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Bladder neck mobility in continent nulliparous women

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Objective To evaluate the mobility of the vesical neck during coughing and valsalva in healthy nulliparous volunteers and to test the reliability of the technique applied.

Design Clinical observational study.

Setting Department of Obstetrics and Gynaecology, Cantonal Hospital Lucerne, Switzerland.

Population Thirty-nine nulliparous volunteers.

Methods Vesical neck motion was assessed with perineal ultrasound. Intra–abdominal pressure was controlled for with an intrarectal probe. Intra-rater reliability was evaluated.

Results Vesical neck mobility was significantly lower during coughing (8 mm, SD 4 mm) than during valsalva (15 mm, SD 10 mm) ($P < 0.005$). Between individuals mobility varied from 4 mm to 32 mm during coughing and from 2 mm to 31 mm during valsalva. Test-retest-studies showed a maximum difference between to tests during coughing of 4 mm and during valsalva of 5 mm.

Conclusion The bladder neck is mobile in normal continent women and bladder neck mobility is lower during coughing than during Valsalva.

INTRODUCTION

Bladder neck hypermobility is widely regarded to be associated with the occurrence of stress urinary incontinence[1]. Several techniques have been proposed to quantify bladder neck mobility: Q-tip test[2], lateral cysturethrography[1], introital[3], rectal[4], vaginal[5] and perineal ultrasound[6,7]. Perineal ultrasound allows the dynamic evaluation of the bladder neck. It was shown that the bladder neck position can be reproducibly determined using a co-ordinate system[6].

Coughing and valsalva are both used to induce stress incontinence in the urogynaecological clinic. It was shown before that leak point pressures are higher during coughing than during valsalva in the same patients[8].The aim of this study was to test the reliability of bladder neck mobility in healthy nulliparous volunteers and to compare the mobility during coughing and valsalva.

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METHODS

The study protocol was approved by the local ethical committee and all participants gave informed written consent. Thirty-nine nulliparous volunteers 18 years and older without a history of recurrent urinary tract infections or diseases of the lower and upper urinary tract were recruited. Nursing students, midwife students, doctors and nurses of the hospital were invited to participate by distributing flyers in class and in the hospital. Forty-five women were interested, but six declined participation after receiving more information about the study design, leaving 39 women who participated. The volunteers answered a set of standardised questions on history of urinary incontinence, constipation, chronic cough and smoking.

After midstream urine was tested for signs of infection, the women were placed in the lithotomy position. The bladder was filled with 200mL of sterile water using a catheter. The women were instructed to cough vigorously in the supine and in the standing position while the outer urethral meatus was observed for any leakage. Afterwards a rectal balloon catheter was placed in the rectum to measure abdominal pressure.

Perineal ultrasound was performed with a 3.5MHz curved linear array transducer (Siemens SI 400, Erlangen, Germany). The bladder neck and the pubic bone were visualised songraphically. The position of the bladder neck was analysed according to a standardised and reproducible method described by Schaer *et al.*[6]. Using a co-ordinate system with the X-axis through the pubic symphysis and the Y-axis perpendicular to the X-axis at the posterior end of the pubic bone, the position of

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the bladder neck was established at rest and during coughing or valsalva[9]. The vector between the two positions was calculated using the formula:

$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Volunteers performed a standardised set of coughing and valsalva manoeuvres. This included a resting period, straining down with increasing effort three times, contraction of the pelvic floor muscle three times, coughing with single coughs and increasing strength five times. This was repeated twice, with a 15 minute resting period in between. The ultrasound examination was recorded on two different video tapes to allow detailed analysis later on. Intrarectal pressure was measured during coughing and during valsalva. The traces were displayed on the ultrasound machine's screen and additionally stored electronically.

While the ultrasound examination was done by one author (G.F.) the evaluation was done on a separate occasion by another author (U.P.) who did not know the volunteers. Tape 1 and tape 2 were assessed at different times. The results of the first tape were compared with those of the second tape to test for reliability.

The test–retest reliability was assessed with the Intraclass Correlation Coefficient[10,11], and by using the statistical methods described by Bland and Altman[12]. Data analysis was also performed to assess mean bladder neck mobility during coughing and valsalva and to compare between the two manoeuvres. Wilcoxon's signed rank test and Mann-Whitney *U* test were used where appropriate. $P < 0.05$ was defined as significant. The Statistical Package for the Social Science for Windows (Version 9) (SPSS Inc, Chicago, Illinois USA) was used.

RESULTS

The mean (SD) age was 24.2 (6.0) years (range 18 to 36 years). None of the women had a history of urinary incontinence, chronic constipation or chronic coughing. No leakage was observed while coughing in the supine or standing position in any of the women. Two measurements were compared only when the intra-abdominal pressure showed no difference greater than 10 cm H_2O. Results are therefore presented for subgroups.

Vesical neck descent during coughing was significantly lower than during valsalva in 25 women (8 mm (SD 4) mm *versus* 15 mm (SD 10) $P < 0.005$; Wilcoxon rank test). The difference between the two tests ranged from 0-23 mm (Fig. 1).

Eighteen women could be compared for bladder neck mobility during valsalva [intra abdominal pressure 60 cm H_2O (SD5)]. Bladder neck descent varied widely between these women from 2 mm to 31 mm (mean 14, SD 9 mm). Vesical neck mobility also varied between women ($n = 21$) during coughing (intra-abdominal pressure 110 $\pm$ 5 cm H_2O) from 4 mm to 32 mm (mean 9, SD 6 mm) (Fig. 2 a and b).

Evaluation of the test-retest reliability for bladder neck mobility during valsalva was possible in 20 women. The comparison showed that the differences between bladder neck descent at two times did not exceed 5 mm (mean difference 1 mm, SD 3 mm). The intraclass correlation coefficient α was 0.99 (95% Confidence Interval 0.970 to 0.995 $P < 0.0001$).

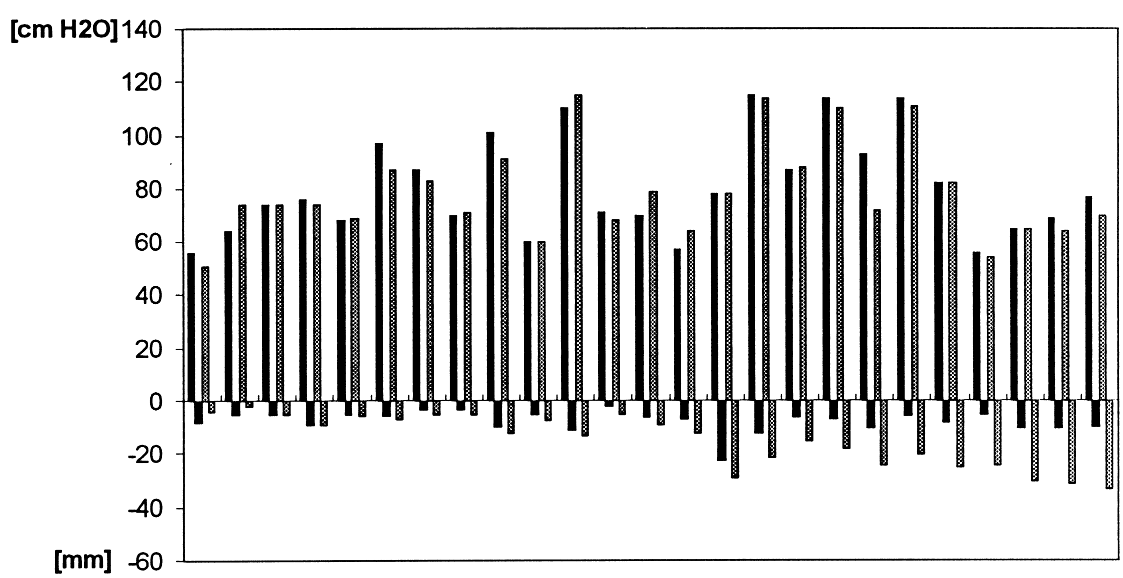

Fig. 1. Bladder neck mobility in women ($n = 25$) who coughed (black bars) and strained (grey bars) with the same intra-abdominal pressure. The bars directed upward display the intra-abdominal pressure generated during the manoeuvre. The bars directed downward represent the bladder neck descent.

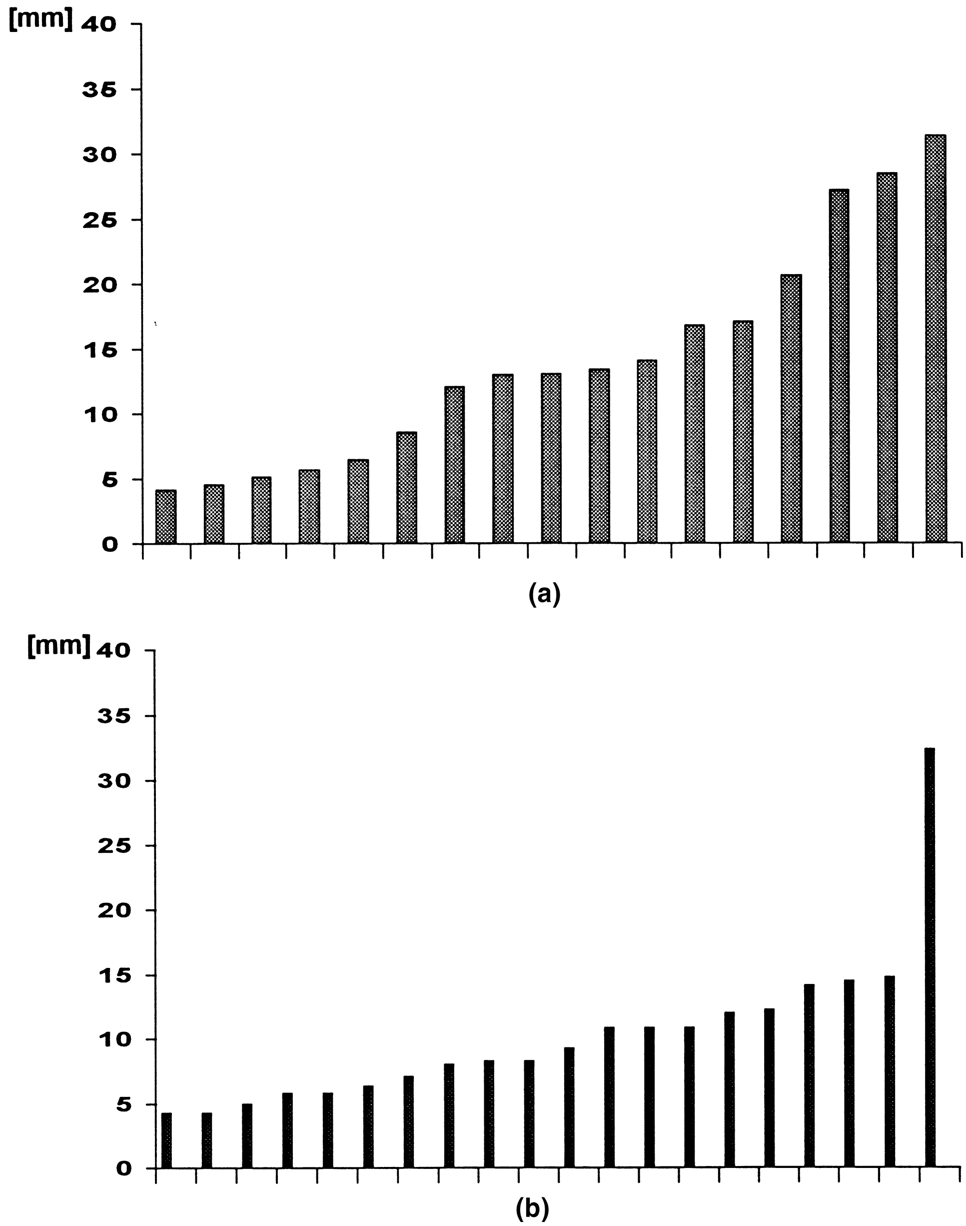

Fig. 2. Bladder neck descent in different individuals during (a) valsalva with an intra-abdominal pressure of 60 cm ($\pm$ 5) H_2O ($n = 18$) and during (b) coughing with an intra-abdominal pressure of 110 cm ($\pm$ 5) H_2O ($n = 21$).

Test–retest reliability could also be calculated during coughing in 20 women. In these women the maximum difference between two tests was 4 mm (mean difference 1 mm, SD 2 mm). The intraclass correlation coefficient α was 0.956 (95% Confidence Interval 0.896 to 0.984 $P < 0.0001$).

Test–retest reliabilities for valsalva and coughing are shown in Fig. 3a and b, calculated according to the method described by Bland and Altman.

DISCUSSION

Coughing and valsalva are two methods used for the demonstration of stress urinary incontinence[13]. This study showed that bladder neck mobility is significantly less during coughing, compared with valsalva. This could be explained by a pelvic muscle contraction during coughing that stabilises the pelvic floor and supports the bladder neck. During valsalva women might relax the pelvic floor muscles thereby allowing an increased mobility of the bladder neck. This finding agrees with differences between the cough and the valsalva leak point pressure that have been described before[8,14]. Cough leak point pressures are significantly higher than valsalva leak point pressures in the same patients. To our knowledge there is no study published that compared bladder neck mobility and leak point pressures during

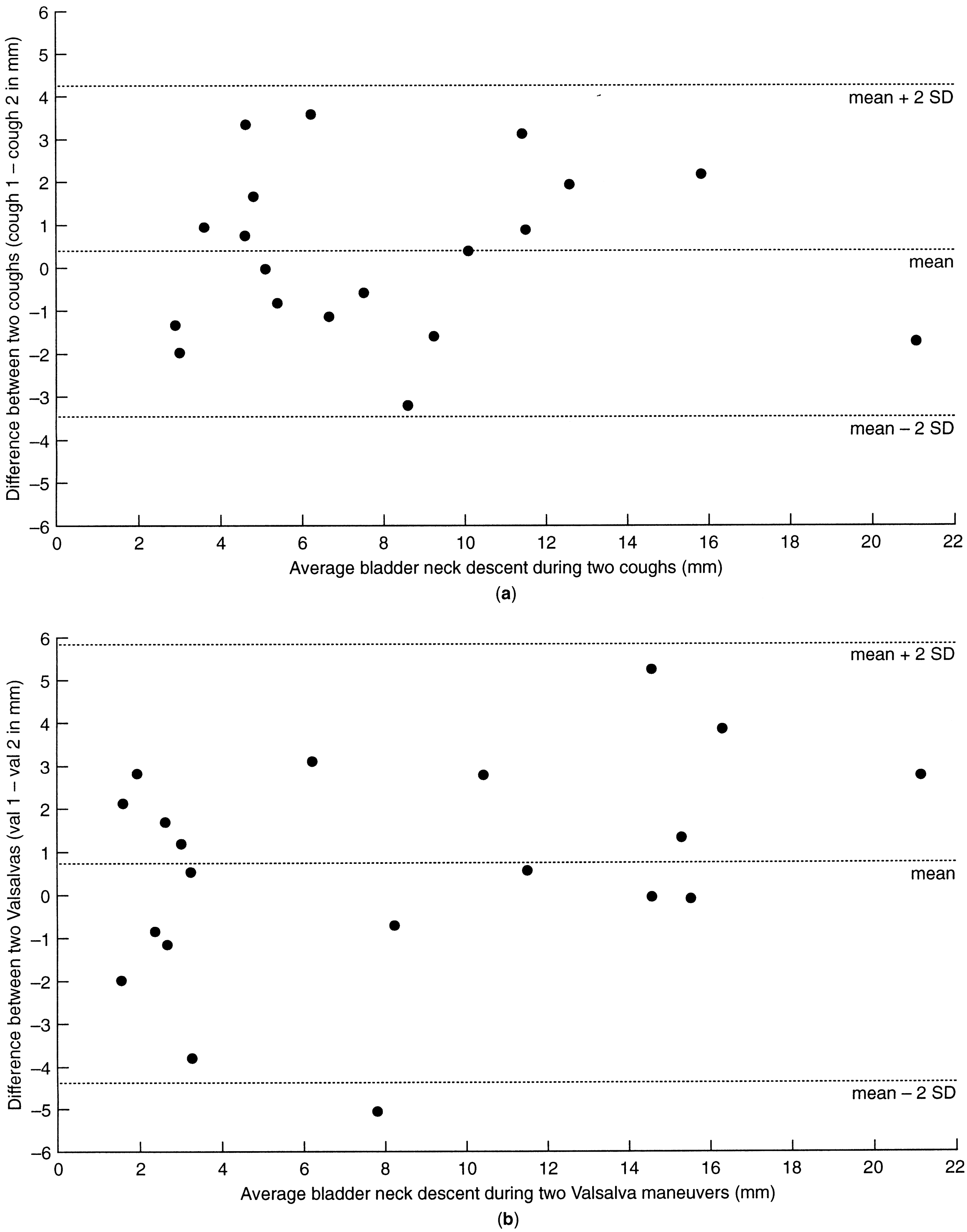

Fig. 3. Test–retest reliability of bladder neck descent during (a) coughing and during (b) valsalva. The difference between to measurements ($cough_1$ - $cough_2$ or val_1 - val_2) is shown on the Y-axis. The X-axis represents the average bladder neck descent of the two measurements (($cough_1$ + $cough_2$)/2 or (val_1 + val_2)/2).

coughing and valsalva in incontinent women to establish the relation between bladder neck mobility and leak point pressures. We are currently conducting a study to evaluate this question.

Perineal ultrasound has been described before to be a reproducible method for the evaluation of bladder neck position[6]. In this study test–retest bladder neck descent was not significantly different during both coughing and valsalva. Differences did not exceed 4 mm for coughing and 5 mm for valsalva. When interpreting these results, it has to be taken into account that bladder neck mobility is a physiological movement that might be influenced by various factors, such as urge to void, bladder filling or muscle fatigue. This information is especially important when study results about bladder neck mobility in a longitudinal setting are presented. Changes of less than four mm during coughing and five mm during valsalva seem to be within the technical limits of reliability of the method.

Stress urinary incontinence has long been presumed to be associated with urethral hypermobility. Hypermobility has been defined as a Q-tip angle of more than 20°[2] or bladder neck displacement of more than 14 mm on ultrasound[15]. Fantl *et al.*[16] however failed to demonstrate a correlation between urethral mobility and stress urinary incontinence at all. Other authors could show a slight difference between the means but with significant overlap in values between continent and incontinent women[17]. One aim of the present study was to describe normal values for urethral mobility in continent women who had never given birth. We could demonstrate that vesical neck mobility at coughing and at valsalva varies from 2 to 32 mm between women. We were therefore unable to determine normal urethral mobility in this small study population. Larger studies are necessary to define normal values.

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