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TOO TIGHT TO GIVE BIRTH? - assessment of pelvic floor muscle function in 277 nulliparous pregnant women

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2

ABSTRACT

Introduction and hypothesis: Theoretically, tight or strong pelvic floor muscles may impair the progress of labor and lead to instrumental deliveries. We aimed to investigate whether vaginal resting pressure, pelvic floor muscle strength or endurance at mid-pregnancy affect delivery outcome.

Methods: this was a prospective cohort study of women giving birth at a university hospital. Vaginal resting pressure, pelvic floor muscle strength and endurance in 300 nulliparous pregnant women were assessed at mean gestational week 20.8 ($\pm$1.4) using a high precision pressure transducer connected to a vaginal balloon. Delivery outcome measures (acute cesarean section, prolonged second stage of labor (> 2 hours), instrumental vaginal delivery (vacuum and forceps), episiotomy and 3rd and 4th degree perineal tear) were retrieved from the hospital's electronic birth records.

Results: Twenty-three women were lost to follow-up, mostly because they gave birth at another hospital. Women with prolonged second stage had significantly higher resting pressure than women with second stage less than 2 hours; mean difference 4.4 cm H_2O (95% CI: 1.2-7.6), p<0.01, aOR: 1.049 (95% CI: 1.011-1.089, p=0.012). Vaginal resting pressure did not affect other delivery outcomes. Pelvic floor muscle strength and endurance similarly were not associated with any delivery outcomes.

Conclusions: While mid-pregnancy vaginal resting pressure is associated with prolonged second stage of labor, neither vaginal resting pressure nor pelvic floor muscle strength or endurance are associated with operative delivery or perineal tears. Strong pelvic floor muscles are not disadvantageous for vaginal delivery.

Key words: delivery, endurance, pelvic floor, strength, second stage, vaginal resting pressure

Brief summary: Mid-pregnancy pelvic floor muscle strength or endurance do not affect delivery outcome.

INTRODUCTION

A recent Cochrane review concluded that pregnant women without prior urinary incontinence (UI) who were randomized to intensive antenatal pelvic floor muscle training (PFMT) were 30% less likely to report UI up to six months postpartum than women randomized to no PFMT or usual antenatal care [1]. Thus, women should be encouraged to perform PFMT during pregnancy to prevent UI [1]. However, there is scant knowledge about the influence of the pelvic floor muscles (PFM) on labor and delivery outcome [2,3].

There has been some concern that a tight and strong pelvic floor might obstruct labor and result in instrumental delivery, perineal trauma and/ or injury of peripheral nerves, connective tissue and muscles [3]. On the other hand, others suggest that stronger PFM may facilitate labor and vaginal childbirths [1]. Some studies have concluded that there is no increased risk of prolonged labor or operative deliveries after antenatal PFMT [4-7] whereas others have found higher rates of cesarean section [8]. However, none of these studies assessed objective measures of pelvic floor function in relation to delivery outcome.

The aim of the present study was to investigate the influence of vaginal resting pressure (VRP), PFM strength measured as maximum voluntary contraction (MVC), and endurance at mid-pregnancy on delivery outcomes.

METHODS

Participants

Three hundred nulliparous pregnant women participating in a prospective cohort study at Akershus University Hospital, Norway were recruited into this study. The women were recruited at their scheduled ultrasound assessment at gestational week 18 and met for their examination for the present study at mean gestational week 20.8 (± 1.4). The time period for inclusion was from January 2010 until April 2011. All women gave written informed consent to participate, and the study was approved by the Regional Medical Ethics Committee (2009/170), Norwegian Social Science Data Services (2799026), and registered at ClinicalTrials.gov (NCT01045135).

Inclusion criteria were being in their first ongoing singleton pregnancy and being able to understand Scandinavian language. Exclusion criteria were multiple pregnancy or previous miscarriage after gestational week 16, premature birth < 32 weeks, stillbirth or serious illness to mother or child.

Assessment of the pelvic floor muscles

Ability to contract

Two trained physical therapists taught participants how to perform a correct PFM contraction. Correct contraction was defined as a squeeze around the pelvic openings and a lift of the perineum. Ability to perform correct contractions was verified by observation of inward perineal movement and vaginal palpation [9].

Measurement of vaginal resting pressure, PFM strength and endurance

VRP, PFM strength expressed as maximal voluntary contraction (MVC), and PFM endurance were measured using a high precision pressure transducer connected to a balloon catheter (Camtech AS, Sandvika Norway). The method has demonstrated intra-observer reliability [10]. The balloon was placed according to usual procedure with the middle of the balloon 3.5 cm from the vaginal introitus [11]. Only contractions with simultaneous visible inward movement of the catheter /perineum were considered correct [9]. Muscle endurance was

measured as the area under the curve during attempt to hold the contraction for 10 seconds [12]. Three MVC followed by a short resting period and one holding period were performed. All measurements were done in supine crook lying position.

Outcome variables
Delivery data were extracted from the hospital's electronic birth records. Medical personnel responsible for registering obstetrical data had no knowledge about the previous PFM assessment.

Cesarean sections were divided into either elective or acute. Women undergoing elective cesarean section were excluded from the analyses. Second stage of labor was defined as the interval between full cervical dilatation and birth of the child, and prolonged second stage of labor was defined as more than 2 hours [13,14]. Instrumental vaginal delivery was vacuum or forceps assisted delivery or both. Due to low rate of forceps these variables are reported together. 3rd and 4th degree perineal tears were defined according to Sultan et al [15] as disruption of the anal sphincter muscles which may be partial or complete (III a-c) without involvement of the anal epithelium. A 4th degree tear includes disruption of the anal epithelium as well. Episiotomy was done per common Norwegian practice using a left side medio-lateral incision. Induction was any non- spontaneous start of labor.

Statistical methods
Background variables are reported as means with SD or numbers with percentages. Differences between VRP, strength (mean of three MVC) and muscular endurance in women with and without acute cesarean section, prolonged 2nd stage (>2 hours), instrumental delivery, 3rd-4th degree perineal tear and episiotomy are reported as means with 95% CI and analyzed by use of Mann- Whitney or Independent Sample T-test. The association of VRP, PFM strength and endurance and each delivery outcome was also analyzed in separate models by logistic regression and reported as crude and adjusted Odds Ratios (cOR and aOR) with 95% confidence intervals (CI). We adjusted for maternal age, pre-pregnancy body mass index (BMI), birth weight, induction of labor, epidural and head circumference. P-value was set to $\leq$ 0.05. With Bonferroni adjustment for 5 comparisons the alpha level is 0.01.

RESULTS

Of the 300 participants 23 (7.7%) were lost to follow up, leaving 277 with delivery data. Of the 23 women lost to follow up, 10 delivered at another hospital, 9 did not want to continue, three had a stillbirth and one was excluded due to delivery before 32 weeks of gestation. Table 1 shows background characteristics of the 277 participating nulliparous pregnant women at mid-pregnancy (mean gestational week 20.8 ($\pm$1.4). Mean BMI was in the normal range, and most of the participants had higher education. Table 2 describes delivery variables of the study sample. There were no important differences between the 277 who completed the study and the 23 that did not.

Table 3 shows mean differences in VRP, PFM strength and endurance at mid-pregnancy in women with and without acute cesarean section, prolonged second stage of labor, instrumental vaginal delivery (vacuum and forceps), 3rd and 4th degree perineal tear and episiotomy. Women with prolonged second stage of labor had statistically significant higher resting pressure at mid-pregnancy, p<0.01. VRP did not affect any other delivery outcome. No statistically significant differences in PFM strength or endurance were found for any of the delivery variables.

Table 4 shows crude and adjusted OR for VRP, MVC and endurance and acute CS, instrumental vaginal delivery, episiotomy, 3rd or 4th degree perineal tear and second stage of labor. Crude and aOR showed a significant association only between mid-pregnancy VRP and prolonged second stage of labor.

DISCUSSION

Main findings

In the present study of nulliparous pregnant women, mid-pregnancy VRP was significantly associated with prolonged second stage, but none of the other delivery outcomes, while PFM strength and endurance did not affect the rate of acute CS, prolonged 2nd stage, instrumental vaginal delivery, episiotomy and 3rd and 4th degree perineal tear.

Strengths and limitations

The strengths of the present study include the large sample size, minimal losses to follow up, PFM assessment using a method shown to be reliable and valid [9-10], and standardized delivery outcome ascertainment by clinicians unaware of the PFM variables. A limitation of the study is the low numbers of acute CS and 3rd or 4th degree tear that, although clinically desirable, may influence our ability to detect differences (type II error). The rate of CS and 3rd or 4th degree tears in this cohort of primiparous women is comparable to the general birth population at our hospital, indicating that the results from this study are generalizable outside the study sample. Another limitation is that the women were examined at midpregnancy and not closer to delivery. Elenskaia et al [16] found a significant increase in resting pressure and PFM strength in nulliparous pregnant women measured in gestational week 21 (range 15-28 and week 36 (range 31-39). However, they did not investigate how PFM variables influenced delivery outcomes, and the effect of resting pressure and PFM strength in late pregnancy therefore remains unknown.

Interpretation

The results showing that PFM strength and endurance did not influence delivery outcome support findings from three previous randomized controlled trials in which there were no deleterious impact on variables between women assigned to PFMT or controls [5,6,17]. In one study fewer had deliveries with prolonged second stage in the PFM training group and

there were no differences in operative vaginal delivery, episiotomy, 3rd or 4th degree tears, epidural analgesia or oxytocin augmentation [5]. However, there was a statistically significant difference between comparison groups in gestational age, weight of baby and head circumference between the training and control groups, and these factors were not controlled for. In the present study we controlled for maternal age, pre-pregnancy BMI, induction, epidural, birth weight and head circumference, and none of these factors influenced the results. In addition, other studies included no objective measurements of VRP, PFM strength and endurance; report of training participation cannot replace data on actual PFM variables.

Our results showed that a higher VRP at mid-pregnancy was significantly associated with prolonged second stage of labor, and this association was significant also when adjusting for known confounding factors. However, both crude and adjusted OR for the association was low, (1.051 for adjusted), and it can be argued that this is not clinically relevant. PFM strength and endurance may be considered proxies for PFM thickness as there are some correlations between these factors [18,19]. We have deliberately used the term vaginal resting pressure rather than pelvic floor muscle resting pressure; as other structures, such as fat or viscera might contribute to the measured pressure obtained. However, our population contained few obese women so it is unlikely that fat played a sizable role in the measured pressure. Resting pressure may be considered a more direct measure of tightness of the PFM as this variable reflects the resting condition without any voluntary contraction. Indeed, there is a correlation between VRP and levator hiatus (LH) area, but PFM strength and VRP explained only 26.4% of the variance in LH area after controlling for age, parity, BMI and socioeconomic status in women with pelvic organ prolapse [19]. To date very few studies have analyzed delivery outcomes according to VRP. Aran et al [20] found that in 88 women who all had labor induction with oxytocin, women who failed labor and subsequently underwent CS had significantly higher resting pressure and maximum voluntary contraction compared to those who had vaginal delivery. PFM variables were measured just before labor induction. There were no differences in maternal age, BMI and neonatal weight between the groups. This, however, was a selected group, as they all had induction, and the results cannot be generalized to other populations.

The widespread belief that a tight pelvic floor may obstruct labor and birth was the motivation for the development of a Birth-trainer to stretch the perineum, vagina and PFM with the goal of preventing major perineal and PFM injuries [21]. However, a RCT of 146 pregnant women randomized to either stretching of the PFM or no stretching found no statistically significant differences in delivery mode, length of 2nd stage, episiotomy or perineal tear [21]. The authors consider the trial a pilot study and intend to increase their number of participants to test this hypothesis in a larger sample of pregnant women.

The present study found that PFM strength and endurance did not influence delivery outcome. Hence, women's voluntary ability to contract as close to maximum as possible and their ability to hold the PFM contraction had no negative effect on childbirth. Antenatal PFMT significantly increases PFM strength [22]. However, we have not been able to find any data on the effect of PFMT on VRP [1]. Our results indicate that mid-pregnancy VRP may be a risk factor for prolonged second stage of labor. However, the clinical relevance of this finding is limited as the difference in VRP between women with and without prolonged second stage was only 4.4 cm H_2O. We suggest that VRP may be an important factor to measure in future studies on the effect of peripartum PFMT on health variables in mother and child.

CONCLUSIONS

This study indicates that mid-pregnancy vaginal resting pressure may be associated with prolonged second stage of labor. However, neither vaginal resting pressure nor pelvic floor muscle strength or endurance was associated with operative delivery or perineal tears, and the clinical relevance of such a small risk estimate can be discussed . Strong pelvic floor muscles are not disadvantageous for vaginal delivery. More research on vaginal resting pressure is warranted.

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Table 1.Background characteristics of nulliparous women at gestational week 18-22. Means with standard deviations (SD). Numbers with percentages (%). N=277.

Age (years)	28.7 (4.3)
Pre-pregnancy BMI (/kg/m^2)	23.8 (3.9)
Educational level	
College/university	209 (75.5%)
Primary school, high school or other	68 (24.5%)
Marital status	
Married or cohabitant	265 (95.7%)
Single	12 (4.3%)
Smoking pre-pregnancy	
Yes	70 (25.3%)
Smoking during present pregnancy	
Yes	14 (5.1%)

Table 2. Description of labor and delivery variables of the study population. Numbers and percentages (%).Means with standard deviations (SD). N=277.

Normal vaginal delivery	193 (69.7%)
Cesarean section	39 (14.1%)
Elective	10 (3.6%)
Acute	29 (10.9%)
Induction	52 (18.8%)
Epidural	112 (40.4%)
Instrumental vaginal delivery	
Vacuum	41 (14.84%)
Forceps	4 (1.4%)
Episiotomy	73 (26.4%)
Perineal tear	
No tear	164 (59.2%)
1st degree	37 (13.4%)
2nd degree	67 (24.2%)
3 and 4th degree	9 (3.3%)
Second stage of labor (minutes)	71.7 (53.5)
$\leq$ 2 hours	202 (72.9%)
>2 hours	38 (13.7%)
Mean weight of baby (grams)	3501 (509.0)
Mean head circumference (cm)	34.4 (5.0)

Table 3: Vaginal resting pressure (VRP), pelvic floor muscle (PFM) strength and endurance in women with and without acute cesarean section (CS), prolonged second stage of labor (>120 min), episiotomy, instrumental vaginal delivery (IVD) and 3rd and 4th degree perineal tear. Mean with standard deviation.

	VRP (cmH$_2$O)	PFM strength/ MVC (cmH$_2$O)	PFM endurance (cmH$_2$O -10sec)
Acute CS Yes No	43.8 (12.6) 42.2 (9.1) p=0.53	35.3 (18.3) 35.3 (18.7) p=0.15	250.9 (134.2) 137.5 (9.9) p=0.79
Prolonged 2nd stage Yes No	46.6 (8.8) 42.2 (9.3) p=0.01	39.7 (16.6) 34.9 (18.7) p=0.13	273.9 (114.4) 240.9 (139.2) p=0.17
Episiotomy Yes No	42.2 (9.3) 43.1 (9.7) p=0.47	34.8 (17.3) 35.4 (18.7) p=0.83	246.5 (129.1) 243.7 (137.3) p=0.88
IVD Yes No	44.8 (8.7) 42.2 (9.2) p=0.10	34.8 (16.8) 35.3 (18.7) p=0.86	243.3 (126.1) 243 .8 (137.5) p=0.99
3rd and 4th degree perineal tear Yes No	46.9 (7.6) 42.7 (9.6) p=0.20	34.3 (15.5) 35.3 (18.4) p=0.87	257.7 (124.8) 244.0 (135.4) p=0.77

Table 4. Difference in vaginal resting pressure (VRP), pelvic floor muscle strength (maximal voluntary contraction (MVC)) and endurance at mean gestational week 20.8 ($\pm$ 1.4) comparing women with and without acute cesarean section, numbers with prolonged second stage of labor, episiotomy, instrumental vaginal delivery (vacuum and forceps) and 3rd and 4th degree perineal tear. Mean differences with 95% confidence intervals (CI). N= 267 (women with elective cesarean section excluded).

	VRP (cmH$_2$O)	PFM strength/ MVC (cmH$_2$O)	PFM endurance (cmH$_2$O -10sec)
Acute Cesarean section (yes/no)	1.6 (-3.4,6.5)	0.2 (-7.3,7.3)	7.2 (-46.6,61.0)
Prolonged 2nd stage (yes/no) 120 min	4.4 (1.2,7.6)	4.9 (-1.5,11.3)	33.1 (-14.2,80.3)
Episiotomy (yes/no)	-1.0 (-3.5,1.6)	-0.5 (-5.5,4.4)	2.8 (-33.7,39.4)
Instrumental vaginal delivery(yes/no)	-2.5 (-5.5,0.4)	0.5 (-5.4,6.5)	0.4 (-43.8,44.6)
3rd and 4th degree perineal tear (yes/no)	4.2 (-2.2,10.6)	-1.0 (-13.2,11.2)	13.7 (-77.0,103.8)

Table 5. Vaginal resting pressure (VRP), pelvic floor muscle (PFM) strength (maximum voluntary contraction (MVC)) and muscle endurance in women with or without acute cesarean section, instrumental vaginal delivery, 3rd and 4th degree perineal tear, prolonged second stage of labor and episiotomy. N= 267 (elective cesarean section excluded).

		Acute cesarean section	Instrumental vaginal delivery	Episiotomy	3 or 4 degree perineal tear	Second stage > 120 min
PFM strength/ MVC	cOR (95%CI) (p-value)	1.000 (0.979-1.021) (0.995)	1.002 (0.984-1.020) (0.857)	0.998 (0.984-1.013) (0.833)	0.997 (0.961-1.034) (0.871)	1.014 (0.996-1.033) (0.138)
	aOR*(95%CI) (p-value)	1.003 (0.980-1.026) (0.801)	1.007 (0.998-1.027) (0.444)	0.997 (0.982-1.012) (0.696)	0.995 (0.958-1.034) (0.816)	1.006 (0.986-1.026) (0,548)
Endurance	cOR (95%CI) (p-value)	1.000 (0.997-1.002) (0.792)	1.000 (0.998-1.002) (0.985)	1.000 (0.998-1.002) (0.878)	1.001 (0.996-1.006) (0.765)	1.002 (0.999-1.004) (0.171)
	aOR* (95%CI) (p-value)	1.000 (0.997-1.003) (0.960)	1.001 (0.998-1.003) (0.522)	1.000 (0.998-1.002) (0.987)	1.001 (0.996-1.006) (0.713)	1.001 (0.998-1.004) (0.531)
VRP	cOR (95%CI) (p-value)	0.984 (0.947-1.023) (0.418)	0.971 (0.939-1.005) (0.097)	0.989 (0.961-1.018) (0.464)	1.040 (0.980-1.105) (0.197)	1.048 (1.011-1.086) (0.010)
	aOR* (95%CI) (p-value)	0.991 (0.950-1.035) (0.687)	0.975 (0.940-1.011) (0.167)	0.984 (0.956-1.014) (0.298)	1.027 (0.967-1.091) (0.381)	1.051 (1.010-1.093) (0.013)

cOR; crude odds ratio, aOR; adjusted odds ratio, CI; confidence interval

* Adjusted for maternal age, pre-pregnancy BMI, induction, epidural, birth weight and head circumference