ORIGINAL RESEARCH

Transvulvar ultrasound of urethrovesical junction and proximal urethra as prognostic markers of burch procedure outcome

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Abstract

Objective: To compare sonographic pre- and post-op parameters related to the urethrovesical junction (UVJ) and proximal urethra (PU) in women with stress urinary incontinence (SUI) surgically cured or not with the Burch procedure, and to evaluate whether these can be used as prognostic markers.

Methods: Thirty female patients were selected by convenience sampling and assigned into two groups: 15 patients considered as clinically cured (the case group) and 15 as not cured (the control group). The enrollees were submitted to pre- (30 days prior) and post-op (180 days after) transvulvar ultrasound assessments of the UVJ and PU.

Results: On post-op assessments measured on strain, the vertical UVJ distance from the inferior pubic border and the PU length were significantly larger in cured patients (12.87 ± 5.80mm vs 5.13 ± 6.55mm in controls, $P<0.01$; and 13.07 ± 6.44mm vs 6.20 ± 6.14mm in controls, $P<0.01$) respectively. The vertical UVJ displacement or descent and PU displacement or variation were significantly shorter in cured patients (8.47 ± 3.98mm vs 5.13 ± 2.36mm in controls, $P< 0.001$; and 8.33 ± 4.54mm vs 5.20 ± 2.90mm in controls, $P< 0.05$) respectively. More importantly, on pre-op assessments, only the PU displacement or variation was significantly larger in cured patients (15.87 ± 4.55mm vs 12.47 ± 3.52 mm in controls, $P<0.05$).

Conclusions: Transvulvar ultrasound of the UVJ and PU can be used as prognostic markers of surgical outcomes in women with SUI treated with the Burch procedure.

Key words

Transvulvar ultrasonography, Perineal ultrasonography, Urethrovesical junction, Stress urinary incontinence, Burch procedure

1 Introduction

Stress urinary incontinence (SUI) is an important public health problem not only for its psychosocial and economic repercussions but mainly due to its overall impact in patients' quality of life. Given its considerable prevalence, it is

estimated that U$ 26 billion dollars are spent annually just in the United States of America, of which about U$ 393.5 million dollars are spent in diagnostic tests [1-3].

The presumed diagnosis of SUI is basically clinical. Appropriate history taking and physical examination can identify most patients with a significant SUI component without the need for urodynamic testing. For confirmation of the diagnosis, the most commonly used test is the urodynamic evaluation of the urinary bladder and urethra, which shows urine loss in the absence of detrusor muscle contraction. In such cases, it is classified as genuine SUI. The importance of the urethrovesical junction (UVJ) and proximal urethra (PU) mobility in the maintenance of female urinary continence has already been established [4, 6-11]. However, the urodynamic evaluation determines only indirectly the UVJ and PU mobility, differently from what can be clearly demonstrated in real time imaging by ultrasound [4-20].

The ultrasonographic examination of the UVJ and PU has been increasingly used in the preoperative evaluation and postoperative follow-up of patients with SUI, to document the UVJ and PU positioning before and after the elected surgical treatment [4-13,17-19]. At least one study suggested that the positioning of the UVJ and PU in the postoperative period is a good marker for treatment prognosis (whether a surgical procedure for SUI correction had been successful or not) [14].

The present study is aimed at evaluating whether the positioning of the UVJ and PU assessed by transvulvar ultrasound can serve as a prognostic marker of treatment outcome in women with SUI operated according to the Burch technique.

2 Materials and methods

Before the first participant was recruited for this nested case-control study, the research protocol had been reviewed and approved by the local Ethics Committee. Women referred to the Urinary Incontinence Research Unit (UIRU) in Recife (Brazil) complaining of SUI and who had SUI confirmed in the specific work-up protocol had the study details explained in lay terms and those who accepted to participate were invited to sign in an informed consent form. We used a standardized validated symptom questionnaire to elicit the patient's symptoms and performed a thorough urogynaecological examination to establish the clinical diagnosis. All participants, in addition to the routine medical and clinical laboratory work-up, had transvulvar ultrasound assessments of key anatomical urinary parameters (described below) in average 30 days prior to surgery and on post-op day 180th.

Among women submitted to treatment of SUI using the Burch colposuspension procedure, the first 15 sequential patients who had no SUI symptoms anymore and that had total cure confirmed by clinical examination on post-op day 30th made the case group. The first 15 sequential patients who complained of no change in SUI symptoms as compared to prior to surgery and that had it confirmed by clinical examination made the control group. Those who had partial improvements in symptoms post-surgery or complications were excluded the present analysis. All 30 enrollees who had the study specific ultrasound assessments pre-operatively complied with the post-op assessment protocol as well.

The exclusion criteria were women with a neurological abnormality, including neurogenic bladder, patients with signs or symptoms of urge incontinence or with a history of surgical treatment for SUI, pregnant women, women with cystoceles grades III and IV, and women who had partial relief of SUI symptoms or that presented with a complication (such as retention, urgency, infection, …) 30 days after Burch procedure. Patients with a history of surgical treatment of SUI or of neurological problems related to micturition, such as a neurogenic bladder, were excluded from the study. All participants were clinically stable.

The Burch colposuspension surgery performed in these patients has been summarily as follows. Through a Pfannenstiel incision and dissection of the retropubic Retzius space, the Cooper’s ligaments, bladder, urethra, UVJ, and pubourethral fascia clearly identified. Two stitches with Prolene 0 sutures were applied, two and four centimeter in parallel from the

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urethra and one centimeter below the bladder base on each side of the UVJ, to the pubourethral fascia tying it up to the Cooper's ligaments on each side with moderate tension to suspend the UVJ.

All participants were examined by a single ultrasound expert in the transvulvar approach and who had more than five years' experience in the procedure, thus minimizing both inter- and intra-observer biases.

For the transvulvar ultrasound assessment of the anatomical urinary parameters investigated here, we used an ALOKA SSD 500 machine connected to a seven Megahertz convex vaginal transducer. The measurements were taken from patients in the dorsal lithotomy position with a barely empty bladder (having < 50ml of urine). The ultrasound transducer was covered in ultrasound gel, covered by a glove and then more gel was applied before being placed on the perineum in a mid-sagittal orientation. The transducer was positioned against the vulva right below the urethra, where the window view allows for a proper assessment of the urethra, bladder, UVJ and the pubis.

Three measurements were taken for each variable at rest and on strain and their means were reported in the tables below. Measurements were taken both at rest and on strain (during maximum Valsalva's maneuver) in the pre- and post-op periods. The displacements were calculated by subtraction of the value at rest from the one on strain. The zero level has been defined as the inferior pubic border. When the UVJ was positioned above the inferior pubic border, the measurement was the distance in mm from the zero level and to it we attributed a positive value. When the UVJ went below the inferior pubic border, the measurement in mm was calculated from the zero level and we attributed a negative value. When the UVJ was initially above the inferior pubic border at the rest and went below it on strain, the final measurement was the sum of the positive value to the negative one disregarding the mathematical signaling standards.

The following parameters, as illustrated in figure 1, have been measured:

- Vertical UVJ distance (VUVJD): the length of a longitudinal straight line drew from the inferior pubic border to a transversal line that crosses the UVJ.
- Proximal urethra (PU) length: the distance between the UVJ and the urethral point of the PUD.
- Horizontal UVJ distance (HUVJD): the length of a transversal straight line drew from the UVJ to the longitudinal line that crosses the pubis.
- Pubourethral distance (PUD): the length of a transversal straight line drew between the urethra and the pubis.

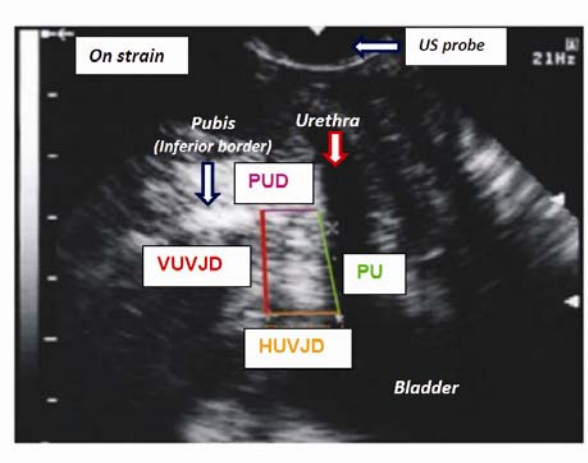

Figure 1. Transvulvar ultrasound of the UVJ showing the vertical (VUVJD) and horizontal (HUVJD) distances as well as measurements of the pubourethral distance (PUD) and the length of the proximal urethra (PU) on strain.

In average 180 days after the surgical procedure, a quality control ultrasound assessment of the anatomical parameters being studied was carried out in all enrollees. Variables such as age, number of vaginal deliveries and body mass index

(BMI), which might be related to the studied endpoints, were compared between groups to rule out possible biases from the sampling method used.

The data were analyzed using the EPI-INFO 2002 version 1.0 statistical package. The following statistical tests have been used: the 2-tailed Fisher´s exact test was used for analysis of averages and variances when a cell on a 2×2 table scored less than five. The level of statistical significance considered was a *P*-value < 0.05.

3 Results

The patients' overall mean age was 49 ± 8.3 [35; 60] years. Their mean number of vaginal deliveries and BMI were 28.6 ± 4.3 [21.09; 39.23] and 2.7 ± 0.5 [2; 3] respectively. There was no significant difference between the case and control groups regarding patient's age, number of vaginal deliveries and BMI, as it is depicted in table 1.

Table 1. Comparison of the case and control groups regarding main confounding variables – patient's age, number of vaginal deliveries and body mass index (BMI)

Variables	Case	Control	*P*-value
Age (years) – Mean ± SD [variation]	47.13 ± 9.21 [35; 60]	50.27 ± 7.27 [41; 60]	0.31
Vaginal deliveries – Mean ± SD [variation]	2.7 ± 0.49 [2; 3]	2.8 ± 0.41 [1; 3]	0.43
BMI – Mean ± SD [variation]	28.05 ± 3.86 [22.00; 34.79]	29.13 ± 4.71 [21.09; 39.23]	0.50

The mean measurement of the UVJ descent or vertical movement, also called in this paper VUVJD, on strain was significantly decreased in the post-operative period compared to before surgical correction in patients who became totally cured from SUI ($P<0.05$), as it can be observed in table 2. The same is true for the other vertical anatomical parameter assessed the PU length (see Table 3).

Table 2. Means of pre- and post-op measurements of the vertical urethrovesical junction distance (VUVJD) among patients with stress urinary incontinence who became fully cured after treatment with the Burch procedure as compared to the ones that remained with the same symptoms after surgery.

VUVJD (mm)	Pre-op assessments (average 30 days prior to surgery)			Post-op assessments (average 180 days after surgery)		
	At rest	On strain	Displacement or descent	At rest	On strain	Displacement or descent
Fully cured patients						
Mean ± SD	17.20 ± 5.68	4.27 ± 4.06	17.20 ± 5.21	17.20 ± 4.96	12.87 ± 5.80	5.13 ± 2.36
No surgical impact on symptoms						
Mean ± SD	15.40 ± 4.63	5.20 ± 4.74	14.07 ± 4.93	13.60 ± 6.29	5.13 ± 6.55	8.47 ± 3.98
Significance	$P>0.05$	$P>0.05$	$P>0.05$	$P>0.05$	$P<0.01$	$P<0.01$

The evaluated anatomical parameters related to the horizontal axis, PUD and HUVJD, did not differ significantly when the means at rest versus on strain of pre- and post-op transvulvar ultrasound assessments were compared (see Tables 4 and 5).

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Table 3. Means of pre- and post-op measurements of the proximal urethra (PU) length among patients with stress urinary incontinence who became fully cured after treatment with the Burch procedure as compared to the ones that remained complaining of the same symptoms after surgery.

PU length (mm)	Pre-op assessments (average 30 days prior to surgery)			Post-op assessments (average 180 days after surgery)		
	At rest	On strain	Displacement or variation	At rest	On strain	Displacement or variation
Fully cured patients						
Mean ± SD	17.87 ± 5.66	2.00 ± 3.61	15.87 ± 4.55	18.27 ± 5.60	13.07 ± 6.44	5.20 ± 2.90
No surgical impact on symptoms						
Mean ± SD	15.93 ± 4.46	3.47 ± 5.41	12.47 ± 3.52	14.53 ± 7.04	6.20 ± 6.14	8.33 ± 4.54
Significance	$P > 0.05$	$P > 0.05$	$P < 0.05$	$P > 0.05$	$P < 0.01$	$P < 0.05$

Table 4. Means of pre- and post-op measurements of the horizontal urethrovesical junction distance (HUVJD) among patients with stress urinary incontinence who became fully cured after treatment with the Burch procedure as compared to the ones that remained with the same symptoms after surgery.

HUVJD (mm)	Pre-op assessments (average 30 days prior to surgery)			Post-op assessments (average 180 days after surgery)		
	At rest	On strain	Displacement	At rest	On strain	Displacement
Fully cured patients						
Mean ± SD	15.27 ± 7.17	21.73 ± 7.61	6.87 ± 4.49	5.87 ± 5.57	6.20 ± 5.76	0.33 ± 3.39
No surgical impact on symptoms						
Mean ± SD	13.47 ± 6.62	18.87 ± 5.71	6.60 ± 6.28	8.47 ± 5.74	9.40 ± 6.16	0.93 ± 7.10
Significance	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$

Table 5. Means of pre- and post-op measurements of the pubourethral distance (PUD) among patients with stress urinary incontinence who became fully cured after treatment with the Burch procedure as compared to the ones that remained complaining of the same symptoms after surgery.

PUD (mm)	Pre-op assessments (average 30 days prior to surgery)			Post-op assessments (average 180 days after surgery)		
	At rest	On strain	Displacement	At rest	On strain	Displacement
Fully cured patients						
Mean ± SD	13.73 ± 4.23	21.67 ± 7.93	7.93 ± 5.62	11.47 ± 3.04	10.40 ± 3.77	-1.07 ± 3.97
No surgical impact on symptoms						
Mean ± SD	13.47 ± 3.07	18.13 ± 4.98	4.80 ± 3.78	11.80 ± 4.09	11.27 ± 4.82	-0.53 ± 5.19
Significance	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.05$	$P > 0.01$	$P > 0.05$

4 Discussion

The present study main aim was to test the hypothesis that transvulvar ultrasound of the UVJ and PU can be used as prognostic markers of surgical outcome for women with SUI treated with the Burch procedure. We have chosen the Burch procedure for this study because it is considered a gold-standard for treatment of women with SUI [18] and the technique has already been standardized at our Urogynaecology Service for over ten years.

Despite the convenience sampling method used for recruitment of participants, there were no confounding biases related to age, number of vaginal deliveries or BMI in the present study (see Table 1).

As shown in table 1, in women who became fully cured from SUI after treatment with the Burch procedure, the mean vertical UVJ position on strain, in relation to the lower pubic border, was significantly (P<0.01) higher up (12.87mm) than the one in women whose surgery had no impact on symptoms (5.13mm). In fact, in women who failed surgical correction, the mean vertical UVJ position on strain post-operatively was basically unchanged compared to the pre-op assessment (5.20mm). As a consequence, the mean vertical UVJ displacement or descent (5.13mm) was significantly (P<0.01) decreased in cured women compared to the mean measurement in women who continued to experience the initial symptoms (8.47mm). Interestingly, it became similar to the mean measurement (5.33mm) found in healthy nulligravidae women without SUI, as previously reported [4].

In the case group, only one woman (6.7%) who became fully asymptomatic after surgical correction had a mean vertical UVJ displacement over nine millimeters, what has been considered UVJ hypermobility [4]. On the other hand, 53.4% of women who complained of unchanged SUI symptoms after surgery had evidence of UVJ hypermobility.

Women who remained with SUI symptoms after the surgical procedure failed to produce a significant decrease in the vertical UVJ displacement; it went from 14.07mm pre-op to 8.47mm post-op (close to the hypermobility range). In other words, the vertical UVJ hypermobility documented pre-operatively in these patients has not been appropriately fixed (see Table 2). These findings suggest that surgical elimination of SUI symptoms in women is linked with bringing the UVJ to a higher up position in relation to the inferior pubic border through proper colposuspension, thus decreasing UVJ hypermobility.

Other authors have published similar observations, that UVJ or bladder neck hypermobility was significantly reduced after successful anti-incontinence surgery, from 67.1% before surgery to 5.5% immediately after surgery (P<0.0001). Post-operative hypermobility documentation was associated with a higher recurrence rate [14].

It was noteworthy the findings from PU length assessments (see Table 3). Women successfully treated with the Burch procedure had a significantly (P<0.01) longer mean PU length measurement on strain (13.07mm) in the post-op period compared to those who had no change in SUI symptoms (6.20mm). Hence elongating the urethral length surgically decreases the PU length displacement or variation in post-op assessments. Therefore, a successful Burch procedure tends to elongate the PU length (clearly seen on post-op assessments on strain) and decrease its displacement or variation based on pre- versus post-op transvulvar ultrasound assessments (see Table 3). In addition, the PU length displacement or variation was significantly (P<0.05) lower (5.20mm) in the post-op period in women cured with the surgical treatment compared to the ones that did not (8.33mm).

More importantly, we have observed that measurements of the PU length (see Table 3) taken in the pre-op period could also be indicative of women with SUI more likely to produce a successful surgical outcome. Prior to surgical treatment, women who eventually turned out to eliminate SUI symptoms after the Burch procedure had a significantly (P>0.05) longer mean PU length displacement or variation (15.87mm) than the ones that did not (12.47mm).

Our findings suggest that the PU length can be an even better prognostic marker of surgical outcome for women with SUI than the vertical UVJ mobility. The reason being that, in addition to the significant findings in the post-op assessments observed for both the PU length and vertical UVJ, only the PU length displacement or variation was significantly longer in the pre-op period as well (see Table 3).

No significant observations (P>0.05) were made in the present study related to assessments of horizontal UVJ and PUD measurements (see Tables 4 and 5).

Finally, the present study provides evidence supporting that a proper colposuspension using the Burch procedure should focus on bringing the UVJ up and decreasing UVJ hypermobility. Similar results have been described for the Kelly-Kennedy and tension-free vaginal tape (TVT) procedures [9, 15, 16].

We believe that anatomical changes to the UVJ and PU assessed by transvulvar ultrasound can be useful in pre- and post-op evaluations of women with SUI requiring different surgical treatment options. Further research with larger sample sizes, broader characterization of the study population and using other surgical procedures designed to treat women with SUI are envisaged.

5 Conclusion

A shorter mean vertical UVJ displacement or descent measured post-operatively (average 180 days after surgery) by transvulvar ultrasound was significantly associated with full surgical success in women with SUI treated with the Burch procedure. A longer mean PU length measurement on strain after surgery was significantly associated with 100% correction of SUI symptoms in surgically treated women. Interestingly, a larger mean PU length displacement or variation measured pre-operatively and a shorter such mean measured post-operatively were also significantly associated with complete disappearance of SUI symptoms in operated women. Transvulvar ultrasound assessments of the UVJ and PU can be used as prognostic markers of surgical results in women with SUI treated with the Burch procedure.

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