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PERINEAL NOISE RECORDING RELATED TO BLADDER OUTLET OBSTRUCTION?

<u>Hypothesis / aims of study</u>
In men with LUTS the recommended (invasive) method to diagnose BOO is a pressure flow study. Alternative (non-invasive) methods have been developed for diagnosing BOO, but most of these methods require interruption or manipulation of the urinary flow[1]. We are developing a simple, non-invasive diagnostic method that is based on recording of noise, resulting from turbulence in the urinary flow, with a microphone placed at the perineum (see Figure 1). The recorded noise is related to the degree of obstruction. We studied this relation in a biophysical model, comparable to the male urethra, made from PolyVinyl Alcohol cryogel.

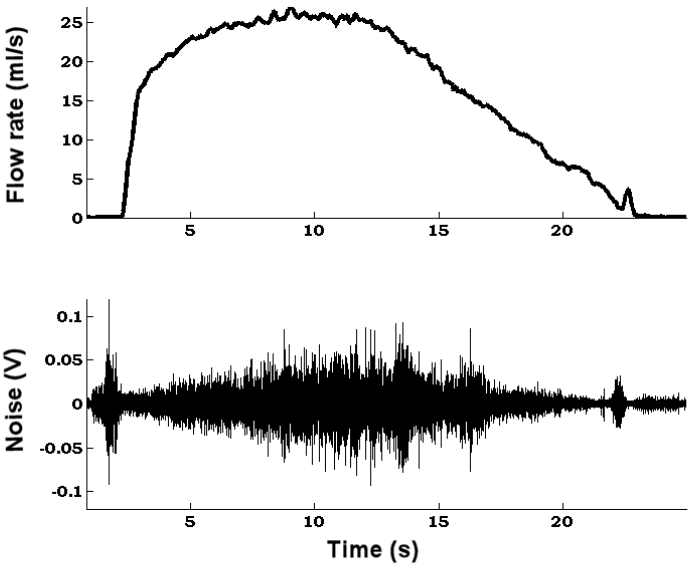

Figure 1: An example of simultaneously measured urine flow rate (top panel) and perineal noise (bottom panel) in a volunteer. The noise was recorded using a microphone pressed against the perineum. The peaks in the noise recording before voiding starts and at the end of voiding are caused by contraction of pelvic floor muscles.

<u>Study design, materials and methods</u>
One side of the model urethra was connected to a water column and the other side drained into a flow meter. To the model urethra we applied different degrees of obstruction by inflating a cuff around it that was controlled by a second water column. We varied the water level in both columns and measured flow rate through, and pressure up- and downstream of the obstruction. We combined the pressure drop over the urethra, representing the bladder pressure, and the flow rate to calculate the bladder outlet obstruction index[2] (BOOI). The resulting BOOI ranged from -17 to +118. We recorded noise at 1 to 12 cm downstream of the obstruction and repeated each measurement five times. From each measurement we calculated the standard deviation (spread) around the mean frequency of the power spectrum between 200 and 2500 Hz and averaged all measurements at each value for BOOI. We tested the correlation between the spread and BOOI using Spearman's correlation coefficient and compared the average spread between obstructed ($40 < \text{BOOI} \leq 118$) and unobstructed[3] ($-17 \leq \text{BOOI} < 20$) models using a Student's t-test. Finally we calculated the area under the ROC-curve for the spread around the mean frequency as a diagnostic parameter.

<u>Results</u>
We found that the spread around the mean frequency monotonously decreased with increasing BOOI (see Figure 2, Spearman's correlation coefficient = -.651, $p<.001$). Furthermore this spread (mean ± s.e.m.) was significantly different between obstructed (132 ± 2 Hz) and unobstructed (255 ± 6 Hz) flow (Student's t-test, $p<.001$). The ROC-curve for the spread had an area under the curve of 0.93.

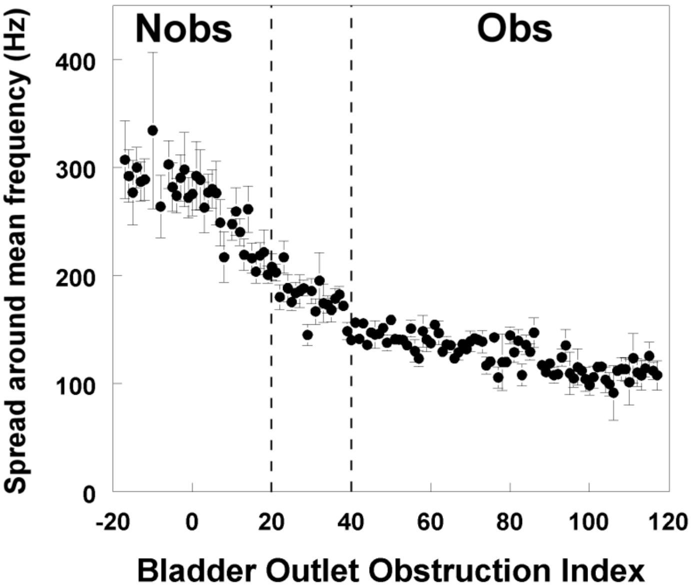

Figure 2: Spread (mean ± standard error of the mean) around the mean frequency of the power spectrum, derived from noise recordings downstream of different degrees of prostatic bladder outlet obstruction in a biophysical model of the male urethra. The spread was significantly different between obstructed (Obs) and unobstructed (Nobs) models, Student's t-test, $p<.001$.

Interpretation of results

We have shown in a biophysical model of the urethra that the spread around the mean frequency of the power spectrum, derived from noise recorded downstream of an obstruction, is monotonously and negatively related to the degree of obstruction. This means that with increasing degree of obstruction the mean frequency becomes more dominant in the power spectrum. Therefore, using the spread as a parameter, the degree of obstruction in our model can be calculated from a noise recording. Extrapolation of these results to male patients with lower urinary tract symptoms suggests that the degree of prostatic bladder outlet obstruction can be calculated from a simple, non-invasive perineal noise recording (as illustrated in Figure 1).

Concluding message

Based on these results it can be concluded that perineal noise recording shows very good potential as a simple non-invasive method to diagnose and grade prostatic bladder outlet obstruction from one unmanipulated voiding in male patients with lower urinary tract symptoms.

References

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