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Levator ani defect status and lower urinary tract symptoms in women with pelvic organ prolapse

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Abstract

Objectives—Among women with pelvic organ prolapse, compare rates of lower urinary tract symptoms by levator ani defect (LAD) status.

Methods—Urinary incontinence and obstructive voiding are analyzed among 151 women with prolapse whose LAD status was determined with magnetic resonance imaging.

Results—Women with major LAD are less likely than women with normal muscles to experience stress incontinence when “coughing, laughing, or sneezing” (OR 0.27) and when “twisting, reaching, lifting, or bending over” (OR 0.26). They are less likely to have obstructive symptoms characterized by assuming an “unusual toileting position” or changing “positions...to start or complete urination” (OR 0.27). Women with minor LAD are more likely than those with normal muscles to experience stress incontinence with exercise (OR 3.1) and urge incontinence (OR 4.0).

Conclusion—Lower urinary tract symptoms are less common among women with prolapse and major levator ani defects and more common among those with minor defects.

Keywords

Levator ani; obstructive voiding; pelvic organ prolapse; urinary incontinence

Introduction

Studies describing the “type and frequency of symptoms in women with symptomatic prolapse” have been identified as a research priority by the National Institute of Child Health and Human Development [1]. The prevalence of lower urinary tract symptoms among women with prolapse varies widely in the literature. Rates for stress urinary incontinence (SUI) range from 13–83% and rates for urge urinary incontinence (UII) and obstructive voiding (OV) range from 20–72% and from 4–58% respectively [2]. This variation in symptoms reflects the incomplete understanding of the relationship between prolapse and lower urinary tract symptoms. It may also account for the weak associations reported by different authors between prolapse types and lower urinary tract symptoms [3,4,5,6,7].

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Levator ani dysfunction has long been believed to have an important role in the pathophysiology of pelvic organ prolapse. Levator ani defects documented by magnetic resonance imaging and by ultrasound imaging are associated with an elevated risk of developing prolapse [8,9,10]. The role of these defects in lower urinary tract symptoms is just beginning to be understood among patients with pelvic floor dysfunction. Levator ani injuries are more common among primiparous women with stress incontinence [11,12] but studies of middle aged populations with pelvic floor dysfunction did not confirm this association [13,14]. This study seeks to quantify the prevalence of SUI, UUI and OV symptoms among women with prolapse when stratified by levator ani muscle defect status.

Materials and Methods

Subject Recruitment & Population Studied

Between November 2000 and October 2004, women with and without primary pelvic organ prolapse were recruited to participate in an IRB approved case-control study [8]. All subjects signed an informed consent document. The primary aim of the parent study was to evaluate the likelihood of a levator ani injury in patients with prolapse compared to controls. The complete inclusion and exclusion criteria have been previously described [8]. There are 151 cases with prolapse at least one centimeter beyond the hymen (i.e. cases) and 135 women with all areas of vaginal support at least one centimeter above the hymen (i.e. controls). This report is a secondary analysis of lower urinary tract symptoms among the case cohort. The control cohort could not be used for this analysis because subjects were excluded if they reported urinary incontinence symptoms.

Questionnaire Protocol

Symptoms of stress urinary incontinence, urge urinary incontinence, and obstructive voiding were queried as described in the appendix 1. It also included a section on age, race, reproductive, and surgical histories.

Clinical examination

Each subject's height and weight were measured. Subjects were examined in a semi-recumbent position. Vaginal support was described with the pelvic organ prolapse quantification (POP-Q) [15]. A post void residual was determined by catheterization. A filling cystometrogram with 300cc of normal saline was performed with a dual tip microtransducer simultaneously recording urethral and bladder pressures. Urethral pressure profiles were performed and the maximum urethral closure pressure (MUCP) was calculated as the average difference between the maximum urethral pressure and the resting bladder pressure during three trials. With the prolapse reduced, supine stress tests were performed to determine the cough and Valsalva leak point pressures. Standing cough and Valsalva stress tests were also performed with a paper towel held over the urethral meatus. Continence was determined with visual inspection of a paper towel immediately following either three hard coughs or a vigorous Valsalva effort. Testing was carried out by one of the authors or another member of the female pelvic medicine and reconstructive surgery group.

Magnetic Resonance Imaging for assessment of levator ani defect status

Each woman underwent MR imaging in the axial, sagittal, and coronal planes using a fast spin proton density technique [8,16]. Levator muscle defects were graded independently on MR scans by two examiners (DMM & JOLD) blinded to subject status using a system previously described for evaluating birth-associated damage [16]. The left and right muscles were scored separately. Examples of different degrees of muscle defect and the scoring methods have been previously published [8,16]. A score of '0' was assigned if no damage

was visible, '1' if less than half of the muscle was missing, '2' if more than half, and '3' if the complete muscle bulk was lost. Instances where scores differed between the two reviewers, scans were subsequently viewed together to assign a final score. The scores for the two sides were added for the total score from 0 to 6. Scores were categorized as follows: 0, 'normal'; 1–3, 'minor defect'; 4–6 'major defect'. Women with a score of 3 on one side and 0 on the other were considered major defects [8,16].

Statistical Analysis

The presence or absence of lower urinary tract symptoms with respect to each item was determined by dichotomizing between the second and third Likert responses. For instance, stress incontinence queried by SUI item #1 was considered "present" if it occurred "on about half the occasions" or on "most or all occasions" and was considered "absent" if it occurred "never" or "occasionally (once or twice)". In the same manner, a stress incontinence symptom queried by stress UI items #2–4 was "present" if it occurred "on most days" or "on every day" and "absent" if it occurred "never" or "on an occasional day".

The relationships between demographics, findings of physical & pelvic examinations, and urodynamics were evaluated with respect to defect status (normal, minor defect, major defect). The means of continuous variables (age, parity, BMI, etc) were compared using ANOVA and the percentages of categorical variables (hysterectomy status, type of prolapse etc) were compared using a chi square test. Adjustment for the maximum extent of the prolapse beyond the hymen (in centimeters) and the site of the leading edge of prolapse (anterior, apical, or posterior) was made with logistic regression models for each item regarding stress incontinence, urge incontinence and obstructive voiding symptoms.

Results

The demographics and examination findings of women with prolapse are stratified by levator ani defect status and reported in Table 1. Mean parity was highest among women with minor defects and lowest among women with major defects. BMI was greater among women with normal muscles than among those with defects. The groups did not differ by age or hysterectomy status. The maximum extent of prolapse beyond the hymen was 3 mm larger among the women with major defects. Prolapse with a leading anterior edge was observed in a majority of subjects regardless of defect status. Anterior prolapse was most common among women with minor defects and least common among women with normal levator ani muscles.

Lower urinary tract symptoms reported by women with prolapse are reported in Table 2. The results, analyzed by levator ani defect status, are described below.

Stress incontinence symptoms

The percentage of women reporting symptoms of stress incontinence is lowest among women with prolapse who have major levator ani defects and highest among those with minor defects. All but one of the four SUI items has this pattern. When adjustments for the size and site of prolapse are made, women with major levator ani defects are significantly less likely to report stress incontinence with coughing, laughing, or sneezing and with twisting, bending, or lifting. Symptoms relating to exercise and to moving from the sitting to standing position are not significant with adjustment.

Urge incontinence symptoms

The percentage of women reporting urge incontinence symptoms is, like the SUI items, least common among women with a major levator ani defect and most common among those with

a minor defect. With adjustment for prolapse site and size, two of the four items regarding urge incontinence symptoms remain significant. Women with minor levator ani defects are four times more likely to experience leakage when waiting to use the toilet or when experiencing a strong urge to urinate. The lower rates of urge incontinence symptoms observed among women with major levator ani defects did not remain significant with adjustment.

Obstructive voiding symptoms

The percentage of women reporting several obstructive voiding symptoms is lowest among those with major levator ani defects and highest among those minor defects. When adjustment for prolapse size and leading edge are made, symptoms of an intermittent stream are more common among women with a minor levator ani defect and the need to make position changes to complete voiding is less common among those with major levator ani defects.

Discussion

This analysis demonstrates that several lower urinary tract symptoms are related to levator ani muscle integrity assessed by MR imaging. Associations between levator ani defect status and symptoms of stress incontinence, urge incontinence and obstructive voiding symptoms were observed independent of the leading edge of the prolapse or its maximum size. Women with major levator ani defects are almost four times less likely than those with normal muscles to have SUI when “coughing, laughing, or sneezing” or when “bending, twisting, or lifting”. In contrast, women with minor levator ani defects are more likely than those with normal muscles to experience SUI with exercise and to have UUI symptoms. Similar observations with respect to stress incontinence have been described among women diagnosed with levator ani avulsion injury diagnosed by ultrasound [17].

There is no obvious explanation for why women with major defects are less likely and those with minor levator ani defects are more likely to have lower urinary tract symptoms. The pudendal branch that supplies the urethral sphincter could be damaged during difficult vaginal birth, an event associated with levator ani injury [18]. It is possible that minor and major injuries to the levator ani muscles are analogous to incomplete and complete transverse myelopathies in spinal cord injury patients. An incomplete spinal cord injury is associated with preservation of motor and sensory function below the zone of injury whereas a complete injury leads to complete loss of motor and sensory function below the level of injury. With a minor injury, the preservation of one side or parts of both sides can result in asymmetry that alters reflexive responses of the urethra, bladder and pelvic floor leading to symptom exacerbation. In contrast, a complete injury might be symmetrical, lead to the absence of a reflex, and potentially have a less dramatic effect on symptoms.

There are no significant differences in urodynamic findings between the groups stratified by defect status. However, there are trends in the data worthy of comment. Demonstrable stress incontinence during a cough or Valsalva was more common among women with normal muscles compared to those with major levator ani defects. This difference did not reach statistical significance but is consistent with the analysis of stress incontinence symptoms. A larger sample size could clarify whether this association is present or not. It is more difficult to reconcile the paradoxical trends of lower mean MUCP and lower rates of stress incontinence among women with major levator ani defects and higher mean MUCP and higher rates of stress incontinence among women with normal muscles. However, reconciling why there is a lower rate of SUI and a lower mean MUCP is an enigma. It is plausible that neuromuscular injury during a levator ani injury has a field effect on the urethra but this does not provide a mechanism to account for the association of lower MUCP

with lower rates of demonstrable SUI. Regardless, these results are non-significant trends and should be interpreted with caution because the number of women with demonstrable incontinence is low. Demonstrable incontinence was observed in no more than 29% of any group and studies of larger groups of women will be needed to clarify the nature of this association.

Obstructive voiding is not as strongly associated with levator ani defect status as are SUI or UUI symptoms. The differences do not reach statistical significance although women with minor levator defects tend to have higher rates and those with major defects have lower rates for OV symptoms. It is possible that sacral innervation to the detrusor muscle is relatively spared. This hypothesis is supported by the fact that mean post void residuals, maximum flow rates, and average flow rates do not differ among the groups when stratified by defect status. More extensive neurologic evaluation may provide some insight to this interesting area of study.

The current study has certain limitations. It is a secondary analysis of a case-control study recruited to determine if levator ani injury is more common among women with prolapse. Controls were excluded if they had symptoms of pelvic floor dysfunction, including symptoms of urinary incontinence. As a result, we are unable to use the controls in this secondary analysis to compare the rate of lower urinary tract symptoms among women with normal vaginal support grouped by levator ani defect status. Another limitation is the use of a standardized but not a validated questionnaire protocol. This is due to the fact that the study protocol was assembled at a time when there was a relative lack of validated instruments. The full text of the items studied in this analysis is included and the completeness of the dataset suggests that subjects understood what was being asked. The sample size of the current study was adequate to allow for adjustment with a limited number of factors. We chose to adjust for size and leading edge of prolapse because our clinical suspicion was that these would be more likely effect lower urinary tract function. In the future, factors such as parity and BMI will be worthwhile to consider when developing studies.

In summary, this analysis provides evidence that the integrity of the levator ani is associated with lower urinary tract symptoms. Women with prolapse who have major levator ani defects are less likely to have symptoms of stress incontinence than those with normal levator ani muscles or minor defects. The mechanisms to account for these findings are not clear and are areas of research that deserve attention.

Acknowledgments

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Appendix #1: Questionnaire Protocol

Stress urinary incontinence (SUI)

1. “In the past month, have you leaked urine when you coughed, laughed, or sneezed?”

Responses to SUI #1: “never, occasionally (once or twice), on about half the occasions, on most or all of the occasions”.
2. “Do you experience urine leakage related to lifting, reaching, twisting or bending over?”
3. “Do you experience urine leakage when you go from sitting to standing?”
4. “Do you experience urine leakage related to physical exercise such as walking, running, aerobics, or tennis?”

Responses to SUI items #2–4: “never, on an occasional day, on most days, on every day”

Urge urinary incontinence (UUI)

1. “In the past month, have you leaked urine when you were on your way to the toilet?”
2. “In the past month, have you leaked urine when you had to wait to use the toilet?”
3. “In the past month, have you leaked urine when you did not go to the toilet immediately when you first felt the urge?”

Responses to UUI items #1–3: “never, occasionally (once or twice), on about half the occasions, on most or all of the occasions”.

4. “Do you experience urine leakage associated with a feeling of urgency, that is a strong sensation of needing to go to the bathroom?”

Responses to UUI item #4: were “never, on an occasional day, on most days, or on every day”.

Obstructive voiding (OV)

1. “When you urinate, does your stream start and stop and start again before you are finally finished?”
2. “Do you experience a feeling of incomplete bladder emptying?”
3. “Do you have a weak urine stream or feel that you take too long to empty your bladder?”
4. “Do you assume an unusual toileting position or change positions in order to start or complete urination?”
5. “Do you have to push up on a bulge in the vaginal area with your fingers to start or complete urination?”
6. “Do you have to push on your lower abdomen to start or complete urination?”

Responses OV items #1–6: “never, on an occasional day, on most days, on every day”.

Table 1

Demographics and examination findings of women with prolapse stratified by Levator Ani defect status

Demographics	Defect Status			P value
	Normal n=44	Minor n=24	Major n=83	
Age (years, mean $\pm$ SD)	55.4 $\pm$ 12.4	57.3 $\pm$ 13.2	57.5 $\pm$ 13.2	.81
Parity (mean $\pm$ SD)	3.3 $\pm$ 2.1	3.9 $\pm$ 1.7	2.7 $\pm$ 1.9	.02
BMI (kg/m ²)	28.3 $\pm$ 5.7	26.3 $\pm$ 3.4	25.2 $\pm$ 4.5	.003
Hysterectomy (%)	20.4	16.7	21.7	.866
Examination				
Maximum extent of prolapse (cm)	2.6 $\pm$ 2.6	2.6 $\pm$ 1.7	2.9 $\pm$ 1.6	.02
Site of maximum prolapse (percent)				.04
Anterior	54.5	75	62.5	
Apical	13.6	20.8	22.9	
Posterior	31.8	4.2	17.9	
Maximum urethral closure pressure (cmH ₂ O $\pm$ SD)	66.9 $\pm$ 41	53.8 $\pm$ 28.0	55 $\pm$ 22.9	.08
Cough standing stress test (% positive)	29	20	13	.09
Valsalva standing stress test (% positive)	27	25	16.1	.29
Post Void Residual (mL $\pm$ SD)	47.8 $\pm$ 61.7	66.2 $\pm$ 105.6	69.5 $\pm$ 119	.56
Maximum flow rate (mL/sec $\pm$ SD)	30.1 $\pm$ 17.3	24.7 $\pm$ 11.2	26.8 $\pm$ 22.9	.48
Average flow rate (mL/sec $\pm$ SD)	15.9 $\pm$ 12.5	14.7 $\pm$ 10.2	14.7 $\pm$ 19.1	.91

THE REVISED TABLE IS:

Demographics	Defect Status			P value
	Normal n=44	Minor n=24	Major n=83	
Age (years, mean $\pm$ SD)	55.4 $\pm$ 12.4	57.3 $\pm$ 13.2	57.5 $\pm$ 13.2	.81
Parity (mean $\pm$ SD)	3.3 $\pm$ 2.1	3.9 $\pm$ 1.7	2.7 $\pm$ 1.9	.02
BMI (kg/m ²)	28.3 $\pm$ 5.7	26.3 $\pm$ 3.4	25.2 $\pm$ 4.5	.003
Hysterectomy (%)	20.4	16.7	21.7	.866
Examination				
Maximum extent of prolapse (cm)	2.6 $\pm$ 2.6	2.6 $\pm$ 1.7	2.9 $\pm$ 1.6	.02
Site of maximum prolapse (percent)				.04
Anterior	54.5	75	62.5	
Apical	13.6	20.8	22.9	
Posterior	31.8	4.2	17.9	
Maximum urethral closure pressure (cmH ₂ O $\pm$ SD)	66.9 $\pm$ 41	53.8 $\pm$ 28.0	55 $\pm$ 22.9	.08
Supine stress test: % positive (n)				
Cough	15.9 (7)	20.8 (5)	8.4 (7)	.20
Valsalva	18.2 (8)	16.7 (4)	9.6 (8)	.35
Supine Leak point pressure: (cmH ₂ O $\pm$ SD)				
Cough	149 $\pm$ 54.7	132.4 $\pm$ 16.3	120 $\pm$ 35.3	.42
Valsalva	123 $\pm$ 32.4	122.5 $\pm$ 33.1	118.8 $\pm$ 41.2	.97

Demographics	Defect Status			P value
	Normal n=44	Minor n=24	Major n=83	
Standing stress test (% positive)				
Cough	29.6 (13)	20.8 (5)	13.4 (11)	.09
Valsalva	27.3 (12)	25.0 (6)	16.1 (13)	.29
Post Void Residual				
Mean $\pm$ SD (mL)	47.8 $\pm$ 61.7	66.2 $\pm$ 105.6	69.5 $\pm$ 119	.56
>100cc (%)	13.6 (6)	20.8 (5)	21.7 (18)	.54
Flow rate				
Maximum(mL/sec $\pm$ SD)	30.1 $\pm$ 17.3	24.7 $\pm$ 11.2	26.8 $\pm$ 22.9	.48
Average(mL/sec $\pm$ SD)	15.9 $\pm$ 12.5	14.7 $\pm$ 10.2	14.7 $\pm$ 19.1	.91

Table 2
Lower urinary tract symptoms among women with prolapse stratified by Levator Ani defect status

Symptoms**	Percent subjects reporting symptoms stratified by levator ani defect status				Adjusted Odds Ratios* (5, 95 % CI)	
	Normal n=44	Minor n=24	Major n=83	P value	Minor	Major
<i>Stress Urinary Incontinence</i>						
#1: Have you leaked urine when you coughed, laughed, or sneezed? (most or all occasions)	50.0	37.5	20.5	.003	0.60 (.21, 1.7)	0.27** (.12, .61)
#2: Do you experience urine leakage related to physical exercise such as walking, running, aerobics or tennis?	27.9	54.2	19.5	.004	3.1 (1.1, 9.2)	0.62 (.25, 1.5)
#3: Do you experience urine leakage related to lifting, reaching, twisting, or bending over?	28.6	50.0	9.9	<.001	2.4 (.81, 7.0)	0.26** (0.10, 0.70)
#4: Do you experience urine leakage when you go from sitting to standing?	11.4	25.0	6.1	.030	2.6 (.68, 10.3)	0.49 (.13, 1.8)
<i>Urge Urinary Incontinence</i>						
#1: Have you leaked urine when you were on your way to the toilet?	22.7	33.3	12.2	.046	1.6 (.52, 5.0)	0.46 (.18, 1.2)
#2: Have you leaked urine when you had to wait to use the toilet?	15.9	31.8	8.4	.018	2.2 (.64, 7.6)	.46 (.15, 1.5)
#3: Have you leaked urine when you did not go to the toilet immediately when you first felt the urge?	11.6	34.8	8.5	.005	4.0# (1.1, 14.9)	0.7 (.20, 2.4)
#4: Do you experience leakage associated with a feeling of urgency, that is a strong sensation of needing to use the bathroom?	19.5	50.0	17.3	.003	4.5** (1.4, 14.4)	.88 (.33, 2.3)
<i>Obstructive voiding symptoms</i>						
#1: When you urinate, does your stream start and stop and start again before you	31.8	66.7	21.0	<.001	3.9** (1.3, 11.5)	0.52 (.22, 1.2)

Symptoms**	Percent subjects reporting symptoms stratified by levator ani defect status				Adjusted Odds Ratios* (5, 95 % CI)	
	Normal n=44	Minor n=24	Major n=83	P value	Minor	Major
are finally finished?						
#2: Do you experience a feeling of incomplete bladder emptying?"	34.9	50.0	24.7	.057	2.1 (.74, 6.1)	0.62 (.27, 1.4)
#3: Do you have a weak urine stream or feel that you take too long to empty your bladder?"	30.2	29.2	35.8	.743	.88 (.28, 2.8)	1.2 (.52, 2.8)
#4: Do you assume an unusual toileting position or change positions in order to start or complete urination?"	22.7	37.5	8.5	.002	2.0 (.60, 6.8)	.27# (.08, .85)
#5: Do you push up on a bulge in the vaginal area with your fingers to start or complete urination?"	11.4	16.7	4.8	.141	2.2 (.45, 11.2)	.44 (.10, 1.9)
#6: Do you have to push on your lower abdomen to start or complete urination?"	7.0	16.7	3.6	.078	2.3 (.45, 11.6)	.46 (.08, 2.4)

* Odds ratios are adjusted for maximum size of the prolapse beyond the hymen and anterior, apical, posterior pelvic organ prolapse

** symptoms considered present if occurring on "most days" or "on everyday" or "most" or "all occasions"

** p<0.01

p<0.05