



Prolapse reduction deteriorates the urethral closure mechanism

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Received: 19 October 2017 / Accepted: 28 March 2018 / Published online: 11 April 2018

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Abstract

Introduction and hypothesis Pelvic organ prolapse (POP) reduction is often performed in the preoperative assessment of women before POP surgery. Using urethral pressure reflectometry (UPR), we sought to investigate how POP reduction affects the urethral closure mechanism.

Methods Women with anterior or posterior vaginal wall prolapse stage \geq II with and without POP reduction were examined with a speculum. We performed prolapse staging according to the Pelvic Organ Prolapse Quantification system, UPR measurements at rest and during squeezing, and standardized stress tests with 300 ml saline. All examinations were repeated after insertion of a speculum.

Results We included 38 women: 22 with anterior and 16 with posterior vaginal wall prolapse POP-Q stage \geq II. During POP reduction, resting and squeezing urethral pressures decreased by 2.5 cmH₂O ($p = 0.007$) and 5.1 cmH₂O ($p < 0.0001$), respectively, in all women. During POP reduction, the number of positive stress tests increased from four (18%) to eight (36%) in women with anterior vaginal wall prolapse and from one (6%) to nine (56%) in women with posterior vaginal wall prolapse.

Conclusions POP reduction decreases urethral pressure, especially during squeezing, and consequently increases the number of positive stress tests. The test itself artificially deteriorates the urethral closure mechanism.

Keywords Pelvic organ prolapse · Urinary stress incontinence · Urethral pressure reflectometry · Urodynamics

Introduction

The stress test is routinely performed as part of the urogynecological exam, including in preoperative assessments of women with pelvic organ prolapse (POP). If the stress test is negative in women with POP, POP reduction may be performed: the POP is repositioned with, for example, a speculum, and the stress test is repeated. If the stress test is positive, the woman is considered to have occult stress urinary incontinence (SUI). POP reduction was first introduced in the 1980s, when it was suggested that occult SUI was a predictor of postoperative de novo SUI [1–3].

Studies on urethral pressure profilometry before and after POP reduction have attempted to explain how the urethral closure mechanism is affected by the reduction, but the results are confusing; it seems that urethral parameters such as maximum urethral pressure and pressure transmission ratio decrease during POP reduction [4–6]. It is unclear whether POP reduction in fact weakens the urethral closure mechanism, which could explain why some women with negative stress tests suddenly have positive stress tests during POP reduction.

Urethral pressure reflectometry (UPR) has been studied for more than a decade [7]. It has proven highly reproducible in women with and without POP [8, 9], providing an objective assessment of the urethral closure mechanism regardless of any underlying pathology [10]. The most recent studies on UPR investigate how the urethral closure mechanism is affected after anterior and posterior colporrhaphy, respectively; the studies showed that the urethral closure mechanism was deteriorated after anterior colporrhaphy [11], but there were no changes after posterior colporrhaphy [12].

We sought to examine women with anterior or posterior vaginal wall prolapse with UPR before and after POP

This paper was presented as an abstract at the International Continence Society's 47th Annual Meeting in Florence, Italy, in September 2017.

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reduction with a speculum. We hypothesized that POP reduction weakens the urethral closure mechanism.

Materials and methods

We performed a secondary analysis of two cohorts that were prospectively recruited at our Department of Obstetrics and Gynecology, Herlev Gentofte University Hospital, Denmark, from November 2013 to March 2016. The cohorts have been described previously [11, 12]. We recruited women who sought treatment in our outpatient clinic due to a symptomatic anterior or posterior vaginal wall prolapse stage \geq II—measured with the Pelvic Organ Prolapse Quantification (POP-Q) system—regardless of their continence status. The women were recruited if the following conditions were fulfilled:

Women with anterior vaginal wall prolapse stage \geq II:

- With or without apical vaginal wall prolapse
- With no concomitant posterior vaginal wall prolapse stage \geq II

Women with posterior vaginal wall prolapse stage \geq II:

- With no concomitant vaginal wall prolapse stage \geq II in any other compartment

If the women had a history of POP or SUI surgery, hysterectomy, or neurological diseases, if they used medicine for urinary incontinence, if they were pregnant, or if they were not fluent in Danish, they were excluded. All examinations were done with the woman in the supine position. First, we performed POP staging according to the POP-Q system and then emptied the bladder with a SpeediCath Ch 10 catheter. Then, we performed UPR measurements at rest and during squeezing and repeated the measurements after inserting a standard gynecological speculum (Fig. 1) in the vagina. The speculum was placed in the vagina in exactly the same way in all women, regardless of whether or not the woman had an anterior or a posterior vaginal wall prolapse. After UPR measurements, we removed the speculum and emptied the bladder with a SpeediCath Ch 10 catheter. We then performed a standardized stress test with 300 ml saline or up to maximum bladder capacity and we asked the woman to cough vigorously three times. We then repeated the stress test after inserting the speculum in the vagina.

Measurements with UPR

UPR provides simultaneous and continuous measurements of pressure and cross-sectional area along the entire length of the urethra. The method is based on acoustic reflectometry. A bag connected to a tube is



Fig. 1 A standard gynecological speculum

inserted into the urethra. The tube connects to a probe, which contains a microphone and a loudspeaker, which transmits sound waves. A syringe and a computer with an integrated pressure recorder are connected to the probe. The syringe increases the pressure by pumping air into the bag and distends the bag, which opens the urethra. As a result, we measure the opening pressure, which is the pressure needed to open the collapsed urethra. We evaluate measurements from the high-pressure zone—the position with minimal urethral cross-sectional area at a given pressure. Pressures between 0 and 200 cmH₂O and cross-sectional areas between 0.4 and 16 mm² are measured [7].

Measurements with UPR were conducted at rest (P_{O-rest}) and during squeezing ($P_{O-squeeze}$) with and without POP reduction. At rest, we asked the woman to relax while pressure in the bag was increased until the bag, and thereby the urethra, was fully dilated, and the pressure was decreased, all within 14 s. We conducted ten consecutive measurements at rest and calculated a mean of the ten. During each squeeze, we asked the woman to hold the squeeze for 7 s while increasing the pressure in the bag until it was fully dilated. We then asked the woman to relax, and we deflated the bag. We conducted five consecutive measurements during squeezing, and calculated a mean of the five.

Initially, we performed UPR measurements during straining as well. However, straining measurements require simultaneous and continuous measurements of abdominal pressure (with a rectal catheter), which turned out to be impossible once the speculum was inserted. Analyses of the first five women revealed that the speculum pressed on the rectal catheter during straining, which resulted in artificial measurements of abdominal pressure. Therefore, we stopped performing straining measurements.

Ethics

The study was approved by the National Committee on Health Research Ethics (project-ID: H-4-2013-069) and the Danish Data Protection Agency, and all study participants gave their written consent. The study was registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT02050568).

Statistics

SAS 9.4 (SAS Institute Inc., USA) was used for statistical analyses. Continuous data were analyzed using paired or unpaired *t* tests, and *p* values <0.05 were considered statistically significant. All methods, definitions, and units conform to the standards set by the International Urogynecological Association and the International Continence Society, except where specifically noted [13].

Results

We recruited 38 women for this study: 22 with anterior and 16 with posterior vaginal wall prolapse POP-Q stage \geq II. Mean age was 62 years; 32 were postmenopausal, 21 used local estrogen therapy, and median parity was two. Results of the POP-Q and UPR measurements are presented in Tables 1 and 2, respectively. Overall, urethral opening pressures at rest and during squeezing decreased significantly after POP reduction. We compared the women with anterior and posterior vaginal wall prolapse and found that both groups had similar results.

Before POP reduction, stress tests were positive in four (18%) women with anterior and one (6%) with posterior vaginal wall prolapse. With the speculum in place, stress tests were positive in eight (36%) women with anterior and nine (56%) with posterior vaginal wall prolapse.

Discussion

Our results showed that introducing a speculum into the vagina reduces urethral pressure, especially during squeezing. Moreover, we found stress tests to be far more positive during

POP reduction. Our results clearly showed that POP reduction increased the number of positive stress tests in women with anterior and those with posterior vaginal wall prolapse. We previously found that the urethral closure mechanism, especially during straining, is deteriorated after anterior colporrhaphy ($p < 0.0001$) [11]. Interestingly, we also found that posterior colporrhaphy has no impact on the urethral closure mechanism, and the results of the stress test were the same before and after surgery [12]. We were unable to examine women during straining with the speculum. However, the stress test is an evaluation of the urethral closure mechanism during stress, i.e., cough, and as such may be considered a surrogate measure. Thus, results of our study do not correlate with our previous study on posterior colporrhaphy [12]. Therefore, we hypothesize that POP reduction temporarily weakens the urethral closure mechanism at rest and during stress in women with anterior or posterior vaginal wall prolapse. The notion that POP reduction can predict postoperative outcome implies that the reduction in and of itself does not affect the urethral closure mechanism. Interestingly, several studies have shown how the introduction of a speculum in the vagina may have an impact on urethral parameters in women with no POP [4–6]. Maximum urethral closure pressure [6], pressure transmission ratio [4, 5], urethral closure pressure [4–6] and Valsalva leak-point pressure [4–6] have all been found to decrease during POP reduction with a speculum in women with and without POP. The introduction of a speculum in the vagina seems to affect urethral parameters in all women, regardless of the presence of POP.

We believe that POP reduction artificially opens the vagina and reduces the natural support provided from the posterior vaginal wall, thereby creating a space between the anterior and posterior vaginal wall. Under normal circumstances, pressure in the upper part of the vagina is equal to the abdominal pressure [14]. Once the vagina is opened, it is introduced to atmospheric pressure, and therefore, pressure in the vagina decreases and the otherwise natural influence of abdominal pressure on urethral pressure is abolished. The urethral closure mechanism is therefore weakened, so when the woman coughs during POP reduction and the abdominal pressure—and thereby the bladder pressure—increases, the urethra cannot compensate by increasing urethral pressure. This could

Table 1 Pelvic Organ Prolapse Quantification (POP-Q) system measures

POP-Q measure	Anterior vaginal wall prolapse <i>N</i> = 22	Posterior vaginal wall prolapse <i>N</i> = 16
Aa	2.5 (0, 3)	−2 (−2, −2)
Ba	2.5 (0, 5)	−2 (−3, −2)
Ap	−2 (−3, −2)	0 (−1, 2)
Bp	−2 (−3, −2)	0 (−1, 2)
C	−5 (−7, 4)	−5 (−7, −3)

Median (range)

Table 2 Resting and squeezing urethral opening pressure with and without pelvic organ prolapse (POP) reduction

Parameter	Without speculum	With speculum	Difference \pm SD (SEM)	<i>P</i> value	Anterior vs. posterior (<i>p</i> value)
Resting urethral opening pressure, P_{O-rest}					
All women, cmH ₂ O	51.4	48.9	2.5 \pm 5.3 (0.9)	0.007	0.4 (0.8)*
Anterior POP, cmH ₂ O	48.3	45.7	2.6 \pm 5.2 (1.1)	0.03	
Posterior POP, cmH ₂ O	55.7	53.4	2.2 \pm 5.5 (1.4)	0.1	
Squeezing urethral opening pressure, $P_{O-squeeze}$					
All women, cmH ₂ O	64.5	59.3	5.1 \pm 7.2 (1.2)	<0.0001	1.0 (0.7)*
Anterior POP, cmH ₂ O	58.8	54.1	4.7 \pm 7.2 (1.5)	0.006	
Posterior POP, cmH ₂ O	72.3	66.6	5.7 \pm 7.2 (1.8)	0.006	

Means

SD standard deviation, P_{O-rest} resting urethral pressure, $P_{O-squeeze}$ squeezing urethral pressure*Unpaired *t* test

explain why our results revealed a greater reduction in squeezing urethral pressure compared with the resting urethral pressure. During a squeeze, abdominal pressure may rise, and during POP reduction, the otherwise natural compensatory rise in urethral pressure may not occur. In fact, this could explain why clinicians during midurethral sling surgery, for example, often find that women are more likely to leak during stress tests when the speculum is in place. POP reduction is therefore an artificial situation, and for this reason, it cannot predict postoperative outcome.

Richardson et al. [1] were the first to suggest that POP reduction could identify the women in need of concomitant incontinence surgery at the time of POP surgery. At present, POP reduction is still believed to mimic the postoperative outcome, even though the usefulness of the test was beint questioned even before our study [15–17]. Due to a plausible increased risk of postoperative de novo SUI, women with occult SUI may be offered concomitant incontinence surgery at the time of POP surgery. Interestingly, if a woman has no symptoms of SUI, the numbers needed to treat (NNT) in order to prevent her from developing UI is 6.3 [18]. However, the development of UI does not necessarily lead to the need for incontinence surgery [19, 20]. A study on women with POP with concomitant SUI randomized women to either POP surgery or POP surgery with concomitant midurethral slings; the NNT in order to prevent one woman from undergoing subsequent sling surgery was ten [21]. Therefore, even POP with concomitant SUI does not necessarily require concomitant incontinence surgery.

The reason why previous studies have found an association between POP reduction and postoperative SUI may be explained by a confounding factor: if a woman's urethral closure

mechanism is weak, it is likely that she will have a positive stress test during POP reduction. This can be misinterpreted as POP reduction revealing occult SUI, but in reality, the test itself weakens the urethral closure mechanism even further during the test. This may explain why only half of all women with occult SUI actually develop de novo SUI after POP surgery [22]. Due to the small sample size, our study did not allow for subgroup analyses on the urethral pressures of those women who had positive stress tests during POP reduction. Nevertheless, we believe that we need to look for more accurate ways to assess the urethral closure mechanism. Urethral pressure profilometry has vast overlaps between parameters in women with and without incontinence, making parameters such as maximum urethral closure pressure difficult to use [23]. The use of leak-point pressure actually requires that the woman has leakage; otherwise, it cannot be measured [24]. UPR is the only method that has succeeded in separating women with and without SUI [25]. There seems to be a strong association between straining urethral pressure and the occurrence of postoperative SUI [11]. This might be a more accurate prognostic evaluation than POP reduction.

In conclusion, we found that POP reduction with a speculum decreases urethral pressure and increases the number of positive stress tests in women with either anterior or posterior vaginal wall prolapse. Thus, POP reduction artificially deteriorates the urethral closure mechanism during the examination.

Acknowledgments We thank Nurse Berit Sejersen Larsen for her assistance with all examinations in this study.

Funding The study was fully funded by the University of Copenhagen, as part of a PhD Scholarship. The University of Copenhagen had no part in the study.

Compliance with ethical standards

Conflicts of interest Y.K., G.L. and N.K. have received honoraria as investigators from Astellas. G.L. has also been a consultant for Contura.

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