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INCREASING AGE IS A RISK FACTOR FOR DECREASED POSTPARTUM PELVIC FLOOR STRENGTH

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Abstract

Objectives—To determine factors associated with decreased pelvic floor strength (PFS) after the first vaginal delivery in a cohort of low risk women

Methods—This is a secondary analysis of a prospective study examining the risk of pelvic floor injury in a cohort of primiparous women. All recruited participants underwent an examination, 3D ultrasound and measurement of pelvic floor strength (PFS) in the third trimester and repeated at 4 weeks-6 months postpartum using a perineometer.

Results—There were 84 women recruited for the study, and 70 completed the postpartum assessment. Average age was 28.4 years (SD, 4.8). There were 46 (66%) subjects with a vaginal delivery (VD) and 24 (34%) with a cesarean delivery (CD) who labored. Decreased PFS was observed more frequently in the VD group compared to the CD group (68% vs. 42%, $p=0.03$).

In modified Poisson regression models controlling for mode of delivery and time of postpartum assessment, women who were age 25-29 (RR=2.80, 95% CI 1.03-7.57) and ≥ 30 (RR=2.53, 95% CI 0.93-6.86) were over 2.5 times more likely to have decreased postpartum PFS compared to women < 25 yo.

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Conclusions—In this population, women age 25 and older were more than twice as likely to have a decrease in postpartum PFS.

Keywords

pelvic floor muscles; pelvic muscle strength; levator ani function

Introduction

Proper pelvic floor muscle function (PFM) is an important part of overall pelvic health since these muscles play an important role in the support and function of the pelvic organs. Pelvic floor dysfunction means that the mutually complementary actions of the pelvic floor muscles in anatomical and physiologic function is lost. One of the important causes of pelvic floor dysfunction is the weakening and function of the pelvic floor muscles.

During pregnancy, pelvic floor muscles have a fundamental role in supporting the female pelvic organs and facilitating normal function. However, during pregnancy this supporting structure is overloaded because of the progressive growth of the uterus with the developing fetus¹. During childbirth the levator ani muscle (LAM) complex undergoes marked distension and deformation. Using three-dimensional ultrasound, Dietz et al. showed that area of the levator hiatus varies from 6-36 cm². With the area of the average fetal head measuring 70-90 cm, it is clear that the LAM complex undergoes marked distention and deformation during childbirth³. Consequently, multiple studies have shown that pelvic floor weakness occurs following childbirth⁴⁻⁶. This effect seems to impact women more often following a vaginal delivery, compared to a cesarean delivery^{4,7,8}.

To assess the PFM function, several methods have been described, including digital palpation, or devices such as a perineometer, surface electromyography, and a dynamometer⁹⁻¹². The most frequently used method is vaginal palpation, in which the examiner inserts one or two fingers into the vaginal introitus, verifies the ability of the patient to contract and relax correctly, and measures PFS via a maximal occlusive and lifting force. Proper PFM contraction is defined as the ability to properly contract the pelvic floor, meaning a squeeze and an inward movement of the pelvic floor. Pelvic floor strength (PFS) is defined as the maximum voluntary contraction, which happens when a person attempts to recruit as many fibers in a muscle as possible^{9,13}. A weak pelvic floor is associated with urinary and fecal incontinence, pelvic organ prolapse, and sexual dysfunction^{9,13,14}.

The advantages of digital palpation include that it is inexpensive, easy to use, minimally invasive, and it can measure strength in addition to duration of contraction. On the other hand, it depends on examiner experience and perception^{9,15}. Among the devices, the perineometer is the most commonly used. During the evaluation, the woman is asked to contract the PFM as hard as possible and the device registers the pressure that this contraction exerts on the probe, in cmH₂O or mmHg^{9,12}.

A persistent decrease in pelvic floor weakness postpartum is likely the first detectable sign of pelvic floor dysfunction postpartum and may offer the opportunity for early intervention

early in a woman's life. The goal of this study was to determine factors associated with decreased PFS after the first vaginal delivery in a cohort of low risk women

Methods

This is a secondary analysis of a prospective study examining the risk of pelvic floor injury in a cohort of low risk primiparous women planning a vaginal delivery. Institutional Review Board approved the protocol for this study. Subjects with a singleton pregnancy were recruited through campus and community advertisements, and each participant signed informed consent prior to participation in the study. All women with a singleton pregnancy underwent an examination, 3D ultrasound and measurement of pelvic floor strength at 24-37 weeks and between 4 weeks and 6 months postpartum. Recruitment took place between July 2012 and September 2014. Exclusion criteria included a history of prior incontinence or prolapse surgery, a diagnosis of reproductive anomalies, prior pelvic radiation, or inability to complete written questionnaires. To assess pelvic floor symptoms and function, each participant completed a medical history. A standardized examination was performed, including height, and weight, and pelvic floor support assessment using the Pelvic Organ Prolapse Quantification (POP-Q) system. Body mass index (BMI) was calculated as kilograms per meter squared. To minimize the potential for bias the participants were asked not to discuss any information regarding their delivery with the primary examiner (LHQ). All obstetric and neonatal information was obtained from the postpartum chart by a research nurse.

Prior to measurement of PFS, correct pelvic floor contraction was verified. Subjects were asked to perform a “squeeze” maneuver of the pelvic floor and correct contraction of the pelvic floor was verified by the primary examiner (LHQ). PFS was measured using a Peritron™ perineometer, which is a 28mm diameter compressible probe connected to a handheld microprocessor. It provides readings of pelvic floor contraction in cm of H₂O with precision up to one decimal point, and it has been demonstrated to show reproducible and reliable measurements^{4,16,17}. The resting vaginal pressure and two peak pressures were measured. For this study, PFS is defined as the augmented vaginal pressure, calculated by measuring the average of 2 peak pressures minus the resting vaginal pressure. Absolute change in PFS was calculated by subtracting the pre-delivery PFS measure from the postpartum PFS measures. A binary measure of decreased PFS was defined as PFS change < 0 compared to 0.

At the completion of the physical examination, including measurement of PFS, all participants underwent a 3D endovaginal ultrasound (3D-EVUS) (BK Medical Ultrafocus, Peabody, MA, USA). We developed a standardized US protocol for obtaining all images to minimize interoperator variability. The 3D EVUS technique has been described previously^{18,19,20} and is summarized as follows: ultrasound examination was performed using an 8838 12 MHz transducer and convex transperineal probe. All ultrasound exams were performed, with the patient in dorsal lithotomy position, with hips flexed and abducted. No preparation was required and the patient was recommended to have a comfortable volume of urine in the bladder. No rectal or vaginal contrast was used. To avoid excessive

pressure on surrounding structures that might distort the anatomy, the probe was inserted into the vagina in a neutral position.

Each 360 degrees EVUS volume was digitally cataloged for future analysis. All scans were obtained by the principal investigator (LHQ), and each participant was then assigned a unique, deidentified study number. All ultrasound volumes were stored offline for 3-D postprocessing. The ultrasound reader (GR), was blinded to delivery status (pre or post delivery), as well as examination, demographic, obstetric and neonatal information. The minimal levator hiatus area (MLH) and levator ani deficiency (LAD) scores were calculated according to a previously published protocol, shown to have excellent inter-rater reliability and categorized into mild/mod and severe LAD.^{19,21}

SAS v9.4 (SAS Institute, Cary, NC) was used for all statistical analyses. Associations between PFS change and patient or delivery characteristics were evaluated, including age (<25, 25-29, 30), race (White/non-White), body mass index (<25, 25 to <30, 30), mode of delivery (vaginal/cesarean), birth weight (grams), second stage of labor (> 30, 30 to <120, > 120 minutes), vacuum (yes/no), laceration (yes/no), degree of laceration (none, first, second or third degree), episiotomy (yes/no) and time of postpartum assessment (< 3 months, 3 to 6 months). There were no deliveries with a head circumference > 90th percentile (> 38 cm); thus, we were unable to evaluate this factor. Categorical variables were compared using Pearson's chi-square or Fisher's exact tests. A paired t-test was calculated to determine if the difference between pre- and post-delivery PFS measures was different from 0. Mean PFS change was compared across binary covariates using Student's t-tests. Welch's ANOVA tests, which are robust to violation of the assumption of equal variances, were used to compare mean PFS change across three or more groups. Other continuous measures were compared across groups using Student's t-tests or Wilcoxon Rank Sum tests as appropriate for the distribution of the data. Spearman correlation coefficients were calculated for comparisons between continuous measures. Risk ratios (RR) and 95% confidence intervals (95% CI) for decreased PFS were calculated using a generalized estimating equation method to estimate Poisson regression models with robust standard errors. A p-value of < 0.05 was considered statistically significant for all analyses.

Results

There were 84 women recruited for the study, and 70 completed the postpartum visits. Two were excluded due the inability to perform a pelvic floor contraction, for a total of 68 subjects available for this analysis. Median age for the cohort was 28.8 years (interquartile range (IQR) 5.3), (Range 18-45 years) with a median BMI of 28.4 kg/m² (IQR 7.7). In this study population, 71% were White and 12% were African American. Median follow-up was 6.9 weeks (IQR, 3.6). Ten women (15%) had a postpartum visit between 3- 6 months, the remaining subjects had postpartum visits between 4 weeks to 3 months. There were no significant differences in the median follow up time by age category (p=0.22) and median age was similar in women with postpartum follow up in < 3 months and 3 months (29 (IQR, 4.5) vs 26 (IQR 12.7), p=0.36). There were 46 (66%) subjects with a vaginal delivery (VD) and 24 (34%) with a cesarean delivery (CD) who labored. Overall, the median length of the second stage was 73.5 min (IQR,90.5), with the cesarean group having longer median

second stage of 180 min (IQR,177) compared to the vaginal group (65, IQR,54, $p=0.03$). The cesarean group also had babies with a slightly higher median head circumference (median, IQR: 35,2 v. 34,2, $p=0.01$) (Table 1).

Overall, 59% of women had a decrease in PFS postpartum as compared to baseline measurement and the mean change in PFS was -3.43 cm H₂O (SD, 12.6, range -32.0 to 34.1) ($p=0.03$). Decreased PFS was observed more frequently in the VD group compared to the CD group (68% vs. 42%, $p=0.03$) and women with vaginal deliveries had mean changes in PFS of -6.9 cm H₂O (SD, -10.4) compared to 2.9 cm H₂O (SD, -2.3) for women with cesarean deliveries ($p=0.002$). Similarly, decreased PFS was detected more frequently in women with postpartum evaluations less than 3 months compared to 3 to 6 months following delivery (64% vs. 36%, $p=0.08$), although this difference did not achieve statistical significance. Mean change in PFS, however, indicated a decrease in PFS among the 58 women assessed less than 3 months postpartum (-5.2 , sd 11.6) but an increase in PFS on average among the 10 women assessed 3 to 6 months postpartum (7.0, sd 13.7, $p=0.004$).

The distribution of change in pelvic floor strength by age group is displayed in Figure 1. The greatest decrease in PFS occurred among women age 25-29 years of age, but the difference in mean PFS change was not significantly different across the three age categories (Welch's ANOVA $p=0.12$). When looking at just the women who had a decrease in PFS, a decrease occurred less often in women <25 years old (25%) compared to the other two age groups (70% and 62% for 25-29 and ≥ 30 , respectively, $p=0.03$). The mean change in PFS strength was also significantly decreased in women with a vaginal laceration compared to those with no laceration, when defined as the presence or absence of a laceration (-7.70 cm H₂O (SD, 11.69) vs. 1.37 cm H₂O (SD, 12.04), $p=0.002$), (Figure 2). However, mean PFS change did not decrease further with more severe lacerations ($p=0.05$). The proportion of women with decreased PFS was greater among women with a laceration (69% vs 47%), but this difference did not achieve statistical significance ($p=0.06$).

Race, body mass index, length of second stage of labor, vacuum delivery and episiotomy were not associated with difference in mean PFS change or differences in the proportion of women with decreased PFS. When analyses of all factors were limited to women with vaginal deliveries, the findings remained consistent, except that the association with BMI became statistically significant ($p=0.01$, Fisher's exact test). Among women with vaginal deliveries, overweight women were more likely to exhibit decreased PFS (53%) compared to normal (27%) or obese (20%) women.

The overall incidence of severe levator ani deficiency was 10% in this cohort. As expected, PFS change was negatively correlated with postpartum changes in MLH as measured by 3D EVUS (Spearman correlation= -0.29 , $p=0.02$). However, there were also no significant associations between PFS change and worsening LAD scores.

In a modified Poisson regression models controlling for mode of delivery and timing of postpartum follow-up visit, women who were age 25-29 (RR=2.80, 95% CI 1.03-7.57) and ≥ 30 (RR=2.53, 95% CI 0.93-6.86) were over 2.5 times more likely to have decreased postpartum PFS compared to women < 25 years old (Table 2). When assessing the impact of

adjusting for other measured characteristics, no factors changed the risk ratios for age by 10% or more when added to the model one at a time. The association between age and decreased PFS remained similar but slightly attenuated when also adjusting for pre-delivery PFS.

Discussion

The results of this study demonstrate an increased risk of having reduced postpartum pelvic muscle strength with increasing age after the first vaginal delivery. However, while the proportion of those with decrease PFS was greater in the older age groups, the magnitude of the mean change in strength did not differ significantly across the three age categories examined. Women >25 were at about 2.5 times more likely to have a decrease in their pelvic floor strength postpartum compared to those < 25 years old. The reduction of pelvic muscle strength after vaginal delivery compared to cesarean has been reported in multiple studies^{7,8,12,22}. The general consensus is that vaginal delivery reduces strength^{4,7,8,10,23}. The finding of increasing age significantly impacting PFS reduction is novel. Age alone has not been shown to lead to a significant decline in vaginal closure force, cross-sectional area, or ability to visualize levator ani muscles morphology in nulliparous women^{24,25,26}. Changes in the pelvic floor strength that persist postpartum may reflect a pelvic floor less able to withstand the development of pelvic floor disorders when other risk factors develop later in life. The findings of a decrease in pelvic floor strength postpartum, particularly in women older than 25, may offer a prime opportunity to offer early pelvic floor rehabilitation as an intervention.

In this study of low risk primiparous women, 59% of women overall were found to have decreased pelvic floor strength, therefore, about 41% had similar or increased strength. The clinical implications of our findings suggest that most women can be informed that vaginal delivery is not going to have a uniform detrimental effect to their pelvic floor strength. In fact, in some instances, pelvic floor strength is unchanged by a vaginal delivery. In addition, decreased PFS was detected in 64% of women when this was measured <3 months postpartum, compared to 36% 3-6 months postpartum. Although the latter was not found to be statistically significant, this observation implies that pelvic floor strength may need longer than 3 months to recover. A recent study on levator muscle recovery postpartum found that most of the recovery occurs during the first 6 months postpartum, although not all women recover to pre-delivery state.²⁷

In addition to obstetric factors, the labor process itself likely has an impact on the postpartum pelvic floor muscle function. Meyer et al. studied the effects of childbirth on PFS and showed that women who delivered by cesarean section had no significant reductions in PFS, while women who delivered vaginally showed significant reduction PFS (with forceps assisted deliveries having the greatest reduction in strength)²⁸. In our study, all of the participants who underwent a cesarean, did so after active labor or after complete cervical dilation. In fact, the caesarean group had a longer second stage compared to the vaginal group. A labored cesarean may reflect other factors, such as obstructive labor resulting in cesarean delivery. We found that 25% of cesareans had a decrease in PFS, in line with previous studies showing a decrease in strength in caesareans who labor^{4,22}.

In the present study we did not find differences in PFS reduction between spontaneous deliveries and vacuum assisted deliveries. This is line with a study by Friedman et al. which showed no significant difference in pelvic floor strength between women with a spontaneous vaginal delivery, compared to vacuum assisted deliveries⁴. This same study showed the greatest reduction in pelvic floor strength in women after a forceps delivery. We were not able to make this distinction, since our group of instrumental deliveries was small, consisting of 5 vacuum deliveries and no forceps deliveries, reflecting the current obstetric practices of this region of the United States.

The strengths of this study include the prospective nature of the enrollment, measurement of PFS before and after delivery, multiple obstetric exposures considered, and the assessment of pelvic floor strength with a reliable, validated tool that has been used in several studies^{4,16,29}. Limitations to our study include small sample sizes for each category. We acknowledge that the study was not designed to determine the effects of age in PFS. Also, we did not gather information on whether our patients perform pelvic floor exercises postpartum or gathered information on their exercise routine. Another limitation includes our mean follow up time with a median of 6.9 weeks. From recent literature, we have learned that the pelvic floor continues to recover for at least 6 months²⁷. A longer follow up will be required to determine the long term clinical impact of the decrease in pelvic floor strength in this cohort. In conclusion, increasing age and pre-existing pelvic floor weakness need to be considered when counselling women planning a vaginal delivery, since pelvic floor rehabilitation may provide an early intervention and provide protective benefits. Longitudinal studies will be required.

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Figure 1.
Distribution of Change in Pelvic Floor Strength by Age Group

Figure 2.
Distribution of Change in Pelvic Floor Strength by Vaginal Laceration

Table 1

Characteristics of 68 patients with singleton deliveries

	Vaginal Delivery (n=44) Median (IQR)	Cesarean Delivery (n=24) Median (IQR)	p
Age, years	28.4 (5.2)	29.4 (3.9)	0.05 ^a
BMI, kg/m ²	28.5 (6.9)	27.9 (9.2)	0.95 ^a
Length second stage, minutes	65 (54)	180 (177) ^b	0.03 ^a
Head circumference, cm	34 (2)	35 (2)	0.02 ^a
<u>Postpartum visit, weeks</u>	<u>6.9 (3.5)</u>	<u>6.8 (6.3)</u>	<u>0.90^a</u>

	Mean (SD)	Mean (SD)	p
Baby weight, grams	3245 (380)	3453 (575)	0.12 ^c

	n (%)	n (%)	p
White Race (n, %)	32 (76%)	15 (63%)	0.23 ^d
Perineal lacerations (n, %)	36 (82%)	0 (0%)	<0.0001 ^d
Episiotomy (n, %)	2 (4.6%)	1 (4.2%)	1.0 ^e

^aWilcoxon Rank Sum test^bOnly 5 observations available^cStudent's t-test^dChi-square test^eFisher's exact test

Table 2

Association between age and decreased pelvic floor strength

	Number of Patients	Decreased PFS n (%)	Risk Ratio ^a	95% CI	Risk Ratio ^a	95% CI
Age <25	12	3 (25.0)	1.00	Referent	1.00	Referent
Age 25-29	30	21 (70.0)	2.80	1.03-7.57	2.71	1.00-7.31
Age 30	26	16 (61.5)	2.53	0.93-6.86	2.52	0.94-6.74

^b Adjusted for mode of delivery, time of postpartum assessment and pre delivery PFS^a Adjusted for mode of delivery and time of postpartum assessment