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## Association of Index Finger Palpatory Assessment of Pubovisceral Muscle Body Integrity with MRI-Documented Tear

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## **ETHICS STATEMENT**

The study was approved by the University of Michigan Institutional Review Board.

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**ABSTRACT**

**Aims:** Pubovisceral (PV) muscle tears are associated with pelvic floor disorders. The goal of this study was to determine whether index finger palpatory assessment of PV muscle body integrity through the lateral vaginal wall is a reliable indicator of PV muscle tear severity diagnosed by magnetic resonance imaging (MRI).

**Methods:** We studied 85 women 7 weeks after vaginal birth. All had at least one risk factor for obstetric-related PV muscle tear. The ordinal outcome measure of MRI-documented PV muscle tear was defined as none, <50% unilateral tear, <50% bilateral tear or  $\geq 50\%$  unilateral tear, or  $\geq 50\%$  tear bilaterally. PV muscle body integrity by palpatory assessment was scored on a matrix, with each side scored independently and classified as PV muscle body “present” (assuredly felt), “equivocal” (not sure if felt), or “absent” (assuredly not felt). Proportional odds models were constructed to estimate the relationship between PV muscle body integrity palpatory assessment and MRI-documented PV muscle tears.

**Results:** Thirty-five percent of study participants exhibited varying degrees of MRI-documented PV muscle tears. Using palpatory assessment, we identified “PV muscle body present bilaterally” in 20%, “equivocal unilaterally or present contralaterally” in 8%, “equivocal or absent unilaterally” or “equivocal bilaterally” in 62%, and “absent bilaterally” in 9%. The odds ratio for estimating MRI results from palpatory assessment was 3.62 (95% CI 1.70-7.73,  $p = .001$ ).

**Conclusions:** A rapid and inexpensive palpatory assessment in the clinic was highly associated with the risk of MRI-documented PV muscle tear and is a useful component of a clinical assessment.

## KEYWORDS

Palpation, postpartum women, levator ani tear, pelvic floor muscles, birth injuries, physical assessment, muscle evaluation

## INTRODUCTION

The pubovisceral (PV) muscle, also known as pubococcygeus, is the portion of the levator ani muscle most vulnerable to sustaining a tear from the pubic bone during vaginal birth.<sup>1-3</sup> The PV muscle is at high risk for stretch-related tear,<sup>4</sup> likely due to a multitude of interacting factors. Variations in maternal pelvic shape, fetal head shape, the degree of molding during delivery, symphyseal diastasis, and presentation may all affect the maximum muscle stretch ratios, increasing the risk of muscle tear.<sup>5</sup> The prevalence of PV muscle tear ranges from 13% - 36% of women who have had a vaginal delivery.<sup>6-8</sup> A higher prevalence of PV muscle tear has been associated with older maternal age and obstetric variables indicative of a more complex vaginal birth.<sup>8-12</sup>

For the purposes of this paper, a PV muscle tear is characterized on magnetic resonance imaging (MRI) by a discontinuity or visible loss of muscle bulk that can be observed.<sup>9,13</sup> A complete PV muscle tear is defined as a full disruption of its origin at the pubic bone.

A PV muscle tear has been identified as a risk factor for two important pelvic floor disorders: pelvic organ prolapse and stress urinary incontinence (SUI), though the latter remains controversial.<sup>9,14</sup> For decades, the predominant nonsurgical treatment for SUI and pelvic organ prolapse has focused on the concept of increasing the strength of the levator ani muscle complex that surrounds the genital hiatus in order to compensate for any prior injury. It is noteworthy that the use of strengthening exercises, known as

pelvic muscle exercises, have generally been prescribed in the presence of a possible PV muscle tear; however, there is a lack of evidence as to whether women with a documented PV muscle tear actually benefit from pelvic muscle exercises in comparison with their peers whose PV muscle is not torn. This physiologic reality may logically explain why certain women report that, even though they follow pelvic floor exercise regimens, they fail to improve on measures of pelvic muscle strength, regardless of their effort.

MRI, as well as ultrasound imaging tests, have been used to identify PV muscle tears in research studies, but rarely in clinical settings.<sup>7,11,15</sup> This is at least in part due to lack of selection criteria concerning individual need for these high-cost diagnostic measures. The current state is that postpartum women, even with clear risk factors for PV muscle tear at childbirth, rarely receive any assessment at all for PV muscle tear postpartum.

Whether symptomatic or not in the postpartum period, the missing piece in the chain of evaluation (from identification of delivery-related risk factors to determination of whether a woman in actuality experienced a PV muscle tear) is an agreed-upon, specific, low-cost, validated clinical examination assessment. The aim of this study was to determine the extent to which assessment of the PV muscle body integrity using index finger palpatory assessment at the muscle site where it passes the vaginal sidewall bilaterally is predictive of MRI results.

## MATERIALS AND METHODS

### Study Design

The results reported here were obtained from a planned sub-analysis of a parent study, Evaluating Maternal Recovery from Labor and Delivery (EMRLD). EMRLD is a longitudinal observational cohort study initiated in January 14, 2004 and ended in April 1, 2012 with data collection intervals at 7 weeks and 8 months postpartum. The main aim of EMRLD was to study the post-vaginal birth recovery of the PV muscle (also more broadly called the levator ani muscle or, colloquially, the “Kegel muscle”). Main results were previously reported.<sup>9,12</sup> In this study, only data at 7 weeks postpartum were used because PV muscle tears essentially remained unchanged at 8 months, and data at 7 weeks have a larger sample size. Written informed consent was signed by all participants prior to study participation.

### Study Sample

A flowchart of study participation selection (Figure 1) portrays the parent study criteria for recruitment of 95 women enrolled in the parent study. All women were required to be over 18 years and able to read and sign the consent forms. All had to have at least one risk factor for PV muscle tear, including maternal age greater than 33 years, second stage of labor greater than 150 minutes or less than 30 minutes, delivered infant weighing greater than 4000 gm, forceps or vacuum delivery, or third- or fourth-degree anal sphincter laceration. Exclusion criteria for the parent study included prior urogynecologic surgery, unwillingness to undergo a pelvic exam, history of neurological conditions or traumatic accident injury, medical conditions (such as connective tissue disorders), or that English was not the primary health care language for the patient.

Additional criteria was applied for this study. Of the 95 participants from the parent study, five were excluded due to lack of an interpretable MRI, and five due to lack of palpatory assessment data, with one due to pain. Thus, 85 postpartum women comprised the final sample.

### **Index Finger Palpatory Assessment of PV Muscle Body Integrity: Predictor**

#### **Variable**

We use the phrase “index finger palpatory assessment of PV muscle body integrity” to distinguish from “pelvic floor muscle digital assessment,” such as the Brink digital exam. Although they both are physical examination skills using palpation, the former is used to assess for muscle body integrity, while the latter<sup>16</sup> assumes integrity and assesses for muscle strength.

For index finger palpatory assessment, the index finger was placed at the expected anatomical location of the mid-muscle body of the PV as felt about 2 cm inside the vagina, with the finger curled to the right or left against the vaginal sidewall (Figure 2). The finger was lightly pressed against the vaginal sidewall. Sweeping slightly up and down using the finger pad to palpate for fullness of the PV muscle body on one side and then on the other side, attempting to determine if the body of the muscle can be clearly felt with the woman at rest. If the body of the muscle cannot be clearly felt, the above procedure can be repeated while the woman attempts a pelvic muscle contraction. Ultimately, the status of the PV muscle body was determined during palpatory assessment by degree of bulk felt as continuous soft tissue resistance interposed between the lateral vaginal wall and the bony pubic rami. Absence of the muscle body will be felt

as a bony area at the inferior pubic ramus, and there will be pronounced thinness of the PV muscle more dorsally.

To record findings of the palpatory assessment, the clinician chooses between three categories per palpatory assessment of each side. If the body of the muscle could definitively be felt on palpatory assessment, that side was graded as “PV muscle present”. If the muscle body could not be felt, and instead there was a sense of indentation and/or feeling of hardness of the pubic ramus, the palpatory assessment for that side was graded as PV muscle “absent”. If the examiner was unable to confidently ascertain that the PV muscle body was either “present” or “absent”, the finding was scored as “equivocal.” The process for scoring was repeated on the contralateral side.

#### Dependent Variable: PV Muscle Tear Status Assessed via MRI

PV muscle tear status, measured via MRI, served as the dependent variable in this study. MRI has been the definitive test to identify PV muscle tears, and details of the MRI procedures used for the parent study of EMRLD are published elsewhere.<sup>9,13</sup> In brief, a 3-T Philips Achieva (Philips Medical System, Eindhoven, The Netherlands) with an 8-channel cardiac coil was used, and 2 mm images were obtained in the coronal, axial, and sagittal planes. The scoring from the MRI assessment for PV muscle tear by a musculoskeletal radiologist was categorized into five levels for each side of the muscle: no tear, subtle tear, < 50% tear, > 50% tear, and complete tear.

#### Procedures

In this study, the examiner who performed the index finger palpatory assessment was a women’s health nurse practitioner who had experience in performing the same assessment in approximately 200 non-postpartum incontinent women in a prior study.

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The examiner did not have any unique training or exposure to additional education beyond her graduate degree. Thus, this examiner was a representative of general women's health primary care providers.

The MRIs were read by a board-certified, fellowship-trained musculoskeletal (MSK) MRI radiologist who was blinded to birth data, risk category, and palpatory assessment results for PV muscle body integrity.<sup>9,13</sup>

### Data Management and Analysis

Data from the index finger palpatory assessment scoring matrix from both sides was classified into four levels that could represent an individual's overall status: PV muscle body present bilaterally (coded as "0"), equivocal at least unilaterally and present on the contralateral side, equivocal bilaterally (coded as "1"), or absent at least unilaterally (coded as "2"), and absent bilaterally (coded as "3").

Data from both PV muscle sides per MRI evaluation was also categorized into four levels: no tear or subtle bilateral tear (coded as "None"), < 50% unilateral tear (coded as "level I tear"), < 50% bilateral or  $\geq$  50% unilateral tear (coded as "level II tear"), and  $\geq$  50% bilateral tear (coded as "level III tear").<sup>9,12</sup>

Descriptive statistics were used to characterize the sample variables, including maternal age, education level, race, PV muscle status by palpatory assessment and by MRI, and birth-related risk factors for PV muscle tear. Means, standard deviations, and ranges were calculated for continuous variables, and frequencies and percentages were calculated for categorical variables.

A proportional odds model<sup>17</sup> was used to estimate the association between PV muscle body integrity by index finger palpatory assessment and PV muscle tear by MRI

by calculating the odds of higher-level category of MRI-documented PV muscle tear relative to the lower-level category contributed by each increasing level in the palpatory assessment measure.

All the analyses were performed using SPSS 23 (SPSS Inc, Chicago). The significance level was chosen as  $p < .05$ .

## RESULTS

### Final Sample Description

Descriptive characteristics of the 85-woman study sample, including distribution of obstetric-related risk factors for PV muscle tear, are presented in Table 1. Average age of the study sample was 29.2 years. Twenty-four women were older than 33 years, with mean age 36.3 years. The majority (65%) of women had a college education or higher. Most women were white (83%).

Nine percent of women were identified by palpatory assessment as PV muscle body “absent” bilaterally, while 20% of women were identified as PV muscle body “present” bilaterally. Thirty-five percent of women had MRI-documented PV muscle tear with varying degrees of severity represented.

### Bivariate Proportional Odds Model Results

Results of the proportional odds model exploring the index finger palpatory assessment as an estimate of MRI-documented PV muscle tear severity are shown in Table 2. On average, the estimated odds of having a high-level MRI-documented PV muscle tear category relative to lower category increased by 3.62 (95% confidence interval [CI] 1.70 – 7.73,  $p = .001$ ) times for each level increase in PV muscle tear assessed by index finger palpatory assessment.

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## DISCUSSION

The results show that PV muscle palpatory assessment, as conducted by an experienced women's health nurse practitioner feeling for the body of the PV muscle through the lateral vaginal wall, was a statistically significant estimator of PV muscle tear severity, as shown on MRI. It should be noted that these findings hold for women at high risk for PV muscle tear due to a recent complex vaginal birth. The frequency of the 'any tear' results corroborate an earlier report that employed ultrasound determination of PV muscle tear.<sup>18</sup> Both ultrasound and MRI can identify complete PV muscle tear well; however, MRI may be more precise in differentiating the broader spectrum of severity levels.<sup>19</sup>

Gainey,<sup>20,21</sup> a highly experienced obstetrician, published his use of index finger palpatory assessment to estimate presence of PV muscle tear in 1943, reporting on 1,000 patients. He found that 20% of primiparous women had an absence of the muscle, which he called a tear, during palpation. Although that was 75 years ago, it is striking that Gainey's estimate of tears in a population of women who gave birth remains consistent with the percentages found today using MRI and ultrasound.<sup>1,2</sup> That is not only a testament to Gainey's skill, but also an indicator that his techniques deserve attention today.

Although it is now rare to use palpatory assessment alone to diagnose PV muscle tear,<sup>22</sup> Dietz and Shek have documented that muscle tear is likely identifiable by palpation.<sup>23</sup> In addition, van Delft et al. used palpatory assessment to check for PV muscle tear by assessing the presence or absence of the PV muscle body.<sup>15</sup> They found that, after appropriate training, the technique can be readily learned and reliably

incorporated into the clinical and research settings. Since the results of palpatory assessment may be influenced by the observers' experience and knowledge, more precise and costlier tests, such as ultrasound and MRI, are needed to confirm the diagnostic results of palpatory assessment, depending on the degree of uncertainty of the provider and the purpose of diagnosis.

Some special obstetrical factors during vaginal birth may play a critical role in PV muscle tear. For example, Low et al.<sup>12</sup> have reported that birth risk factors, including older maternal age and longer second-stage *active* pushing, increased the likelihood of severe PV muscle tear in this same study population. A conceptual idea (Figure 3) is that women who experienced recent vaginal birth and had additional risk factors (e.g., maternal age  $\geq 33$  years, second-stage labor lasting  $\geq 150$  minutes or  $\leq 30$  minutes, infant weight  $\geq 4000$  gm) may especially benefit from a simple, quick index finger palpatory assessment to estimate any equivocal or absent PV muscle body.

With the proper anatomic knowledge, which is an imperative, Gainey's technique of active index finger palpatory assessment reintroduced here is easy to learn and can be an effective aid in providing feedback to patients. Clinicians can acquire proficiency in this examination through proper training and provide a timely initial estimate of the PV muscle body status post-birth. Previous studies found that palpatory assessment had acceptable reliability to identify PV muscle tear for clinical incorporation after training in the technique.<sup>15</sup>

Although several methods exist to evaluate PV muscle functional status, such as the instrumented speculum, modified Oxford scale, and Brink digital palpation, these

methods are designed to measure vaginal closure force as a response to volitional pelvic muscle contraction, while palpatory assessment (at rest or during attempted volitional pelvic muscle contraction) is intended to evaluate anatomical status. Moreover, unlike MRI, palpatory assessment is low-cost and is readily available, even in limited resource settings.

PV muscle body integrity status rated other than “PV muscle assuredly present” by palpatory assessment does not necessarily mean women do, or do not, display symptoms of pelvic floor disorders or pain. It is presently unknown whether knowledge of whether a PV muscle tear is likely to be present could help contribute to preventing the development of pelvic floor disorders later in life, or whether existing strategies for treating pelvic floor disorders are optimal or even appropriate in the presence of a PV muscle tear.

An association between PV muscle tear and both underactive pelvic muscle contraction<sup>24</sup> and vaginal closure force reduction has already been reported.<sup>9,23,25</sup> With PV muscle tear, the PV muscle logically loses its functional effectiveness due to the avulsion from its origin. It follows that pelvic muscle exercises, consisting of repetitive contractions with the goal to strengthen the PV muscle, might not be effective if the muscle is torn away from its origin and is chronic.<sup>9</sup> Therefore, it appears worthwhile to assess the PV muscle for tear status before prescribing pelvic muscle exercises as a treatment. This is similar to evaluating for anterior cruciate ligament (ACL) tear status, via the simple anterior drawer test, prior to embarking on a selected program of physical therapy for knee disorders. Need for follow-up MRI for diagnostic certainty would be dependent on whether care choices are dependent on the precision of diagnosis.

Confirmatory diagnosis provides the basis for physical therapy decisions, including the rationale for modifications to physical activity. Evaluation of “strength” (vaginal closure force), without attention to a potential tear, may fail to reveal the reasons for a loss of vaginal closure force. Women with torn PV muscle might best be instructed, for instance, in lifestyle factors and even pessary support for the pelvic organs during high-impact activities.

There are several limitations to this study. These participants were selected based on risk factors for PV muscle tear rather than presence of symptoms of urinary incontinence or pelvic organ prolapse. Hence, the value of PV muscle body integrity palpatory assessment for symptomatic women could not be explored in the context of this study design. Neither inter- nor intra-rater reliability could be evaluated in this study, due to cost of a second evaluator and in consideration that the parent study’s two timepoints were separated by 8 months of post-birth vaginal changes.<sup>9</sup> The odds ratio was not adjusted for other confounding obstetric risk factors for PV muscle tear. Lastly, the sample size was relatively small, and larger studies are needed to confirm the findings and determine inter- and intra-reliability.

## CONCLUSIONS

Index finger palpatory assessment at the site of the PV muscle body can be used to estimate the odds of PV muscle tear in postpartum women with known PV muscle tear risk factors. Using index finger palpatory assessment clinically is a starting point for assessment and decision-making about appropriateness of otherwise routinely prescribed pelvic muscle strengthening programs, which currently are typically recommended without regard to consideration of a condition of PV muscle tear.

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**TABLES**

**Table 1.** Characteristics of postpartum women at high risk for PV muscle tear (N=85)

<b>Characteristics</b>	<b>Count (N)</b>	<b>Mean (SD) or frequency</b>	<b>Range or %</b>
<b>Demographic</b>			
Maternal age (y)	85	29.2 (5.7)	19 - 46
Maternal age ( $\geq$ 33 y)	24	36.3 (3.4)	33 - 46
Education	83		
High school graduate or less		12	15%
Some college		17	21%
College/technical school graduate		21	25%

Characteristics	Count (N)	Mean (SD) or frequency	Range or %
Graduate school		33	40%
Race	84		
Black		5	6%
White		70	83%
Asian		5	6%
Other		4	5%

**PV Muscle Body Status**

Index finger palpatory assessment	85		
PV muscle “ <b>present</b> ” bilaterally		17	20%
PV muscle “ <b>present</b> ” on one side and “ <b>equivocal</b> ” on the other side		7	8%
PV muscle “ <b>absent</b> ” on one side or “ <b>equivocal</b> ” on both sides		53	62%
PV muscle “ <b>absent</b> ” on both sides		8	9%
MRI-documented PV muscle tear	85		

Characteristics	Count (N)	Mean (SD) or frequency	Range or %
<b>No tear</b> (no or subtle PV muscle tear)		55	65%
<b>Level I tear</b> (< 50% unilateral PV muscle tear)		9	11%
<b>Level II tear</b> (< 50% bilateral PV muscle tear or $\geq$ 50% unilateral PV muscle tear)		13	15%
<b>Level III tear</b> ( $\geq$ 50% bilateral PV muscle tear)		8	9%
<b>Birth Factors</b>			
Second-stage (min)	84	150.6 (126.9)	5 - 518
Second-stage ( $\geq$ 150 min)	38	257.8 (107.3)	152 - 518
Second-stage ( $\leq$ 30 min)	22	17.6 (7.6)	5 - 30
Active pushing (min)	73	108.2 (86.1)	5 - 312
Passive pushing (min)	73	46.3 (74.2)	0 - 307
Baby's weight (g)	84	3402.9 (541.7)	2100 - 4825
Baby's weight ( $\geq$ 4000 g)	11	4284.6 (255.3)	4000 - 4825
Baby's head circumference (cm)	82	34.2 (1.7)	30 - 38
Epidural (yes or no)	85	68 (yes)	80%
Oxytocin (yes or no)	85	34 (yes)	40%
Episiotomy (yes or no)	85	17 (yes)	20%
Anal tear (yes or no)	65	26 (yes)	40%
Vacuum (yes or no)	85	5 (yes)	6%
Forceps (yes or no)	85	2 (yes)	2%

*Abbreviations.* MRI denotes magnetic resonance imaging; PV: pubovisceral; SD: standard deviation.

**Table 2.** The association of palpated PV muscle body integrity with MRI-documented PV muscle tear status among women at high risk for PV muscle tear (N = 85)

	OR	95% CI	p-value
Index finger palpatory assessment for estimating odds of PV muscle tear *	3.62	1.70-7.73	.001

Test of parallel lines for the proportional odds assumption: Chi-square = 1.01, df = 2,  $p=.604$   
 Goodness-of-fit test of overall model (likelihood ratio): Chi-square = 9.64, df = 8,  $p=.291$ ,  
 Pseudo  $R^2 = .202$

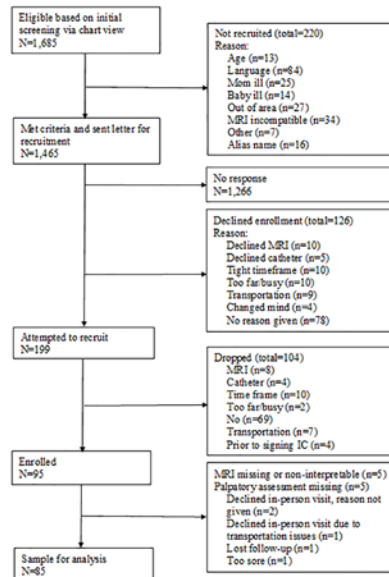
*Abbreviations.* CI denotes confidence interval; MRI: magnetic resonance imaging; OR: odds ratio; PV: pubovisceral.

\*Treated as a continuous scale (0 to 3), 0 indicates PV muscle body present, and 3 indicates that PV muscle body is not palpable.

**FIGURES**

**Figure 1.** Flow diagram for study participant selection

*Abbreviations:* IC denotes informed consent; MRI: magnetic resonance imaging.



**Figure 2.** Diagrammatic portrayal of index finger placement for palpatory assessment of the PV muscle body integrity. ©DeLancey

*Abbreviations:* PV muscle denotes pubovisceral muscle.



**Figure 3.** Conceptual model of who might benefit from index finger palpatory assessment to clinically estimate PV muscle tear after childbirth

*Abbreviations:* MRI denotes magnetic resonance imaging; PV: pubovisceral.

