the long-term [11].

In regards to the elaboration of rehabilitation and preventive strategies for PFM dysfunctions, the knowledge about this question is necessary. Therefore, the aim of this study was to evaluate and compare the PFM function of nulliparous and primiparous women with history of vaginal delivery and cesarean section. The hypothesis of the present study is that PFM function is most impaired in primiparous when compared to nulliparous, regardless of the mode of delivery.

Materials and Methods

This is a is cross-sectional study and it took place at the Women's Health Research Laboratory, in the Department of Physical Therapy at Federal University of São Carlos, São Carlos SP, Brazil, from November 2014 to November 2015.

The recruited were sexually active (report of any sexual intercourse in the last three months) [12] nulliparous and primiparous women aged between 18 and 40 years; regarding the primiparous,

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delivery must had occurred at term (after 37 weeks of pregnancy) and the assessment done strictly from one to three years postpartum. Non-inclusion criteria were: current or previous BMI ≥ 30 kg/m^2, current pregnancy, instrumental vaginal delivery, motor or neurological deficit in the lower extremity, prior abortion after 12 weeks of pregnancy, smoking, alcoholism or use of illicit drugs, pelvic organ prolapse extending beyond the vaginal introitus, urinary tract infection, diabetes mellitus, constipation (fewer than three defecations per week) and absence of voluntary PFM contraction verified by digital palpation.

The study was advertised to the population through the Social Communication Center of the Federal University of São Carlos, social media websites and flyers throughout the city. Women interested in participating contacted the Women's Health Research Laboratory and had an appointment arranged for the first assessment.

The sample size was calculated using G*Power software, based on PFM strength data by vaginal manometry from Hilde *et al.* [9], in order to compare the three groups of participants. The ANOVA test application was considered, with a large effect size (f2 = 0.42), 0.80 of power and a 5% significance level. A sample of 20 participants in each group was determined: vaginal delivery group, cesarean group and nulliparous group. The project was approved by the Research Ethics Committee of the Federal University of São Carlos, under the document number 819,698. The volunteers were informed about the proposed procedures and signed an informed consent form. There was no allowance for volunteers to participate in the study.

A single physical therapist performed the anamnesis and application of questionnaires. Another physical therapist, experienced in PFM function assessment, and blinded in relation to the mode of delivery, performed the digital palpation, vaginal manometry and surface electromyography (SEMG).

The procedures were executed in two days in order to conform to the volunteers' routine. On the first day, anamnesis, digital palpation and vaginal manometry were performed. The anamnesis was carried out to investigate the gynecological and obstetric history and to apply the inclusion and non-inclusion criteria. The current urinary loss was investigated through two modified questions from the "King's Health Questionnaire" [13, 14]: "Do you feel a strong urge to urinate, with urine loss before getting to the bathroom?" and "Do you lose urine during physical efforts such as coughing, sneezing, running, etc.?" The level of physical activity was assessed through the "Baecke Questionnaire on Habitual Physical Activity" (BQHPA) [15, 16]. The questionnaires were completed by the physical therapist during an interview with the volunteers.

Concerning the digital palpation, the volunteers were positioned in supine, with hip and knees flexed and feet resting on the assessment bed. The physical therapist introduced the index finger in the vagina of the volunteer, properly lubricated and protected by a procedure glove, and asked a maximal voluntary contraction (MVC) of PFM through the instruction of a "squeeze and inward" movement with the greatest strength possible, avoiding the use of abdominal, gluteal and hip adductor muscles. The degree of PFM function was classified according to the Modified Oxford Scale [17].

After five minutes, the vaginal manometry was carried out using a Peritron manometer. The vaginal sensor was introduced until half of the probe was approximately 3.5 cm into the vagina, then the vaginal resting pressure was registered. Next, the device was calibrated and the volunteer was instructed to perform three five-second PFM contractions and with a 30-second resting interval between them [18], with the greatest strength possible and avoiding the use of accessory muscles. The average of the three contractions was calculated and used in the analysis. The performance of proper contractions was confirmed by observing the movement of the probe and minimum contraction of the accessory muscles. The vaginal pressure was measured in centimeters of water. After a minimum 72-hour period, required to schedule the next visit, the SEMG of PFM was performed using a Myotrac Infinity equipment, with frequency acquisition of 1 KHz, accuracy gain of 0.5%, input impedance of 10GΩ, frequency band of 10-1 KHz and common mode rejection ratio >130 dB. A vaginal probe was used, with the two lateral stainless steel electrodes positioned longitudinally and with a latero-lateral disposal when placed into the vagina. A self-adhesive reference electrode was placed on the left anterior superior iliac spine of the volunteer. The participant remained in supine, knees flexed and both feet resting on the examination bed. Abdominal contractions were performed for data normalization [19]. In this respect, the volunteer was instructed to perform a light attempt to sit up, lifting the head and the upper portion of the scapulas off the bed, and holding this position for five seconds before returning to the resting position. One attempt was performed for familiarization, followed by three valid attempts, with one-minute resting interval between them. After five minutes, the SEMG was performed during a MVC of the PFM. The volunteer was instructed to contract the PFM as strongly as possible in a "squeeze and inwards" movement, avoiding contractions of hip adductors, abdominal and gluteal muscles. Three five-second MVC were performed, followed by a one-minute resting interval in between.

Routines to quantify electromyographic activity were developed in the Matlab software (version 7.0.1). The data was filtered through the Butterworth filter, with a band pass from 30 to 450 Hz and zero delay phase. The Notch filter was applied (60, 120, 180 Hz) to eliminate noises from the power grid [20]. To quantify the electrical activity, the root mean square (RMS) of the signal average was used, obtained by windowing. The windows were programmed with a duration of 40 ms and 50% overlap. The maximum RMS of the PFM's MVC was found, normalized by the average RMS value of abdominal contraction activity [19] and noted as a percentage.

In order to test the reproducibility of the evaluations, ten volunteers were assessed in two occasions, with a two-week interval, to determine the intraclass correlation coefficient (ICC) and the standard error of measurement (SEM) for the digital palpation and vaginal manometry. ICC values greater than 0.75 were considered excellent [21]. The reproducibility analysis of PFM function assessment by digital palpation showed an ICC of 0.81 (95% CI, 0.14 to 0.95) and a SEM of 0.6. Vaginal manometry presented an ICC of 0.99 (95% CI 0.93 to 0.99) and 0.5 SEM.

The statistical analysis was performed using the Statistical Package for Social Sciences software (SPSS V17). Data normality was tested by the Shapiro-Wilk test. Non-parametric variables were analyzed using the Kruskal-Wallis test or the Mann-Whitney test. One-way ANOVA was used for parametric variables. A significance level of 5% was adopted.

Results

The study recruited 136 women, 78 of whom were considered eligible the study. Among these, 18 were excluded due to intolerance to the evaluation (n=3), instrumental vaginal delivery (n=2), absence of PFM voluntary contraction (n=3), previous BMI ≥ 30 kg/m2 (n=1), prior pelvic surgery (n=2), urinary tract infection (n=5), neurological disease (n=1), intestine constipation (n=1). Finally, 60 vol-

Table 1. — *Clinical characteristics, demographic data and obstetric history of the volunteers included in the study. Data are presented as mean ± standard deviation.*

	Vaginal delivery group	Cesarean group	Nulliparous group	*p*
Age (years)	31.6 ± 4.1	32.3 ± 4.3	29.1 ± 4.8	0.06
Body mass (kg)	61.0 ± 8.2	62.4 ± 6.7	64.0 ± 6.5	0.28
BMI (kg/m²)	22.6 ± 2.8	23.7 ± 2.4	23.7 ± 2.6	0.17
BQHPA- TS	7.6 ± 1.1	7.7 ± 1.1	8.3 ± 1.0	0.15
Body mass before Pregnancy (kg)	61.1 ± 6.7	61.4 ± 7.5	-	0.86
Body mass gain during Pregnancy (kg)	12.7 ± 3.7	11.6 ± 3.8	-	0.41
Pregnancy week at birth	39.2 ± 1.1	38.9 ± 1.2	-	0.47
Postpartum time (months)	19.4 ± 7.4	20.4 ± 8.2	-	0.72
Restored menstrual cycle (%)	80% (n=16)	75% (n=15)	-	
Newborn				
Body mass (g)	3198.6 ± 370.2	3261.7 ± 539.8	-	0.78
Head circumference (cm)	32.2 ± 1.8	34.2 ± 1.7	-	0.002

BQHPA: Baecke questionnaire on habitual physical activity; TS: total score.

Table 2. — *Digital palpation, vaginal manometry and surface electromyography of pelvic floor muscles. Digital palpation is presented as median with interquartile range (IQR). Other data are presented as mean ± standard deviation (SD) with a confidence interval (CI) of 95%.*

	Vaginal delivery Group		Cesarean group		Nulliparous group		*p*
		CI (95%)		CI (95%)		CI (95%)	
Digital palpation, median (IQR)	2 (3 - 2)	1.8 – 2.4	2 (3 - 2)	1.9 – 2.6	2 (3 - 2)	1.8 – 2.6	0.75
Vaginal pressure at rest (cmH_2O), mean ± SD	30.6 ± 10.9	25.5 – 35.7	38.7 ± 13.1	32.6 – 44.8	34.0 ± 10.2	29.1 – 38.7	0.16
Vaginal pressure during MVC (cmH_2O), mean ± SD	30.2 ± 19.3	21.2 – 39.2	39.8 ± 19.9	30.5 – 49.1	42.2 ± 24.9	30.5 – 53.85	0.25
Maximum RMS of normalized MVC, mean ± SD	410.7 ± 167.4	324.6 – 496.8	441.1 ± 223.8	321.8 – 560.3	355.2 ± 169.1	261.5 – 448.8	0.465

RMS: root mean square; MVC: maximum voluntary contraction.

unteers were included and allocated into groups according to parity and mode of delivery. There was no statistical difference regarding clinical characteristics, demographic data and obstetric history of the groups assessed (Table 1).

Regarding the practice of any PFM training during pregnancy, 40% (n=8) of the women in the vaginal delivery group reported to have practiced, while 30% (n=6) of the cesarean group. Among nulliparous, previous PFM training was performed by 20% (n=4). Most of the volunteers (70%) reported they had never performed this training.

The occurrence of UI was 25% (n=5) in vaginal delivery group, and from those participants 10% (n=2) had stress UI, 10% (n=2) urgency UI and 5% (n=1) mixed UI. In the cesarean group, 20% (n= 4) presented UI, of which 10% (n=2) stress UI, 5% (n=1) urgency UI and 5% (n=1) mixed UI. In the nulliparous group only a single subject (5%) had stress UI.

Table 2 presents data on digital palpation, vaginal manometry and SEMG. No significant difference was found between groups in relation to the function of the PFM evaluated by digital palpation (p = 0.75), vaginal manometry (p = 0.25) and surface electromyography (p = 0.465). The calculation of sampling power for vaginal palpation was done through the Goodness-of-fit test, considering an effect size of 0.3, which resulted in a sampling power of 0.54. Among those volunteers, eight did not return for the SEMG, two were excluded due to signal noises during assessment and other two were excluded due to error during data exporting. The electromyographic analysis included 48 volunteers and a post hoc sample power of 0.67 was obtained, calculated using the ANOVA fixed effects test and considering an effect size of 0.4.

Discussion

The results demonstrated no significant difference in PFM function, vaginal pressure and SEMG between primiparous who had a vaginal delivery or cesarean section between one and three years postpartum, and nulliparous. It is worth to mention that the volunteers included were young, eutrophic, with similar physical activity levels, without intestinal constipation and no history of instrumental vaginal delivery. Such similarities made it possible to compare groups and exclude other factors that could influence the outcomes.

The results found did not correspond to the initial hypothesis of the study, that primiparous would present less PFM function when compared to nulliparous, regardless of the mode of delivery. However, this difference in the PFM function of primiparous – compared to nulliparous – was observed in studies that assessed PFM function in a two- to six-month period after delivery [8, 10, 22]. Regarding mode of delivery, some studies have found greater loss of PFM function after vaginal delivery [8, 9, 23]. Given the period postpartum in which volunteers were assessed in this study, it is possible that PFM function has been recovered to pre-pregnancy levels, although there is a gap in the literature regarding the recovery of function in these muscles after delivery.

Peschers *et al.* [23] found no significant differences in PFM function between six and ten weeks after delivery and nine to 15 months later. In that study, the authors report that PFM function is restored to pre-delivery levels in a period of six to ten weeks postpartum, which was not observed by Elenskaia *et al.* [24]. Elenskaia *et al.* [24], who assessed PFM function of women during pregnancy, 14 weeks and 12 months postpartum through vaginal palpation and manometry, concluded that there was a momentary worsening in PFM function postpartum, regardless the mode of delivery, and the function of these muscles recovered within one year in most women.

Most studies assessing PFM function in a period greater than six months postpartum used transperineal ultrasonography. Staer-Jensen *et al.* [25] investigated changes in the morphology of the pelvic floor of primiparous after vaginal and cesarean deliveries, and compared these changes with data obtained during pregnancy. A significant decrease was observed in all ultrasonographic measurements in the first six months following vaginal delivery. In the cesarean group, there were no significant differences between the examination points. However, at 12 months postpartum, there was no significant difference between the vaginal delivery and cesarean groups for most of the measurements. The authors concluded that the levator ani muscle has the ability to recover after gestation and delivery, with the greatest percentage the restoration obtained within six months postpartum, although the duration of recovery varies. Shek *et al.* [26] and Falkert *et al.* [27] found no evidence of regression in the hiatal dimensions related to pregnancy and delivery, even after two years postpartum.

In the present study, no imaging evaluation of PFM function was used. Nevertheless, the recommendations by Bø and Sherburn [28] where followed, which suggests that PFM function can be better investigated by the use of a combination of inspection, vaginal palpation and vaginal manometry. In addition, the occurrence of an overdistension of the levator hiatus was associated with a highly significant reduction in the degree of FPM function assessed through the Modified Oxford Scale [6].

To investigate the electrical activity of PFM a SEMG was performed. This method has been used in both research and clinical practices. Even so, the lack of standardization for equipment and probe design, and signal processing compromise the comparison of studies. The results of the present study showed no significant difference in the electrical activity of PFM between primiparous and nulliparous; however, no studies evaluating PFM through SEMG in a period postpartum similar to this study were found. Pereira *et al.* [29] observed a lower electric activity of these muscles in primiparous, from 40 to 60 days after delivery, compared to nulliparous. Botelho *et al.* [30] assessed primiparous 40 to 60 days after vaginal delivery with episiotomy, elective caesarean and emergency cesarean. The authors observed a lower electrical activity of PFM after vaginal delivery; yet, the fact that primiparous included in the vaginal group suffering an episiotomy may have influenced the results.

In the present study, there were not included, among other criteria, diabetic, smoking or alcoholic, and obese women, or those with a history of instrumental vaginal delivery. The non-inclusion criteria adopted aimed to limit, as much as possible, the interference of confounding variables in the outcome investigated. In addition, the sampling powers post hoc for vaginal palpation and SEMG were calculated, and the numbers found were below the desirable value of 0.80 for both.

Another limitation of the present study is the absence of an ultrasonographic assessment, by which it would be possible to analyze the area of the vaginal hiatus and urethral mobility. In addition, there was no access to information about the obstetric assistance during labor and delivery. Some factors such as the length of second stage of labor [31] may have influence over PFM function after childbirth. On the other hand, the strengths of the present study involve the reproducibility evaluation of vaginal palpation and manometry methods, as these are measures that can be influenced by skill and clinical experience of the appraiser [28]. The reproducibility results were excellent and reveal the experience of the physical therapist in this type of assessment. Moreover, the blind assessment of PFM function in relation to mode of delivery reduces the occurrence of bias in the methods.

PFM function has been identified as a predictive variable for stress UI [32] and the assessment of PFM voluntary contraction is required to obtain information about contraction ability [28] and to prepare intervention programs [17]. The knowledge of PFM function after pregnancy and childbirth can contribute to the construction of preventive and rehabilitation strategies, since the PFM training is recommended during pregnancy and after delivery to prevent and treat UI [33, 34]. However, in the present study, most volunteers had never performed this type of training. Women should have access to counseling and training to adequately prevent future pelvic floor dysfunctions.

Conclusion

According to the present study, it is possible to conclude that PFM function among primiparous, after spontaneous vaginal delivery and cesarean section, from one to three years postpartum, and nulliparous was similar. PFM recovery after pregnancy and childbirth should be investigated in future studies. To improve the role of the physical therapist in clinics and hospitals, it is important to investigate whether interventions, such as PFM training, can accelerate the healing process and reduce the impact of pregnancy and childbirth over the emergence of dysfunctions.

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