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The Influence of Posture on Perineal Ultrasound Imaging Parameters

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Abstract: A prospective clinical study was carried out to evaluate the influence of posture on perineal ultrasound imaging parameters. One hundred and thirty-two consecutive women presenting with symptoms of lower urinary tract dysfunction were examined by multichannel videourodynamics and perineal ultrasound, both supine and standing. Ultrasound included color Doppler imaging when available, i.e. in a subgroup of 99 patients. The position of the bladder neck at rest was higher in the supine position ($P<0.001$) and it descended further on Valsalva ($P<0.001$), to reach an almost identical final position. There was a higher degree of urethral rotation on supine imaging ($P = 0.001$). Urethral funneling on Valsalva was more likely in the erect position ($P<0.001$), as was urine leakage documented by color Doppler imaging ($P<0.001$). The effect of a pelvic floor contraction was not significantly influenced by posture. Imaging of the urethrovesical junction should be undertaken in both supine and erect positions to document optimally both hypermobility and funneling or leakage.

Keywords: Funneling; Hypermobility; Perineal ultrasound; Posture; Urodynamics

Introduction

Imaging in urogynecology is increasingly being performed by ultrasound rather than by X-ray fluoroscopy, the previous 'gold standard'. The correlation between the two methods has been shown to be good [1–5]. For practical reasons perineal ultrasound is usually undertaken with the patient supine, even though it is generally accepted that the continence mechanism is more adequately tested in the erect position. Fluoroscopic imaging has ideally been performed both supine and erect, the latter after tilting the patient upright on a radiological table. There have been previous studies into the influence of patient posture on ultrasound parameters of bladder neck position and mobility, on using both transvaginal [6] and perineal [7] ultrasound. Numbers in these studies were small, the evaluated parameters differed from those assessed by us, and they did not assess the detection of leakage. We therefore carried out a prospective clinical study on 132 women suffering from symptoms of lower urinary tract dysfunction who had been referred for urodynamic testing.

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Methods

One hundred and thirty-two women undergoing multichannel urodynamics and fluoroscopic imaging for the investigation of lower urinary tract symptoms were examined by perineal ultrasound in the supine and erect positions. Ultrasound was performed using a 5 MHz curved-array transducer placed on the perineum, at an average bladder volume of 334 ml (maximum bladder capacity on filling cystometry). In a subgroup of 99 women who did not significantly vary regarding history, clinical parameters or urodynamic diagnosis, color Doppler imaging was employed to test for urine leakage on coughing and Valsalva. This new modality has been shown to correlate well with leakage observed on fluoroscopy [8]. The study was deemed exempt from formal approval by the institutional ethics committee, as no significant additional intervention was proposed.

Perineal imaging parameters were obtained as described previously [5]. Images were taken both at rest and on Valsalva maneuver, with the position of the

internal urethral meatus determined relative to the inferoposterior margin of the symphysis pubis (bladder neck elevation, BNE). The difference between vertical distances at rest and on Valsalva was defined as bladder neck descent (BND). The retrovesical angle (RVA) was also determined at rest and on Valsalva, and rotation of the proximal urethra was defined as the change in proximal urethral axis with Valsalva. We also included an assessment of pelvic floor function by recording the maximal cranial and ventral displacement of the internal meatus observed on levator contraction [9]. Again the inferoposterior margin of the symphysis pubis served as the point of reference. All measurements referred to in this study are the maximum obtained from three subsequent Valsalva maneuvers or levator contractions. The intra- and interobserver variability of the method has been shown to be good [4]. All ultrasound measurements were performed by one investigator. Urine leakage on color Doppler was determined by both color Doppler energy (CDE) and velocity (CDV) mapping.

Statistical analysis was performed by Diana Battistutta, biostatistician, Brisbane, Australia. For continuous variables, Pearson correlation coefficients and paired *t*-tests were used to test for systematic differences. For categorical variables χ^2 tests were used to summarize differences between pairs of measures. Statistical significance, where quoted, is at the 95% level.

Results

The average age of the subjects was 51 years (range 27–81). Median parity was 3 (range 0–10), with a mean maximum birthweight of vaginally born children of 3698 g (range 2250–5020 g). Mean body mass index was 29 (range 17–59). We determined:

1. the distance between bladder neck and symphyseal margin or bladder neck elevation BNE;
2. bladder neck descent (BND) on Valsalva;
3. the retrovesical angle (RVA) at rest and on Valsalva;
4. urethral rotation;
5. funneling of the proximal urethra;
6. loss on color Doppler imaging on Valsalva maneuvre;
7. displacement of the internal meatus on pelvic floor contraction (ventral and cranial lift).

Table 1 summarizes the results.

The position of the bladder neck at rest was higher in the supine position ($P<0.001$) and it descended further with a Valsalva maneuver ($P<0.001$). There was a greater degree of urethral rotation when the patient was supine ($P = 0.001$).

Funneling of the internal meatus on Valsalva was seen in the supine position in 75 patients and in the erect position in 94 (Table 2). In 33 cases these results did not agree ($P<0.001$): in 26 patients funneling was only visible in the erect position, and in 7 women the reverse occurred.

Table 1. Perineal imaging data ($n = 132$ exc. for urine loss) obtained in the supine and in the upright position. PFMC, pelvic floor muscle contraction

Parameter	Supine	Upright	*P*
RVA at rest	106 (14)	110 (8)	0.002
RVA on Valsalva	148 (32)	150 (33)	n.s.
Rotation of prox. urethra	50 (34)	43 (28)	0.001
Funneling	75	94	<0.001
Urine loss (CD)	39	55	<0.001
BNE at rest	27.4 (4.7)	22.1 (6.8)	<0.001
BNE on Valsalva	3.2 (11.9)	3.4 (10.2)	n.s.
Bladder neck descent	24.1 (11.7)	18.7 (8.3)	<0.001
Ventral lift with PFMC	2.7 (2.3)	2.7 (2.8)	n.s.
Cranial lift with PFMC	6.4 (4.1)	5.7 (4.7)	n.s.

Table 2. Funneling of the proximal urethra is more frequently observed in the erect position

Funneling		supine	
		pos	neg
erect	pos	68	26
	neg	7	31
			$P<0.001$

Table 3. Urine loss as documented by color Doppler (CD) imaging is more commonly seen in the erect position

Urine loss (CD)		supine	
		pos	neg
erect	pos	37	18
	neg	2	42
			$P<0.001$

For urine loss as documented by color Doppler the respective numbers were 39 and 55, with 20 cases of disagreement ($P<0.001$); in 18 women Doppler urine loss was only evident in the erect position, whereas the reverse occurred only twice (Table 3).

Both funneling and urine loss on Doppler were therefore more frequently detected in the erect position. The effect of a pelvic floor contraction was not markedly influenced by posture. However, more patients were unable to perform a measurable pelvic floor contraction in the erect position (15 vs. 3 patients), most frequently because of prolapse.

Discussion

For the purposes of imaging in urogynecology, perineal or translabial ultrasound is usually performed with the patient supine as this is most convenient for both patient and examiner. The lateral cystourethrogram, on the other hand, has traditionally been performed with the

patient standing, and fluoroscopic imaging is often conducted on a tilting table, with views taken both supine and erect. So far, the effect of posture on the parameters determined by ultrasound imaging of the bladder neck has not been conclusively investigated in a large number of patients.

In 132 women undergoing urodynamic assessment it could be shown that the urethrovesical junction and the proximal urethra are more mobile in the supine position. The position of the bladder neck at rest is higher by on average more than 5 mm, and it descends about 5 mm further on Valsalva. However, as a result the position of the internal meatus at maximal Valsalva is almost identical. The retrovesical angle follows the same trend, with maximal opening of the angle almost identical but significant differences between the means of measurements at rest. This may indicate that tissue factors such as elasticity and compliance may influence maximum descent more than the varying strength of Valsalva maneuvers and patient position. It appears that maximal (or close to maximal) descent was reached with an average Valsalva maneuver, regardless of patient position.

If hypermobility is measured by the Q-tip test one would expect increased urethral rotation in the supine patient as ascertained by Q-tip angle. This has indeed been observed [10]. Two other studies investigating the effect of posture used transvaginal [6] and perineal [7] ultrasound. The former study in 25 women found non-significant differences in bladder neck descent (about 3 mm on average) between the supine and the seated positions. Schaer et al. [7] compared imaging data obtained from 80 patients in the supine and upright positions. The retrovesical angle at rest was higher in the standing position but no differences were observed on Valsalva, which agrees with the findings presented here. The bladder neck at rest was higher and descended further, to a lower final position. It is only this last finding that disagrees with the results of this study.

As regards funneling and loss of urine on color Doppler imaging (the latter in a subgroup of 99 patients), both were observed more frequently in the erect position. The effect on funneling has been shown by other investigators [7]. The finding that urine loss on color Doppler imaging is more likely in the erect position confirms the need for imaging in the standing position on urodynamic testing.

The two main factors influencing the likelihood of funneling and leakage, are therefore patient position, as shown above, and bladder volume [11,12]. Leakage is clearly most likely in the standing position and with a full bladder. A third factor, the (voluntary or involuntary) activation of the levator or even the urethral rhabdosphincter on Valsalva or coughing, remains uninvestigated so far and may warrant further study.

Conclusion

Imaging of the urethrovesical junction by perineal ultrasound should ideally be undertaken in the supine as well as in the erect position to document reliably both hypermobility and funneling or urine leakage.

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EDITORIAL COMMENT: This study adds to our body of knowledge regarding the importance of bodily position during ultrasound imaging of the lower urinary tract. The importance of postural effects on the anatomic relationship between the lower urinary tract, the lower genital tract and the pelvic floor during dynamic maneuvers has been recognized for many years. These changes, however, have only been broadly characterized qualitatively and rarely quantitatively. This study helps continue our growth in better understanding these dynamic posture relationships. Unfortunately, limiting the dynamic forces to a Valsalva maneuver challenges the validity of the findings in extrapolating them to the upright female, who frequently walks, lifts, runs, jumps and coughs, but rarely Valsalvas.