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GENERAL GYNECOLOGY

Association between pelvic floor dysfunction, and clinical and ultrasonographic evaluation in primiparous women: a cross-sectional study

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Abstract

Purpose Disorders related to pelvic floor include urinary incontinence (UI), anal incontinence, pelvic organ prolapse, sexual dysfunction and pelvic pain. Because pelvic floor dysfunctions (PFD) can be diagnosed clinically, imaging techniques serve as auxiliary tools for establishing an accurate diagnosis. The objective is to evaluate the PFD in primiparous women after vaginal delivery and the association between clinical examination and three-dimensional ultrasonography (3DUS).

Methods A cross-sectional study was conducted in a in tertiary maternity. All primiparous women with vaginal deliveries that occurred between January 2013 and December 2015 were invited. Women who attended the invitation underwent detailed anamnesis, questionnaire application, physical examination and endovaginal and endoanal 3DUS. Crude and adjusted predictor factors for PFD were analyzed.

Results Fifty women were evaluated. Sexual dysfunction was the most prevalent PFD (64.6%). When associated with clinical features and PFD, oxytocin use increased by approximately four times the odds of UI (crude OR 4.182, 95% CI 1.149–15.219). During the multivariate analysis, the odds of UI were increased in forceps use by approximately 11 times (adjusted OR 11.552, 95% CI 11.155–115.577). When the clinical and obstetrical predictors for PFD were associated with 3DUS, forceps increased the odds of lesion of the pubovisceral muscle and anal sphincter diagnosed by 3DUS by sixfold (crude OR 6.000, 95% CI 1.172–30.725), and in multivariate analysis forceps again increased the odds of injury by approximately 7 times (adjusted OR 7.778, 95% CI 1.380–43.846).

Conclusion Sexual dysfunction was the most frequent PFD. The use of forceps in primiparous women was associated with a greater chance of UI and pelvic floor muscle damage diagnosed by 3DUS.

Keywords Vaginal delivery · Pelvic floor dysfunction · Ultrasound · Childbirth

Introduction

Disorders related to pelvic floor include a common group of pathological conditions, with pregnancy and childbirth recognized as the major risk factors [1]. Other biological factors such as ethnicity, family history, genetic and environmental factors contribute to the development of pelvic floor dysfunction (PFD) [2]. The main PFDs include urinary incontinence (UI), anal incontinence (AI), pelvic organ prolapse (POP), sexual dysfunction (SD) and pelvic pain [3]. The prevalence of UI in the general population is approximately 25%, and of these 33% are related to vaginal delivery [4]. About 50% of women who had vaginal delivery have some degree of POP and 4.3% are affected by AI [5].

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Because PFDs can be diagnosed clinically, imaging techniques serve as auxiliary tools for establishing an accurate diagnosis [6]. Through three-dimensional endovaginal and anorectal ultrasonography, it is possible to visualize the anatomy and function of the pelvic floor muscles [7] in multiple planes and in high resolution, revealing anatomical lesions that are related to obstetric risk factors and symptoms that may manifest early or later after vaginal delivery [8]. It also presents benefits such as accessibility and cost–benefit when compared to magnetic resonance imaging [9].

Therefore, the objective of this study is to evaluate the PFD in primiparous women after vaginal delivery and the association between clinical examination and three-dimensional ultrasonography (3DUS).

Methods

This study consists of a cross-sectional study according to Strobe recommendations. All the women who were selected and who agreed to participate in the study received complete information and signed the informed consent form.

The vaginal deliveries of primiparous women that occurred between January 2013 and December 2015 in the maternity department of the Hospital das Clínicas of the UFMG were selected for the research.

The clinical and obstetric data of interest were obtained from the clinical database, SISMater (Information System on Maternal and Neonatal Health) and medical records. Obstetric predictor variables such as twin births, prematurity, the maternal position at delivery, episiotomy, the occurrence of perineal laceration, use of oxytocin, forceps, birth weight, gestational age, duration of the active phase and maternal age were reviewed and selected for further analysis. Information regarding gestational age equal to or greater than 22 weeks and birth weight equal to or greater than 500 g was considered [5]. The active phase of labor was calculated by subtracting the time of birth from the initial recording time on the partograph. The episiotomy was regarded as intentional laceration to reduce a third and fourth-degree spontaneous laceration, which could lead to the lesion of the anal sphincter [5].

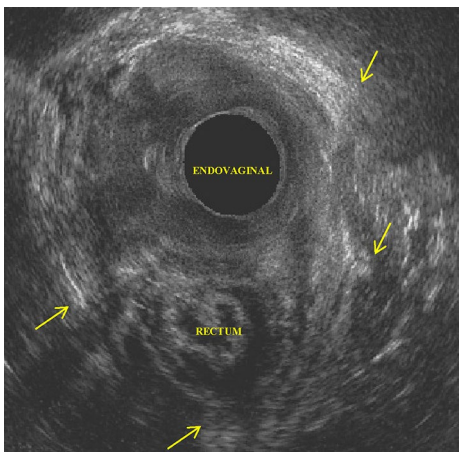

Fig. 1 Bilateral pubovisceral muscle injury

Primiparas who did not have telephone contact available in the database, who declared a second pregnancy at the time of contact, who underwent previous cesarean section, who underwent previous perineal surgery and those who refused to participate in the study were excluded.

Clinical evaluation

All women included in the study attended the Urogynecology Outpatient Clinic and underwent detailed anamnesis, physical examination and endovaginal and endoanal 3DUS; performed by experienced and trained professionals. The following questionnaires assessed urinary incontinence, anal incontinence and sexual dysfunction: the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), the Wexner Scale and the Female Sexual Function Index (FSFI). The FSFI is a questionnaire composed of 19 questions, used to evaluate the female sexual response in five domains: desire, lubrication, orgasm, satisfaction and pain. A final score is obtained by summing these domains and ranges from 2 to 36 points [10]. Sexual dysfunction is defined as "a disturbance in the process that characterizes the sexual response cycle or by pain associated with sexual intercourse." [11]. Weigel et al. proposed a cutoff score to differentiate women with or without sexual dysfunction as 26.55 [12]. Women who scored below the cutoff value on FSFI were classified as sexually dysfunctional.

The evaluation of the pelvic floor muscles was executed by placing the woman in the supine position, performing the bidigital vaginal assessment and requesting the maximum voluntary contraction. Muscle contraction was graded according to the Laycock-modified Oxford Scale [13] that classified it as a 0—no contraction; 1—flicker; 2—weak; 3—moderate with lift; 4—good with lift; 5—strong with lift.

The International Continence Society (ICS) recommends the description and staging of POP through the Pelvic Organ Prolapse Quantification (POP-Q) system [14]. Women were examined in the supine position and measurements were taken in centimeters with the aid of a disposable graduated ruler. All points were measured in maximum Valsalva, except the total vaginal length. The ICS clinically defined POP as significant in stage II or higher.

Ultrasound evaluation

For the ultrasound evaluation, the BK Medical® Pro-Focus 3DUS was used with a 360° transducer type 2052, rotational, frequency from 10 to 16 MHz and focal length ranging from 2.8 to 6.2 cm of depth (Herley, Denmark). The lesion in the pubovisceral muscle (PVM), evaluated by endovaginal ultrasound, was defined as the discontinuation of the PVM in its extension (Fig.1). The internal anal sphincter (IAS) and external anal sphincter (EAS) muscles, evaluated by endoanal ultrasound, were assessed according to their integrity and dimensions by measuring the angle between the injured extremities. The equipment of choice was offered by the service where the study was carried out, and experienced and trained professionals performed the measurements. No comparison was made with other techniques or similar equipment (Fig. 2).

Statistics

The descriptive statistics explored clinical characteristics of women, tests and image outputs, using frequency, measures of central tendency and variability, according to the groups of interest. Univariate and multivariate models of regression analysis were employed to estimate the association of predictors with the PFD.

Qui-square test and Fisher test were the first steps, and odds ratio (OR) and 95% confidence interval (95% CI) were calculated. Multiple regression analysis included, by backward selection, predictor variables from the univariate models (input *P* value of 0.20), considering the clinical relevance and avoiding multicollinearity between the factors. The fit of the models and calibration were obtained with Hosmer–Lemeshow goodness analysis and R^2 based on −2log likelihood. The significance levels, adjusted for the hypothesis test, were 5%.

Results

Six-hundred and ninety-eight primiparous women were contacted for the present study. Fifty-three women responded to the follow-up call and were included. Of these, three were excluded from the study: two due to pregnancy and one due to perineoplasty (Figure S1).

Women were characterized according to the risk factors for PFD: 4% had twin birth, and 12% had preterm deliveries; the mean duration of the active phase was 4:11 ± 4:18 h; labor analgesia was administered in 50% of the women. The lithotomy was the position during the expulsive period in 64% of the primiparous women, and in 36% there was no description of the delivery position. The episiotomy was performed in 58% of the women and the forceps in 16%. There were no records of shoulder dystocia and diabetes mellitus. Twenty-five primiparous women (50%) presented some degree of perineal laceration (first degree 16%, second degree 18% and third degree 16%). No women showed fourth-degree perineal laceration. Twenty-eight primiparous women were using contraceptive hormones, 1 was using thyroid hormones, and 21 reported not using any medications. The clinical and socio-demographic characteristics of the primiparous women are described in Table 1.

Twenty-one women presented a non-zero ICIQ-SF score, (i.e., 42% had UI). The types of UI in these women were 13 with stress urinary incontinence (SUI), 3 with urge urinary incontinence (UUI) and 5 with mixed incontinence. Eighteen (36%) presented some degree of AI on the Wexner Scale. Thirty-one primiparous women (62%) scored below the cutoff value of 26.55 in FSFI, thus presenting SD.

Among the risk factors for PFDs presented in Table 2, we highlight that the use of oxytocin increased by approximately four times the chance of UI (OR 4.182, 95% CI

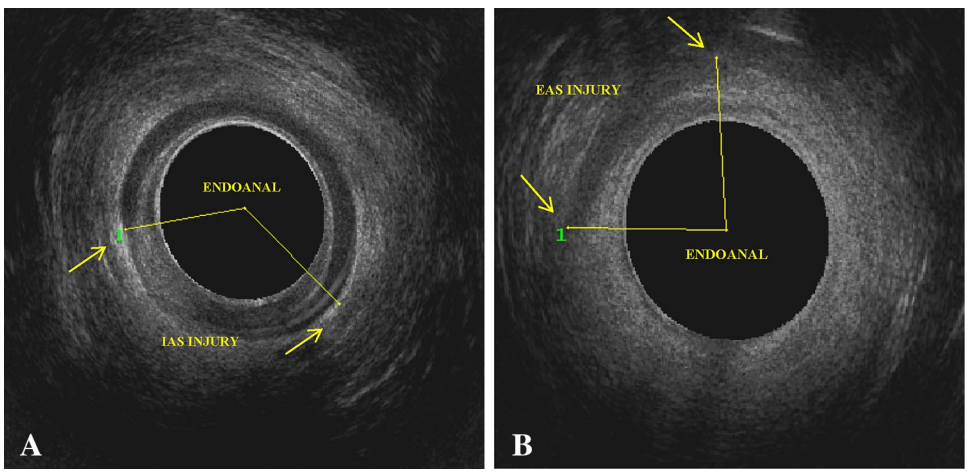

Fig. 2 **a** Internal anal sphincter injury − 125° angle (middle anal canal). **b** External anal sphincter injury − 85.3° angle (inferior anal canal)

Table 1 Socio-demographic and clinical characteristics of primiparous women ($n=50$)

Patient characteristics	
Civil status *n* (%)	
Single	22 (44.0)
Married	28 (56.0)
Education *n* (%)	
Elementary school	3 (6.0)
High school	40 (80.0)
University education	7 (14.0)
Ethnicity *n* (%)	
White	17 (34.0)
Black	13 (26.0)
Brown	20 (40.0)
Medication used *n* (%)	
Hormonal contraception	28 (56.0)
Levothyroxine	1 (2.0)
No medication	21 (42.0)
Maternal age at childbirth (years)	23 (15–41)[b]
Duration of active phase (h)	04:11 ± 04:08[a]
Birth weight (> 3500 g)	3005 (595–4170)[b]
Occurrence of perineal laceration *n* (%)	44 (88.0)
Follow-up time (months)	28.9 ± 8.3[a]
BMI in the evaluation (kg/m^2)	26.2 (17.6–42.8)[b]
Sexual intercourse *n* (%)	
Vaginal	41 (82.0)
Vaginal and anal	9 (18.0)
Intestinal habit *n* (%)	
Intestinal constipation	22 (44.0)
Regular	28 (56.0)

Occurrence of laceration any degree of laceration including that caused by episiotomy. *BMI* body mass index, *Follow-up time* time in months between childbirth and clinical examination

[a]Mean ± standard deviation

[b]Median (maximum − minimum)

1.149–15.219, *P* value 0.025). The other clinical characteristics were not statistically significant when associated with PFD.

Univariate analysis showed that use of oxytocin increased approximately fourfold the chance of UI with OR (4.182 95% CI 1.149–15.219) (Table 3).

In the multivariate analysis (Table 3), the odds of UI were increased with the use of forceps by approximately 11 times (OR 11.552). The other clinical and obstetrical predictors were not statistically significant when associated with UI.

The evaluation of the pelvic floor muscles was performed using the modified Oxford Scale: 0—no contraction: 8%, 1—flicker: 2%, 2—weak: 24%, 3—moderate with lift: 34% and 4—good with lift: 32%. None of the patients had a contraction of strong intensity or cranial elevation of the vaginal wall.

In the evaluation of POP through POP-Q, 3 (6%) women with zero staging were found, 41 (82%) with staging I and 6 (12%) with staging II. The remaining staging was not seen in the primiparous women evaluated.

Of the 50 women evaluated, 10 (20%) presented some lesion proven by 3DUS. On endovaginal ultrasonography, six (12%) primiparous women showed lesions in the PVM. Of these, four (8%) had a right muscle injury, one (2%) left and one (2%) had a bilateral muscle injury (Figure S2). Three women who had PVM lesions also had UI.

In the endoanal ultrasonography, three (6%) primiparous women presented with IAS and EAS (figure S3 and S4) lesions (all three anterior lesion) and two (4%) presented with IAS lesions (one anterior and one posterior). Of these, three women had AI. Among all the women who presented with some injury proven by 3DUS, one (2%) presented with lesion in the three evaluated structures (lesion in the right PVM, anterior IAS and EAS). Five primiparous women who had lesions in the PVM and one primiparous woman with anal sphincter injury complained of SD.

The majority of women who had PVM injury were subjected to episiotomy, had perineal laceration of the second degree and presented with subsequent SD. Most of the women who had lesions of the EAS and more than half of those who had lesions of the IAS presented with AI.

Half of the primiparous women with PVM lesion, all primiparous women with EAS lesions and the vast majority with IAS lesions presented with weak muscle contraction (grade 2 of Oxford Scale).

All women who presented with lesion identified by 3DUS had their POPs classified as stage I. One woman presented with lesion of the IAS and was asymptomatic.

The association between clinical and obstetric predictors for PFD and 3DUS are shown in Table 4. In the univariate analysis, forceps increased sixfold (OR 6.000) the chance of lesion diagnosed by 3DUS, and in the multivariate analysis forceps again increased approximately sevenfold (OR 7.778) the chance of injury. The other clinical characteristics and PFD were not statistically significant for 3DUS lesions.

Forty-one women had POP-Q stage I (82%) and six stage II (12%). Twenty-one women had UI (42%), 18 AI (36%) and 31 SD (62%). Five women (10%) presented the three PFD simultaneously.

Of the 21 women with UI, 19 had POP-Q classified as stage I and only 2 had stage II. On further analyzing patients with UI complaints, three had PVM lesion and EAS, and four presented with IAS lesion.

Table 2 Assessment of the risk factors for pelvic floor dysfunction in primiparous women ($n=50$)

Clinical characteristics	Urinary incontinence (ICIQ-SF)			Anal incontinence (Wexner Scale)			Sexual dysfunction (FSFI)		
	P value	OR	95% CI	*P* value	OR	95% CI	*P* value	OR	95% CI
Gemelar birth	1.000*	1.350	0.080–22.910	0.130*	–	–	0.528*	–	–
Prematurity	0.381*	3.059	0.504–18.581	1.000*	0.844	0.139–5.138	1.000*	1.154	0.188–7.068
Lithotomy position	0.299	0.533	0.162–1.755	0.879	1.100	0.323–3.746	0.072	3.094	0.887–10.795
Episiotomy	0.131	2.500	0.751–8.318	0.834	1.135	0.347–3.716	0.485	1.535	0.459–5.137
Occurrence of perineal laceration	1.000*	1.140	0.173–7.516	0.639*	2.519	0.259–24.470	0.051*	8.923	0.906–87.840
Forceps	0.056*	5.400	0.967–30.165	0.118*	3.718	0.771–17.938	0.396*	3.840	0.422–34.936
Birth weight (> 3500 g)	0.319*	0.438	0.101–1.900	0.724*	0.600	0.137–2.624	1.000*	0.948	0.233–3.850
Use of oxytocin	0.025	4.182	1.149–15.219	0.332	0.519	0.137–1.969	0.480	1.625	0.420–6.291
BMI (> 30 kg/m^2)	0.320*	2.057	0.529–7.996	0.480*	1.806	0.459–7.104	0.727*	1.420	0.315–6.409

Urinary incontinence assessed by the International Consultation of Incontinence Questionnaire-Short Form (ICIQ-SF); anal incontinence assessed by Wexner Scale, sexual dysfunction assessed by Female Sexual Function Index (FSFI)

OR odds ratio, *CI* confidence interval, Chi square test, *Fisher's exact test, *Occurrence of laceration* any degree of laceration including that caused by episiotomy, *BMI* body mass index

Table 3 Analysis of the clinical and obstetric predictors for UI (ICIQ-SF) ($n=50$)

Clinical and obstetric characteristics	Univariate analysis			Multivariate analysis		
	P value	OR	95% CI	Adjusted *P* value	Adjusted OR	Adjusted 95% CI
Lithotomy position	0.301	0.533	0.162–1.755	0.152	0.374	0.098–1.436
Episiotomy	0.135	2.500	0.751–8.318			
Forceps	0.055	5.400	0.967–30.165	0.037	11.552	1.155–115.577
Birth weight	0.637	1.000	0.999–1.001			
Use of oxytocin	0.030	4.182	1.149–15.219			
Duration of active phase	0.370	1.125	0.869–1.456			

Multivariate conditional backward model with input $P=0.10$; adjusted R^2 of the multivariate model: 56%; Hosmer–Lemeshow test, $P=0.881$

OR odds ratio, *CI* confidence interval, *ICIQ-SF* International Consultation of Incontinence Questionnaire-Short Form, *UI* urinary incontinence

Table 4 Analysis of the clinical and obstetric predictors for PFD in patients with 3DUS lesions ($n=10$)

Predictors	Univariate analysis			Multivariate analysis		
	P value	OR	95% CI	Adjusted *P* value	OR ajustado	Adjusted 95% CI
UI	0.205	2.500	0.606–10.321			
AI	0.769	1.238	0.299–5.134			
SD	0.734	0.780	0.186–3.265			
Forceps	0.032	6.000	1.172–30.725	0.020	7.778	1.380–43.846

Multivariate conditional backward model with input $P=0.10$; adjusted R^2 of the multivariate model: 56%; Hosmer–Lemeshow test, $P=0.881$

PFD pelvic floor dysfunction, *3DUS* three-dimensional ultrasonography, *UI* urinary incontinence, *AI* anal incontinence, *SD* sexual dysfunction, *OR* odds ratio, *CI* confidence interval

Of the 18 women who presented with AI, 14 received stage I classification and 4 stage II in POP-Q. Among the women complaining of AI, one with PVM lesion, three with IAS lesion and two with EAS lesion were found.

Among the 31 women with SD, 25 had staging I and 4 staging II in POP-Q. Lesion in the PVM was found in five women with SD. Lesions of the IAS and EAS were found in a woman with SD.

Discussion

Main findings

This study showed that the most frequent PFD in the primiparous women studied was SD, followed by UI and AI. By associating these findings with clinical examination, we found a higher occurrence of POP in women with SD. Also, 3DUS was an effective instrument to identify lesions in the PVM and the IAS and EAS, with association with symptoms of PFD in 20% of the studied group.

The use of oxytocin and forceps were risk factors for UI. The use of forceps was also a risk factor for the occurrence of lesions diagnosed by 3DUS.

Strengths and limitations

The greatest limitation of this study was the low response rate. Only 7% of women who delivered during the period of the study agreed to participate. Another limitation was the evaluation of PVM at rest only. The measurement of the genital hiatus at rest and Valsalva maneuver could have contributed to the association of PFD symptoms and anatomical changes. The use of episiotomies and forceps was higher than expected in this setting [5]. This finding can be attributed to the low number of women who attended the call to participate in the study.

On the other hand, we emphasize that the results found will contribute to the development of future studies of the association of 3DUS and evaluation of the pelvic floor before and after delivery. In addition, the use of validated instruments, POP-Q staging and 3D ultrasound imaging added important value to this study.

Interpretation

In agreement with our findings, a retrospective cohort study by Thom et al. showed that labor induction is associated with late UI, and is more strongly related to two or more inductions (OR 2.67) than only an induction of labor (OR 1.35) [15]. Casey et al., with similar findings, described that women who received a combination of oxytocin and epidural analgesia were more likely to develop symptoms of urgency UI [16]. In our results, 50% of the women received labor analgesia, but we found no significant association of analgesia with UI. Svare et al., when examining the relationship between maternal and perinatal factors and the occurrence of stress and mixed UI, 1 year after the first vaginal delivery, found that the use of oxytocin had a protective effect on the presence of these types of UI [17]. The study by Bazi et al. showed that there were no long-term data on the effect of interventions aimed at shortening the second phase of labor [2]. Karahan et al. showed that the behavior of pelvic floor muscles on electromyography was predominantly silent in the spontaneous delivery group when compared to the oxytocin-induced group. Pressure against the expulsive phase of uterine contraction provoked by contracted muscles seems to lead to obstetrical injuries of these muscles and higher indexes of decisions for episiotomy [18].

The use of forceps significantly increased the chance of UI in the multivariate analysis in the present study. Our findings corroborate the studies by Meyer et al., where UI and bladder neck mobility were significantly increased after spontaneous vaginal delivery and forceps [19].

DeLancey et al. reported that although there is an association between vaginal delivery and stress UI, it is unclear exactly which structures are damaged by birth and which result in a greater likelihood of stress UI. According to the author, the low pressure of urethral closure is the factor most strongly associated with stress UI, followed by alteration of the mobility of the bladder neck after delivery [20]. Our study showed that the most common type of UI was SUI. This finding is similar to a study where 160 primiparous women who had vaginal delivery presented SUI as the most frequent IU type [21]. In addition, the prevalence of SUI was higher after vaginal birth when compared to cesarean delivery [22–25].

Previous studies have shown that 15–30% of all women who had normal delivery had lesions in the PVM [26]. These findings included multiparas as well as primiparas, which may have increased the prevalence of PVM lesions. Our study evaluated only primiparous women, which may justify the lower prevalence. Differently from the results found in the present study, the prevalence of anal sphincter lesion after vaginal delivery varied from 11 to 35% [27]. Our findings indicate a slightly lower prevalence, which can be explained by the small sample. The evaluated patients were selected from the obstetrical database of the maternity department of a university hospital, during a specified period, without taking into consideration any previous symptoms. In addition, none of the patients included had previously undergone ultrasound evaluation. The study by Varma et al. presented a lower percentage of sphincter lesions identified by ultrasound in primiparous women of 6.8% [28].

The majority of the patients evaluated presented weak intensity muscular contraction (Oxford grade 2). All patients who showed some muscular or sphincteric lesion in 3DUS also presented POP-Q stage I, similar to the findings of Dietz et al. and Kearney et al. [29, 30]. Avulsion of the levator muscle seems to increase the risk of significant prolapse of the anterior and central compartments, with less effect in the posterior compartment [1, 31].

Most of the patients who had PVM injury were submitted to episiotomy and presented SD and second degree of perineal laceration. However, this association remains controversial in the recent literature. The study of Kahramanoglu et al. did not present differences in the sexual function between primiparous women who had vaginal delivery with mediolateral episiotomy and those who had cesarean section in the period 12 and 24 months postpartum [32]. According to our findings, Dietz et al. have observed that PVM avulsion appears to have an impact on adjacent or contralateral intact muscle in the case of unilateral lesions. The intact contralateral PVM, by compensatory action, seems to become spastic and very sensitive even after decades, leading to an as yet unknown cause of chronic pelvic pain and dyspareunia [9]. In contrast, Meriwether et al. assessing perineal body during labor showed a positive correlation between a greater introital stretch of the perineal body and improved satisfaction domain scores on the FSFI. This study reassured that maximum stretch in labor does not affect women's sexual function [33]. Another study showed a higher prevalence of sexually inactive women and self-reported scores for sexual dysfunction in FSFI during pregnancy, in the first week postpartum and after 4 months postpartum. However, this study did not specify the parity of the women included in the study [34].

Most of the patients in the study with sphincter injury also complained of AI, and it is well established that obstetric trauma is the most common cause of mechanical injury and/or denervation of the anal sphincter and development of AI [35].

The relationship between UI and sphincter lesions found in our study can be explained by the association of other factors such as the use of episiotomy, occurrence of perineal laceration and use of forceps. Denervation is the most obvious factor to explain this association, due to the deleterious effect of vaginal delivery on the pudendal nerve and its branches [9]. We also emphasize that the use of forceps significantly increased the chance of sphincter injuries by ultrasound similar to that found in the systematic review of O'Mahony et al., who reported that the use of forceps appeared to increase the risk of at least twice that of sphincter injury [36]. 'The use of forceps also consistently increased the likelihood of damage to the levator ani when compared to non-instrumental delivery in 16 different studies [37].

Conclusion

Sexual dysfunction was the most frequent PFD in primiparous women after vaginal delivery in this sample. The use of forceps was associated with a higher chance of UI and pelvic floor muscle damage diagnosed by 3DUS.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The research project was approved by the Research Ethics Committee of the Federal University of Minas Gerais (UFMG) (CAAE: 42099115.3.0000.5149—26 March 2015).

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