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FIRST EXPERIENCES WITH URETHRAL REFLECTOMETRY – A NEW METHOD FOR SIMULTANEOUS MEASUREMENT OF PRESSURE AND CROSS-SECTIONAL AREA

Aims of Study

Simultaneous measurement of pressure and cross-sectional area (CA) in urethra is well described for assessment of urethral function. A commercial probe has recently been launched, but this probe is relatively stiff and CA's below 10 mm² cannot be measured. Reflectometry is a new technique where sound waves are produced and recorded by a probe outside the target organ. When sound is transmitted into a cavity the dimensions of the cavity can be determined as a function of the distance to the probe. The echoes produced from narrowing and widening of the cavity are digitally analysed to create a graphical image of the CA. In medicine this modality has been utilized in Acoustic Rhinometry.
The aim of the present study was to develop a technique for use in the female urethra, and to present the first experiences.

Methods

The method was a modification of Acoustic Rhinometry. A thin plastic bag (6 cm long, 5 mm in diameter, wall thickness 0.025mm) was inserted into the urethra, and filled with air by a pump to different pressures (accuracy ± 1 cm H2O) thereby providing simultaneous values of CA and pressure. In vitro accuracy and repeatability of CA were determined by measurements at selected pressures in different models with known shape and size. In vivo the method was applied on 10 normal women (34-61years) and on 20 patients (34-70 years) supine and standing during rest, coughing, and squeezing. Furthermore urethral profilometry using 8 F fluid –filled catheter and standard urodynamic testing were performed. The pressure recording system was tested against a water column of 0-150 cm.

Results

In vitro measurements
Accuracy of CA measurement [(true value – mean measured value) / true value x 100] in the pressure range of 20-100 cm H20 in rectangular boxes with CA of 4, 9 and 16 mm² (Fig 1) were 15-30%, 5-6% and 6-7% respectively, when using the most diverging values within the central 4 cm of the bag corresponding to the part of the bag used for clinical measurements. Within test repeatability expressed as the variation coefficient (SD/mean x 100) was 1-2%, and test re-test repeatability 4-5%. Measurements in boxes with two constrictions were reliable only to the second constriction (Fig 2).
Accuracy of pressure measurements was ± 1 cm. Plastic bag hysteresis was about 1 cm H2O.

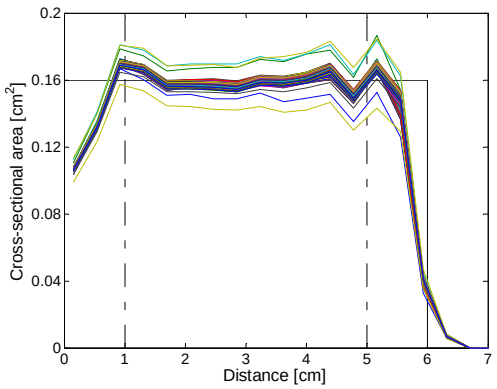

Figure 1. Repeated (n=218) measurements in a box with CA of 16 mm². The dotted line shows the central 4 cm.

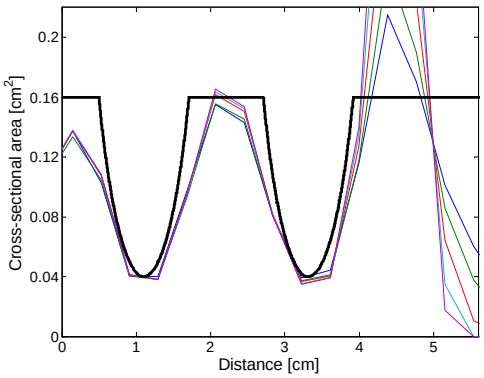

Figure 2. Repeated (n=5) measurements in a box with 2 constrictions.

In vivo measurements

During examination the CA of the entire urethra can be disclosed from bladder neck to meatus, and regions of interest like the high pressure zone can be identified (Fig 3). During examination urethral response to stress episodes can be visualised (Fig 4). By changing pressure in steps of 5 cm H2O within the bag urethral opening and closing pressures can be measured and hysteresis and elastance calculated (Fig 5). The opening pressure corresponds to the “knee” on the ascend graph, the closing pressure to the “knee” on the descend graph, elastance to the slope of the horizontal part of the curve and hysteresis to the pressure difference between the graphs. Within test repeatability for the CA of a normal woman is demonstrated on figure 6 together with maximal urethral pressure (MUP) found at profilometry.

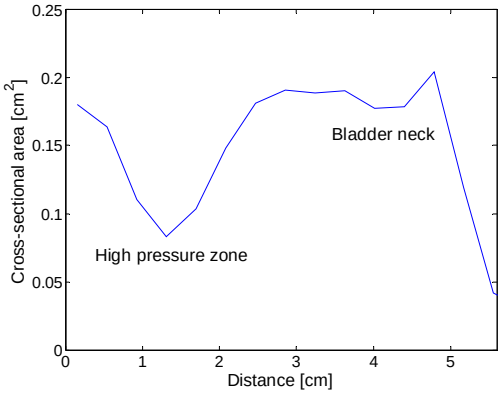

Figure 3. Urethral Reflectometry in a woman with stress incontinence. High-pressure zone and Bladder neck are indicated. (Pressure 54 cm H2O)

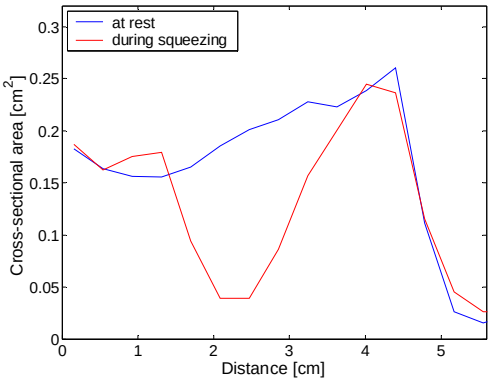

Figure 4. Urethral Reflectometry during rest (blue) and squeezing (red) (Pressure 120 cm H2O)

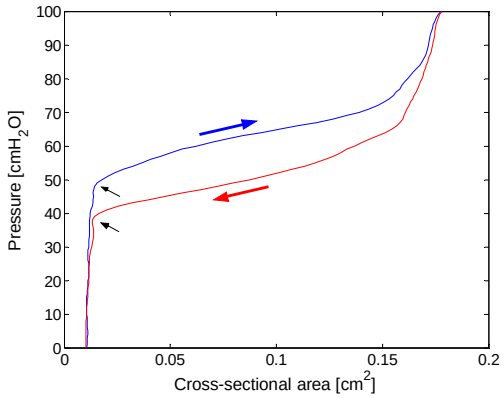

Figure 5. Urethral Reflectometry in a stress incontinent woman at High pressure zone with variable pressures in the bag demonstrating opening pressure, closing pressure, hysteresis and elastance. The black arrows show the opening and closing pressure.

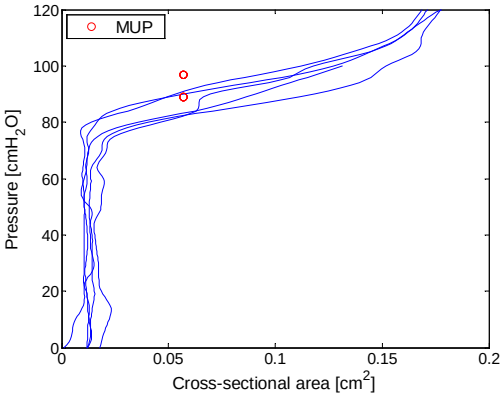

Figure 6. Opening pressure with-in test repeatability (n=5) at High-pressure zone in a normal woman. MUP (n=2) indicated by circles.

Conclusions

This new modality enables easy and reliable measurements of simultaneous pressure and cross-sectional area in the female urethra during different circumstances. Further studies are warranted to confirm the diagnostic value and the usability in relation to intervention.