Postpartum impairment of pelvic floor muscle function: factors involved and association with prolapse.

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Abstract

Introduction and Hypothesis: to assess factors involved in the impairment of pelvic floor muscle (PFM) function from antepartum to six months postpartum. We also investigated whether reduced PFM strength was associated with pelvic organ prolapse postpartum.

Methods: This was a prospective cohort study including 319 primigravid women delivered vaginally. PFM function was assessed in pregnant women at term and six months postpartum by digital palpation and perineometry. Prolapse was explored using the pelvic organ prolapse quantification (POP-Q) system.

Results: Instrumental delivery, larger newborn head circumference and older maternal age were independent risk factors for impaired PFM function postpartum. Women with POP-Q stage≥II postpartum had a significant decrease in PFM strength with respect to the antepartum period, and lower PFM strength than women without such prolapse.

Conclusions: Both constitutional and obstetric factors are involved in impairment of PFM function postpartum. Reduced PFM strength is associated with prolapse in the postpartum period.

Key words: pelvic floor muscle function; pelvic organ prolapse; risk factors; vaginal delivery

BRIEF SUMMARY:

Factors involved in impairment of PFM function from antepartum to six months postpartum were assessed and its association with prolapse was investigated.

Introduction

Vaginal birth is one of the established risk factors for pelvic organ prolapse (POP) [1-4] being considered the most important modifiable factor for this condition [5]. It has been published that the risk of prolapse among parous women increases by 2 to 11 times [1,6,7]. However, the mechanisms by which vaginal delivery lead to failure of pelvic organ support are not completely understood. The passage of the newborn through the birth canal involves stretching of the muscles, laceration, isquemia and neural trauma, all of them being possible mechanisms by which injury may occur. This damage weakens pelvic floor muscle (PFM) function and as a result there is an increase in the load on the connective tissue that attaches the organs to the pelvis. Furthermore, there is growing evidence that injuries to the PFM contribute to the development of pelvic organ prolapse later in life. Both anatomical [8,9] and functional [8,10,11] abnormalities in pelvic floor muscle have been associated with POP.

Morphological abnormalities of the levator ani muscle occurring after vaginal birth have been identified by magnetic resonance imaging (MRI) [12,13] and ultrasound [14,15]. These injuries have been related to difficult vaginal birth and older maternal age [13-15]. Functional impairments of the PFM after vaginal delivery have been also described. Ultrasound performed six to ten weeks postpartum demonstrated a decrease of contraction ability [16]. Physical examination, electromyography and intravaginal squeeze pressure measures have indicated a decrease in PFM strength after vaginal delivery [17-22]. Although these changes have been indentified, studies assessing the relationship between obstetric factors and impaired PFM function after vaginal birth are somewhat inconclusive [16,20,22].

The aims of this study were to assess the impairment of pelvic floor muscle function from antepartum to six months postpartum by measuring intravaginal squeeze pressure, and to investigate any association of such injury with obstetric variables. We hypothesized that instrumental vaginal delivery would be associated with impairment of PFM function postpartum. We also wanted to estimate whether reduced PFM strength was associated with pelvic organ prolapse shortly after delivery.

Materials and methods

A prospective cohort study was undertaken to assess changes in pelvic floor muscle function after first vaginal delivery and its relationship with pelvic organ prolapse. The study group was recruited from the primigravid women who came to give birth at our public hospital from April to October 2007. The exclusion criteria were: multiple pregnancy, gestational age of less than 37 weeks, previous urogynecological surgery, urogynecological malformations and neurological disorders. Those women whose delivery was completed by caesarean section were also excluded.

Pelvic floor muscle function and strength were assessed in pregnant women at term and the same women six months after delivery. Examinations were performed with the women in a supine position with hips and knees flexed. The ability to perform a PFM contraction was assessed by visual observation and vaginal palpation as has been described before [23]. The instruction used for each contraction was to "squeeze and lift" or to "tighten and pull up" the PFM. Women who were not able to perform a PFM contraction were excluded from the study. Muscle strength was quantified first by manual muscle testing. Women were asked to perform a maximum voluntary contraction and a score from 1-5 was given according to the modified Oxford Grading System [24].

Vaginal squeeze pressure was then measured using a perineometer (Peritron®) recording the strongest of three voluntary pelvic floor contractions as proposed elsewhere [25]. The sensor was placed inside the vagina with an insertion collar attached to ensure the repeatability of insertion depth on each occasion. First, a resting pressure reading was taken and after that the calibration was re-set to zero, prior to recording the vaginal squeeze pressure readings. At the same time, it was observed whether there was an inward movement of the perineum to make sure that a correct contraction was being performed. This method has been found to be reliable and valid to assess PFM strength [26].

Pelvic organ support was assessed six months postpartum using the pelvic organ prolapse quantification (POP-Q) system which has been described previously [27]. The examination was performed with the women in the lithotomy position and under maximum straining. Each distance was measured using a wooden spatula marked at 0.5-cm intervals. POP-Q stage was established on the basis of the most prolapsed compartment and the proportion of women with POP-Q stage ≥ II was calculated.

To investigate the risk factors associated with the changes in PFM strength, we analyzed the following variables: age; height; weight; use of oxytocin, epidural anesthesia; second stage of labor and active pushing time; mode of delivery; episiotomy; 3rd and 4th degree perineal tears; birth weight and head circumference of the newborn; pelvic floor muscle training in the postpartum period; and breast feeding in the postpartum visit. Information about labor and delivery was collected from the clinical charts. The second stage of labor was defined as the time from full cervical dilatation to delivery and the active phase of this second stage as the period of active pushing. The second stage of labor was considered "prolonged" when it lasted two or more hours, while prolonged pushing time was defined as one hour or more. Newborn weight and head circumference were also categorized as <4000 g or ≥ 4000 g, and < 36 cm or ≥ 36 cm respectively.

All the women who participated were fully informed about the study before enrollment and gave their consent. The study protocol was approved by the Donostia Hospital Clinical Research Ethics Committee.

Statistical analysis of the data

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 15.0 for Windows). Correlations between manual testing and perineometry measures were assessed by Pearson's correlation test, while comparison between PFM resting tone and strength from antepartum to six months postpartum was performed with paired t-tests. The change of PFM strength in each woman was calculated by subtracting the reading recorded six months postpartum from the antepartum measurement. Negative values indicated higher PFM strength postpartum. Possible associations of constitutional and obstetric variables with changes in PFM strength were explored by comparison of the mean differences (Student's t-test, analysis of variance). Linear regression models were used for multivariable analysis. Statistical significance was set at p=0.05.

Results

During the study period, pelvic floor muscle function was assessed in 432 pregnant women at term. Thirty-five (8.1%) were not able to perform an adequate PFM contraction and were excluded from the study; another 38 women delivered by emergency caesarean section were also excluded. Of the remaining 359 eligible women, 319 (88.8%) attended the six months follow up visit and these formed the study group. Their mean age was 30.9 years (range: 18-46) and mean BMI was 23.1 (range:15.9-44.2). The measurement of PFM strength in the antepartum visit did not show statistical differences in older women (38.34±18.55 vs. 34.58±19.36; p=0.105). Vaginal delivery was spontaneous in 220 (69.0%) women, forceps assisted in 84 (26.3%) and vacuum assisted in 15 (4.7%). After delivery, 151 women underwent PFM training. There was not a specific PFM exercises program for our study group, and the percentage of women who performed pelvic floor exercises was similar in the spontaneous delivery group and those delivered instrumentally (46.4% vs. 49.5%; p=0.60).

The manual testing score of PFM strength and the mean values of vaginal squeeze pressure for each group both at inclusion and six months after delivery are shown in table 1. The Pearson's correlation coefficient between the manual testing score and vaginal squeeze pressure measured by perineometry was 0.77 when calculated antepartum and 0.71 postpartum. Both were significant at the 0.01 level.

A comparison of PFM resting tone and strength from antepartum to six months postpartum according to mode of delivery is shown in table 2. Resting tone decreased after spontaneous and instrumental delivery, while PFM strength decreased after instrumental delivery and increased after spontaneous vaginal delivery.

The influence of other constitutional and obstetric variables on the change of PFM strength six months postpartum was also investigated. The comparison for age, second stage of labor, perineal tears and newborn head circumference indicated statistical differences between the established groups (table 3). A multiple logistic regression model was built including variables that were significant or close to statistical significance (p<2) together with PFM training in the postpartum period and breast feeding as potential confounding factors. This analysis (table 4) indicated that instrumental delivery, larger head circumference of the newborn, and older maternal age were independently associated with an impairment of PFM strength six months after first vaginal birth.

Pelvic organ prolapse assessment six months postpartum indicated that 69 (21.6%) women had a POP-Q stage ≥ II. These women had lower PFM strength than those with no prolapse or at stage I (32.5±18.8 vs. 39.0±20.1; p=0.025). We also assessed the relationship between prolapse and the change of PFM strength from antepartum to six months postpartum. This analysis indicated that women with POP ≥ II six months postpartum had a significant decrease in PFM strength with respect to antepartum period (32.5±18.8 vs. 40.2±18.6; p=0.000) where women with POP <II had a significant increase (39.0±20.1 vs. 36.4±18.8; p=0.024). The mean difference of the changes from antepartum to postpartum between women with POP ≥ II and those with no such prolapse was also statistically significant (mean difference: 9.65; 95% CI:4.81-14.48; p=0.000). In all cases the analysis of the association between POP and PFM strength was adjusted for age and BMI as potential confounders.

Discussion

The present study indicates that instrumental vaginal delivery, larger newborn head circumference and older maternal age are independently associated with an increased risk of impaired pelvic floor muscle function after vaginal birth. These associations were established considering other obstetric factors such as length of second stage of labor, augmentation with oxytocin, epidural anesthesia, episiotomy, 3rd or 4th degree tears, and birth weight.

Both instrumental vaginal delivery and larger head circumference involve excessive stretching of pelvic floor muscles during vaginal birth to allow the passage of the newborn. Instrumental delivery also involves the fetal head descending more rapidly through the birth canal, in comparison with spontaneous vaginal delivery, not allowing time for normal accommodation of the muscles. These mechanisms may tend to lead to an increase in PFM injury and could explain why both factors are associated with impaired PFM function after delivery.

The effect of aging on pelvic floor structures may predispose women to greater damage during vaginal delivery. In particular, changes in tissue biomechanics such as loss of elasticity make older women vulnerable such injuries. Increased maternal age has also been independently associated with anal sphincter trauma after vaginal delivery [28].

Our results are in accordance with the studies that identify risk factors for morphological changes of PFM after vaginal birth. This relationship may be due to the marked effect on PFM strength of avulsion of the puborectalis muscle [29]. Keraney et al. [13] evaluated levator ani muscles six months after first vaginal delivery and found that forceps use increased the odds ratio for levator defects more than 14 times. Anal sphincter rupture, episiotomy and prolonged second stage of labor were other obstetric factors associated with this type of injury. They also concluded that women with levator ani lesions after delivery were significantly older. Dietz and Lanzarone [14] reported that the presence of levator avulsion two to six months postpartum was associated with older maternal age and operative delivery among women delivered vaginally. In another study, including a large population of women, Dietz and Simpson [15] found that both vaginal operative delivery and increased maternal age at first delivery were associated with levator trauma.

The association between instrumental delivery and the decrease in PFM strength postpartum is not so well established. Meyer et al [22] showed a significantly higher incidence of weak pelvic floor ten months postpartum among women delivered by forceps, but the differences in intravaginal pressure with respect to antepartum period did not reach statistical significance. Probably the relatively small number of cases (25 in the forceps delivery group and 82 in the spontaneous delivery group) limited this analysis.

Another interesting finding from our study is the increase in PFM strength from pregnancy to six months postpartum in women delivered spontaneously. With shorter follow-up periods a decrease on PFM strength has been reported [17-19, 21], but other evaluations after longer follow-ups showed no significant changes [22] or even an increase from antepartum period [20]. The need for at least six months for PFM function recovery may explain these differences [30]. Moreover, we believe that part of the increase in PFM strength from antepartum to postpartum could be due to the impairment of PFM function at the end of pregnancy. The mechanical effect of the enlarging uterus and the hormonal changes that prepare the pelvic floor for delivery, which are involved in pregnancy stress urinary incontinence, could also affect PFM function. The evaluation of intravaginal pressure values in the three trimesters of pregnancy has indicated a decrease from 43±28 cm of H_2O in the first trimester of pregnancy to 37±18 cm of H_2O in the third trimester [22]. These differences were not found to be significant by the authors probably due to the small number of cases in each group (15 in the first trimester and 72 in the third). We also noted that they published a mean value of PFM strength in the third trimester of pregnancy which was quite similar to ours in the antepartum visit (37.4±18.2 cm of H_2O). On the other hand, we believe that part of the increase in PFM strength six months postpartum may be attributed to women performing PFM exercises during this period. Nearly half of the women included in our study trained their pelvic floor muscles after giving birth.

Our results also indicate that there is an association between prolapse and lower PFM strength six months postpartum. This finding is in accordance with other studies performed later in life. DeLancey et al. [8] concluded that middle-age women with prolapse generate less vaginal closure force during maximal contraction than controls. Braekken et al. [10] and Samuelson et al. [11] indicated that lower PFM strength was independently associated with POP. In our study we were also able to demonstrate an association between POP and a decrease of PFM strength with respect to antepartum. These results point out that impairment of PFM function during vaginal delivery may be a potential factor in the pathophysiology of prolapse.

One of the strengths of the present study is that PFM function was measured by perineometry. This method has a good reliability and validity [26] and it has been suggested [25] that for measurement of maximum voluntary contraction strength, squeeze pressure should be used instead of manual muscle testing. Another of its strengths was the use of POP-Q system to assess prolapse. Moreover, all the examinations were performed by or under the supervision of the same experienced gynecologist, and during the pelvic floor exam the gynecologists were blinded to delivery data to reduce bias.

Nevertheless, our study has several limitations that should be considered when interpreting the results. First of all, we did not calculate sample size prior to inclusion. However, the statistical power of our sample size was 99%% in the comparison between spontaneous and instrumental delivery, 98.5% in the evaluation of age, and 90.6% in the evaluation of head circumference of the newborn. Another potential limitation of our results was the time when PFM strength was assessed antepartum. We took this measurement when the women came to hospital to give birth. To avoid the potential bias of pain when performing a maximum PFM contraction we only included women in the latent phase of labor that were not affected by a high level of pain, and those without uterine activity. Moreover, as has been pointed out before, published values of PFM strength in the third trimester of pregnancy are quite similar to our measurement in the antepartum visit [22]. The study design also did not allow the different types of instrument-assisted deliveries to be compared. Specifically, due to the small number of cases, vacuum-assisted were not analyzed separately from those assisted by forceps. In any case, we understand that both instruments share a plausible mechanism of PFM injury during vaginal birth, namely, their use results in a lack of time for accommodation of the muscles to the fetal head, as we have pointed out above. The comparisons between spontaneous vaginal and forceps-assisted and between spontaneous and vacuum-assisted deliveries (data not shown) also indicated a significant decrease in PFM strength postpartum among women delivered instrumentally.

Despite these limitations, our results indicate an independent association between instrumental vaginal delivery, larger newborn head circumference and older maternal and a decreased PFM strength six months postpartum. We were able to demonstrate these associations taking into account a large number of obstetric variables, even those that are common in difficult vaginal births. These results may help to clarify some of the doubts concerning the effect of instrumental vaginal delivery on pelvic floor muscle injury.

As we have indicated, nearly half of all the women delivered instrumentally completed pelvic floor exercises postpartum; however, our results suggest that this is not sufficient for recovery of PFM function in this specific group of women. Much more effort should be made to recover muscle function not only after instrumental vaginal delivery but also in older women and when the newborn head circumference is large. Women should be properly informed about this issue and specialist care should be offered to this specific at-risk group.

Finally, this study also provides preliminary evidence of an association between impaired PFM function from antepartum to six months postpartum and the presence of pelvic organ prolapse in this period. Further research is required to investigate the significance of this finding and also the prognosis for developing symptomatic prolapse later in life in women with support defects in the postpartum period.

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Table 1. Manual testing score of PFM strength and mean values of vaginal squeeze pressure for each group at inclusion and six months postpartum

PFM strength antepartum			PFM strength postpartum		
Oxford scale (n, %)		Perineometry (mean, SD)	Oxford scale (n, %)		Perineometry (mean, SD)
0	0 (0)	-	0	6 (1.9)	-
1	31 (9.7)	15.8 ±7.5	1	28 (8.8)	14.7 ± 6.9
2	73 (22.9)	23.8 ± 8.2	2	59 (18.5)	23.3 ± 9.0
3	109 (34.2)	35.3 ±10.2	3	98 (30.7)	36.6 ± 13.4
4	82 (25.7)	49.3 ± 12.6	4	85 (26.6)	44.2 ± 13.8
5	24 (7.5)	72.9 ± 22.4	5	43 (13.5)	65.4 ± 21.1

Table 2. Comparison of PFM resting tone and strength from antepartum to six months postpartum as a function of mode of delivery

	Spontaneous delivery (n=220)			Instrumental delivery (n=99)		
PFM function	Antepartum (37-41 weeks)	Postpartum (6 months)	*p value*	Antepartum (37-41 weeks)	Postpartum (6 months)	*p value*
Resting tone (cm H_20± SD)	35.1 ± 11.2	30.9 ± 11.1	0.000	36.6 ± 11.3	26.1 ± 8.3	0.000
Strength (cm H_20± SD)	37.4 ± 19.2	41.9 ± 20.4	0.000	36.8 ± 17.9	28.1 ± 15.4	0.000

PMF: pelvic floor muscles; SD: standard deviation

Table 3. Analysis of the association between changes in PFM strength from antepartum to six months postpartum and various constitutional and obstetric variables

Constitutional and obstetric variables		n	PFM strength changes*	Mean difference		
				Coefficient	95% CI	*P value*
Age (years)	< 30	93	-5.2	-6.7	-11.2 – -2.3	0.001
	≥ 30	226	1.8			
BMI	< 25	244	-0.7	-1.6	-6.5 – 3.1	0.49
	≥ 25	75	0.9			
Mode of delivery	Spontaneous	220	-4.5	-13.2	-17.4 – -9.0	0.000
	Instrumental	99	8.7			
Use of oxytocin	No	60	-2.9	-3.15	-8.3 – 2.0	0.23
	Yes	259	0.1			
2nd stage of labor ≥ 2 hours	No	220	-1.9	-5.1	-9.5 – -0.7	0.02
	Yes	99	3.1			
Active 2nd stage of labor ≥ 1 hour	No	298	-0.7	-4.9	-13.2 – 3.2	0.23
	Yes	21	4.2			
Epidural anesthesia	No	17	0.3	0.8	-8.3 – 9.9	0.86
	Yes	302	-0.4			
Episiotomy	No	70	-1.7	-1.7	-6.7 – 3.1	0.48
	Yes	249	0.0			
3rd or 4th degree tears	No	314	-0.6	-14.6	-31.0 – 1.8	0.08
	Yes	5	14.0			
Birth weight ≥ 4000g	No	300	-0.7	-5.5	-14.1 – 3.1	0.20
	Yes	19	4.8			
Newborn head circumference ≥ 36 cm	No	251	-2.1	-8.0	-12.9 – -3.0	0.002
	Yes	68	5.9			

BMI: body mass index. CI: confidence interval

(*) PFM strength changes: antepartum measurement – postpartum measurement

Table 4. Multivariable analysis of factors associated with a decreased PFM strength six months postpartum

Constitutional and obstetric variables	**n**	**Mean difference**		
		Coefficient	95% CI	*P value*
Age ≥ 30 years	226	6.43	2.2 – 10.6	0.003
Instrumental delivery	99	11.67	7.4 – 15.9	0.000
2^{nd} stage of labor ≥ 2 hours	99	3.22	-0.9 – 7.4	0.133
3^{rd} or 4^{th} degree tears	5	5.71	-10.1 – 21.5	0.710
Newborn head circumference ≥ 36 cm	68	5.19	0.4 – 9.9	0.032
PFM training	151	-1.23	-5.1 – 2.5	0.509
Breast feeding	155	-0.50	-4.3 – 3.3	0.798

CI: confidence interval