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Electromyographic activity of the pelvic floor muscles in the third trimester: comparison between primigravidae and secundigravidae

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Summary

Objective: The objective was to compare the electromyographic activity of pelvic floor muscle (PFM) on third semester between primigravidae and secundigravidae who had previous vaginal delivery. *Design:* Cross-sectional observational study. *Sample:* Nineteen primigravidae and 21 secundigravidae between 34th and 36th gestational weeks were evaluated. *Materials and Methods:* Data collection consisted in assessing the PFMs activity by surface electromyography. *Main outcome measures:* The variables related to electromyographic assessment such peak and average on the rest, maximal voluntary contraction, and sustained contraction. *Results:* There were no differences on electromyographic activity of PFMs between primigravidae and secondigravidae. However, a significant increase in body mass index and a negative correlation of the newborn weight with the peak value of electromyographic signal during maximal voluntary contraction were observed. *Conclusions:* The factors that can change the electromyographic activity pattern during pregnancy can be related to maternal body mass increased and newborn weight.

Key words: Electromyography; Pelvic floor; Pregnancy; Urinary incontinence.

Introduction

The pelvic floor muscles (PFMs) suffer an overload during pregnancy due to progressive increase of the uterus and its weight and size, which goes from 70 grams to about 1,000 grams [1]. Gradually, the gravid uterus increases the angle between the bladder neck and the urethra, and may contribute to the onset of the PFM dysfunctions, such as urinary symptoms and pelvic organ prolapses [2].

Maternal age over 35 years and previous obesity are mentioned as factors predisposing to PFM dysfunction [3]. In addition, parity is indicated as a risk factor for the onset of urinary symptoms [4]. Some studies have found higher prevalence of PFM dysfunction in women with previous vaginal delivery compared to those who underwent caesarean section [5, 6]. Although parity and vaginal delivery are considered risk factors leading to the development of PFM disorders, there is evidence that such conditions can also occur in pregnant women, suggesting that more than childbirth, the first pregnancy may be associated with PFM changes [7]. Therefore it is important to search for new diagnostic methods and techniques that can support the prevention or treatment of PFM disorders. However, information about the possible changes on electrical activation of the PFM during pregnancy, and their relationship with pregnancy and previous vaginal delivery are not established.

The aim of this study was to compare the electromyographic (EMG) activity of the PFM in the third trimester between primigravidae and secundigravidae, with previous vaginal delivery.

Materials and Methods

This was a cross-sectional study conducted from July 2012 to October 2013. The study was approved by the Ethics Committee on Human Research of the Federal University of Sergipe, in accordance with Resolution 466/12 of the National Health Council (CAAE: 06190112.9.0000.5546). The study was conducted in two Family Health Units in Aracaju city (Sergipe, Brazil). While attending prenatal program, the pregnant women were invited to participate at the study by the responsible researcher. All women signed the consentient form.

The sample size calculation was performed using G* Power 3.1.3 program. The values found on Marques *et al.* [8] study were used as parameter for the EMG activity of the PFM in primigravidae and secundigravidae. For a power of 0.80 and alpha test error of 5%, 21 patients per group was suggested.

Inclusion criteria were primigravidae and secundigravidae (with previous vaginal delivery), aged between 18 and 40 years, body mass index (BMI) before pregnancy considered normal, based on the World Health Organization (WHO) concept [9], gestational age between 34-36 weeks, low risk, single pregnancy, and who were in prenatal care. Exclusion criteria were risk of abortion, uterine bleeding, previous and recurrent abortion, urinary tract in-

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fection and/or inflammation, cognitive impairment, illicit drug, smoking, and alcohol intake.

The evaluation was conducted between the 34th and 36th gestational week, according to the date of last menstruation [10] and/or the first ultrasound performed during pregnancy [11]. The pre-pregnancy BMI was collected through prenatal care card and gestational BMI was assessed based on Atalah table [12]. All data were collected by a single physical therapist with experience in this evaluation.

An anamnesis to inform personal data and obstetrics history was collected. The PFM evaluation was performed by surface EMG, with the following specifications: converting the original signal to the root mean square value, 20 band pass filter to 500 Hz, rate of common mode rejection > 130 dB, and active electrode impedance of 1012 GW. The filter of 60 Hz was used to reduce interferences coming from the power grid. Data were normalized by the peak value of the three maximal voluntary contractions (MVC) [13]. This device records the sum of the electrical potential generated by the muscle fibers depolarization at rest and during voluntary contraction, and its amplitude is recorded in microvolts (uV). It is the most accurate method to measure the integrity for neuromuscular EMG and can be considered as an indirect measure of pelvic floor muscles strength and pressure level during contraction [14].

The positioning during evaluation was supine with hip and knee flexion, and feet flat. The examiner introduced a vaginal sensor with surface capture of stainless steel with 27 mm diameter and 69 mm length and lubricated with water soluble gel on vaginal opening. Two reference electrodes were placed on the right anterior superior iliac crest and on the right lateral malleolus. Self-adhesive electrodes were placed at infraumbilical region of the rectus abdominis for simultaneous measurements of PFM and abdominal muscle activities.

The protocol consisted of 15 seconds of rest for basal activity registration, three MVC maintained by two seconds (with an interval of one minute between each one), and three sustained volunteers contractions (held for six seconds, with an interval of one minute between each one) [15].

In order to identify performing Valsalva maneuver and/or simultaneous contraction of the hip and buttocks adductor muscles, instead of isolated PFM contraction, the abdomen and the perineal region were observed during the PFM contraction. When there was accessory muscles contraction, PFM contraction was not recorded.

Data were tabulated in Excel and statistically analyzed with the Statistica program and through descriptive techniques. The Shapiro-Wilk test indicated non-parametric tests. The Mann-Whitney test was used to compare the EMG activity of the PFM between groups. Correlation analysis between the weight of the newborn in previous pregnancy and the variables related to EMG assessment of PFM was performed using the Spearman correlation coefficient. The following classification of the correlation coefficients was adopted to interpret the magnitude of the correlations: correlation coefficients ≤ 0.3 (weak correlation), > 0.3 to ≤ 0.7 (moderate), and > 0.7 (strong) [16]. A significance level of 5 % ($p \leq 0.05$) was adopted. Data are expressed as mean ± standard deviation.

Results

The study included 40 pregnant women (19 primigravidae and 21 secundigravidae). Table 1 shows the anthropometric characteristics and the gestational age mean at the time of evaluation. The age was significantly greater ($p < 0.0001$) in secundigravidae. For these women, the age mean at first pregnancy was 23.24 ± 3.39 years and the time between pregnancies was 4.90 ± 3.32 years.

Table 2 presents the variables of EMG evaluation of PFM and abdominal muscles. No significant differences were found between groups.

Among the secundigravidae, 47.6% (n=10) underwent episiotomy in previous delivery. Table 3 presents data from the EMG evaluation of PFM in the third trimester of pregnant women who did and did not undergo episiotomy in the previous delivery. No significant differences between groups were observed.

Regarding the newborn weight in previous pregnancy, the mean was 3.38 ± 0.52 kg. There was a significant correlation, moderate and negative ($p = 0.014$, $r = -0.53$), between newborn weight and the peak value of the electromyographic signal during MVC. No correlations were found in other variables.

Table 1. — *Anthropometric characteristics of primigravidae and secundigravidae.*

Characteristics	Primigravidae	Secundigravidae	*p* value
Age (years)	21.74±3.65	28.14±4.15	<0.0001
Gestational age (weeks)	35.11±0.81	34.81±0.81	–
BMI (kg/m²)			
Pre-pregnancy	23.39±3.93	24.89±3.74	0.184
Upon evaluation	27.52±4.02[a]	29.21±4.37[a]	0.378

[a] significant when compared to pre-pregnancy.

Table 2. — *Comparison of EMG evaluation of pelvic floor and abdominal muscles between groups.*

Variables (μV)	Primigravidae	Secundigravidae	*p* value
Rest			
Average - PFM	6.75±2.88	5.75±1.77	0.357
Average - abdominal	4.89±1.99	4.35±1.67	0.323
MVC			
Average - PFM	53.38±8.61	53.55±9.15	0.989
Maximum - PFM	90.34±5.69	92.30±5.04	0.198
Average - abdominal	12.38±5.14	15.13±15.38	0.394
Sustained contraction			
Average - PFM	58.77±12.98	52.06±13.83	0.113
Maximum - PFM	98.94±21.32	93.81±17.68	0.473
Average - abdominal	13.60±5.53	16.39±16.33	0.440

MAP: pelvic floor muscle; MVC: maximal voluntary contraction.

Table 3. — *Mean values of EMG activity of the PFM in the third trimester of pregnant women who did and did not undergo episiotomy in the previous delivery.*

Variables (μV)	Episiotomy	Without episiotomy	*p* value
Rest	5.55±1.78	5.94±1.82	0.622
MVC	52.82±8.98	54.22±9.68	0.888
Sustained contraction	50.11±14.91	53.83±13.25	0.398

Discussion

There was no significant difference in PFM activation in the third trimester when compared to second and first pregnancy, suggesting that parity and previous vaginal delivery were not decisive factors for possible changes in the EMG activity of the PFM.

According Vodusek *et al.* [17], during vaginal delivery, the pelvic floor region is subjected to fetal head pressure that can lead to distension and compression of PFM, connective tissue, and nerves. However, Liang *et al.* [18] claimed that the structural changes of the pelvic floor can gradually regress, returning to pre-pregnancy state with consequent restoration of PFM functions. Likewise, Peschers *et al.* [19] noted that the PFM function was restored ten weeks after vaginal delivery in most women analyzed. This may explain why there were no significant differences between the groups in the third trimester.

Noteworthy, MacLennan *et al.* [20] found no relationship between mode of delivery with the PFM dysfunction, however when considering vaginal delivery with perineal trauma, the occurrence of disorders was higher. Some authors indicate episiotomy as a protective procedure for PFM structures [21]. However, according to a systematic review, selective compared to routine episiotomy, presents a lower risk of posterior perineal trauma, required less suturing, and fewer complications on cicatrization [22]. In the present study, 47.6% of secundigravidae had been submitted to this procedure in the previous birth, but no significant differences were found in the EMG signal of the PFM between women who were and were not submitted to episiotomy.

However, according to Chaliha and Stanton [23], excessive stretching or overloading of PFM tissues can lead to irreversible changes in tissue properties by altering the urethral support and continence mechanisms.

In this sense, the practice of cesarean section has been advocated as a protective procedure for PFM dysfunctions [24]. Allen *et al.* [5] observed abnormalities in pudendal nerve conduction in primiparous undergoing vaginal delivery, compared to those undergoing elective cesarean section. Moreover, Chaliha *et al.* [25] demonstrated that 9% of women undergoing elective cesarean section showed PFM dysfunctions before labor, such as urinary incontinence and detrusor muscle instability. Therefore the pressure of the fetal head on the PFM, which occurs in the second stage of labor, is not primarily responsible for the changes/damage in PFM. This reinforces gestational effects on PFM changes and, thus, there is insufficient evidence to confirm that cesarean section is a protective factor against PFM dysfunctions.

Factors such as maternal age and BMI are important variables that must be considered when evaluating the PFM during pregnancy [26]. Fritel *et al.* [3] concluded that women over 35 years have a higher risk for developing PFM disorders, because the physiological aging is accompanied by an increased in density of PFM fiber denervation. According to Smith *et al.* [27], women with pudendal nerve conduction less than 2.4 ms has a 97% chance of developing urinary incontinence because this factor correlates with low urethral closure pressures. In the present study, the age of secundigravidae was statistically higher than primigravidae. However, the two groups showed maternal age below 35 years, which may have minimized the influence of this variable on urinary symptoms.

Considering BMI values, the primigravidae showed a normal range, but the secundigravidae, the value exceeded the maximum limit of 28.5 kg/m^2. However, it is noteworthy that among the first pregnancy, 31.6% had values above appropriate, with half of those with obesity and, among secundigravidae, the prevalence was 38.1%, with half of women presenting obesity. According to Kirby [28], obesity may contribute to the PFM impairment.

Another factor that seems to predispose to changes in PFM during pregnancy is the weight of the newborn. Eftekhar *et al.* [6] found higher prevalence of disorders in PFM of secundigravidae who had babies with weight greater than 3,000 grams, regardless of the type of delivery. As in the present study, birth weight was correlated significantly and negatively with the peak value of the EMG signal during MVC and this information suggests a possible influence of birth weight on EMG activity of the PFM.

Besides the changes in BMI and birth weight gradually increasing the overload on PFM, hormone action, primarily by the hormone relaxin, can lead to tissue remodeling by reducing his tension and decreasing the pelvic stability [29]. With this, the endopelvic fascia is gradually elongated and weakened due to chronic stress, which can influence the pattern of electrical activity of the PFM [30].

During EMG evaluation of the PFM, simultaneous measurements of the rectus abdominis activity were performed. Sapsford and Hodges [31] observed that in healthy subjects, voluntary activity in the abdominal muscles results in increased pelvic floor muscle activity and this response is preprogrammed. Pereira *et al.* [32] analyzed the co-activation of the abdominal muscles and PFM during isometric exercises in nulligestae, primigravidae, and primiparus not pregnant. The authors stated that only nulligestae had a significant co-activation of these muscles, and no correlation was found between the deficit in muscle synergy and mode of delivery. In the present study, no differences were noted between the abdominal average values between the first and second pregnancy, and in both groups, occurred an increased in abdominal activation during sustained and maximal voluntary contractions. Thus, the synergy of these muscles remained independent of previous parity and mode of delivery.

A limitation in this study was the lack of a group of nuligestae women as a normal pattern in the comparison of EMG activity of the PFM with pregnant women, which could help to elucidate the impact of pregnancy on the PFM. Besides several factors involved in pregnancy and childbirth that can alter the pattern of EMG activity of the

PFM, while influencing their support and continence function, there was no difference in the EMG signal and, consequently, in the PFM between first and second pregnancy. This finding suggesting that parity and previous vaginal delivery of secundigestae were not determining factors to possible changes in the EMG activity of the PFM. Therefore it appears that factors related to gestational process, such as increased maternal body weight and birth weight, may be responsible for changes in EMG activity of the PFM during pregnancy due to the overload on pelvic floor structures.

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References

[1] Lukacz E.S., Lawrence J.M., Contreras R., Nager C.W., Luber K.M.: "Parity, mode of delivery, and pelvic floor disorders". *Obstet. Gynecol.*, 2006, *107*, 1253.

[2] Hebert J.: "Pregnancy and childbirth: the effects on pelvic floor muscles". *Nursing Times*, 2009, *105*, 38.

[3] Fritel X., Fauconnier A., Levet C., Benifla J.L.: "Stress urinary incontinence 4 years after the first delivery: a retrospective cohort after survey". *Acta Obstet. Gynecol. Scand.*, 2004, *83*, 941.

[4] Shafik A., El-Sibai O.: "Study of the levator ani muscle in the multipara: role of levator dysfunction in defecation disorders". *J. Obstet. Gynecol.*, 2002, *22*, 187.

[5] Allen R.E., Hosker G.L., Smith A.R.B., Warrell D.W.: "Pelvic floor damage and childbirth: a neurophysiological study". *Br. J. Obstet. Gynaecol.*, 1990, *97*, 770.

[6] Eftekhar T., Hajibaratali B., Ramezanzadeh F., Shariat M.: "Postpartum evaluation of stress urinary incontinence among primiparas". *Int. J. Gynecol. Obstet.*, 2006, *94*, 114.

[7] Durnea C.M., Khashan A.S., Kenny L.C., Tabirca S.S., O'Reilly B.A.: "The role of pre-pregnancy pelvic floor dysfunction in postnatal pelvic morbidity in primiparous women". I*nt. Urogynecol. J.*, 2014, *25*, 1363.

[8] Marques J., Botelho S., Pereira L.C., Lanza A.H., Amorim C.F., Palma P., Riccetto C.: "Pelvic floor muscle training program increases muscular contractility during first pregnancy and postpartum: electromyographic study". *Neurourol. Urodyn.*, 2013, *32*, 998.

[9] World Health Organization (WHO): "Physical status: the use and interpretation of anthropometry". Report of a WHO Expert Committee. WHO Technical Report Series No. 854. Geneva: World Health Organization, 1995. Available at: http://www.who.int/childgrowth/publications/physical_status/en/

[10] Alexander G.R., Tompkins M.E., Cornely D.A.: "Gestational age reporting and preterm delivery". *Public Health Rep.*, 1990, *105*, 267.

[11] Rossavick L.K., Fishburne J.I.: "Conceptional age, menstrual age, and ultrasound age: A second trimester comparison of pregnancies of known conceptional date with pregnancies dated from the last menstrual period". *Obstet. Gynecol.*, 1989, *73*, 243.

[12] Atalah S.E., Castillo L.C., Castro S.R., Aldea P.A.: "Propuesta de un nuevo estándar de evaluación nutricional en embarazadas". *Rev. Med. Chile*, 1997, *125*, 1429.

[13] Ervilha U.F., Duarte M., Amadio A.C.: "Estudos sobre procedimentos de normalização do sinal eletromiográfico durante o movimento humano". *Rev. Bras. Fisiot.*, 1998, *3*, 15.

[14] Shafik A., Doss S., Assad S.: "Etiology of the resting myoelectric activity of the levator ani muscle: physioanatomic study with a new theory". *World J. Surg.*, 2003, *27*, 309.

[15] Batista R.L., Franco M.M., Naldoni L.M., Duarte G., Oliveira A.S., Ferreira C.H.: "Biofeedback and the electromyographic activity of pelvic floor muscles in pregnant women". *Rev. Bras. Fisioter.*, 2011, *15*, 386.

[16] Barbetta P.: "Estatística aplicada às ciências sociais". Florianópolis: Editora UFSC, 2006.

[17] Vodusek D.B., Janko M., Lokar J.: "EMG, single fibre EMG and sacral reflexes in assessment of sacral nervous system lesions". *J. Neurol. Neurosurg. Psychiatry*, 1982, *45*, 1064.

[18] Liang C.C., Tseng L.H., Horng S.G., Lin I., MChang S.D.: "Correlation of pelvic-organ prolapse quantification system scores with obstetric parameters and lower urinary tract symptoms in primiparae postpartum". *Int. Urogynecol. J.*, 2007, *18*, 537.

[19] Peschers U.M., Schaer G.N., Delancey J.O.L., Schuessler B.: 'Levator ani function before and after childbirth". *Br. J. Obstet. Gynaecol.*, 1997, *104*, 1004.

[20] MacLennan A.H., Taylor A.W., Wilson D.H., Wilson D.: "The prevalence of pelvic floor disorders and their relationship to gender, age, parity and mode of delivery". *Br. J. Obstet. Gynecol.*, 2000, *107*, 1460.

[21] Podnar S., Lukanovic A., Vodusek D.B.: "Anal sphincter electromyography after vaginal delivery: neuropathic insufficiency or normal wear and tear". *Neurourol. Urodyn.*, 2000, *19*, 249.

[22] Hartmann K., Viswanathan M., Palmieri R., Gartlehner G., Thorp J., Lohr K.N.: "Outcomes of routine episiotomy: a sistematic review". *JAMA*, 2004, *293*, 2141.

[23] Chaliha C., Stanton S.L.: "Urological problems in pregnancy". *BJU Int.*, 2002, *89*, 469.

[24] Sand P.K.: "Should women be offered elective cesarean section in the hope of preserving pelvic floor function?" *Int. Urogynecol. J.*, 2005, *16*, 255.

[25] Chaliha C., Khullar V., Stanton S.L., Monga A., Sultan A.H.: "Urinary symptoms in pregnancy: are they useful for diagnosis?" *Br. J. Obstet. Gynecol.*, 2002, *109*, 1181.

[26] Viktrup L., Lose G.: "The risk of stress incontinence 5 years after first delivery". *Am. J. Obstet. Gynecol.*, 2001, *185*, 82.

[27] Smith A.R., Hosker G.L., Warrel D.W.: "The role of pudendal nerve damage in the aetiology of genuine stress incontinence in women". *Br. J. Obstet. Gynaecol.*, 1989, *96*, 29.

[28] Kirby M.: "Managing stress urinary incontinence – a primary care issue". *Int. J. Clin. Pract.*, 2006, *60*, 184.

[29] Neumann P., Gill V.: "Pelvic floor and abdominal muscle interaction: EMG activity and intra-abdominal pressure". *Int. Urogynecol. J.*, 2002, *13*, 125.

[30] DeLancey J.O.L., Kearney R., Chou Q., Speights S., Binno S.: "The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery". *Obstet. Gynecol.*, 2003, *1*, 46.

[31] Sapsford R.R., Hodges P.W.: "Contraction of the pelvic floor muscles during abdominal maneuvers". *Arch. Phys. Med. Rehabil.*, 2001, *82*, 1081.

[32] Pereira L.C., Botelho S., Marques J., Amorim C.F., Lanza A.H., Palma P., Riccetto C.: "Are transversus abdominis/oblique internal and pelvic floor muscles coactivated during pregnancy and postpartum?" *Neurourol. Urodyn.*, 2013, *32*, 416.

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