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Geleijnse G[1], Idzenga T[2], Groen J[1], van Mastrigt R[1]
***1.** Erasmus MC, **2.** University Medical Center St Radboud*

A METHOD FOR ASSESSING THE QUALITY OF PERINEAL SOUND RECORDED DURING VOIDING TO NON-INVASIVELY DIAGNOSE BLADDER OUTLET OBSTRUCTION.

<u>Hypothesis / aims of study</u>

Elderly men generally develop Lower Urinary Tract Symptoms (LUTS), such as low flow rate and incomplete emptying of the bladder. Possible causes are a weakly contracting bladder or a bladder outlet obstruction. Invasive pressure-flow studies are necessary to differentiate between these causes. A potentially cheaper non-invasive method to diagnose bladder outlet obstruction is to record the sound at the perineum during voiding. Earlier studies in models and volunteers concluded that pressure variations at the urethral wall could be measured in the form of audible sound [1,2]. However, optimization of the measurement setup was required.

Objective quality indicators are required as steering parameters to optimize the setup. Our current aim is therefore to develop a method to objectively assess the quality of perineal sound recordings. Two means of assessment were compared: the correlation between the flowrate and perineal sound amplitude versus the increase of power in the sound spectrum during voiding.

<u>Study design, materials and methods</u>

We recruited 66 male patients with LUTS. These patients were referred for a video urodynamic examination (VUDE). Obstruction was diagnosed using the bladder output obstruction index [3]. Prior to the VUDE, a free flow measurement was done with a microphone held in place by a modified jockstrap at the perineum. Each patient was asked to minimize movement during voiding. The flowrate was measured using a rotating disc flow meter (Dantec ®). Perineal sound was recorded using an especially developed amplifier. The flowrate and sound signals were stored on a PC for offline analysis.

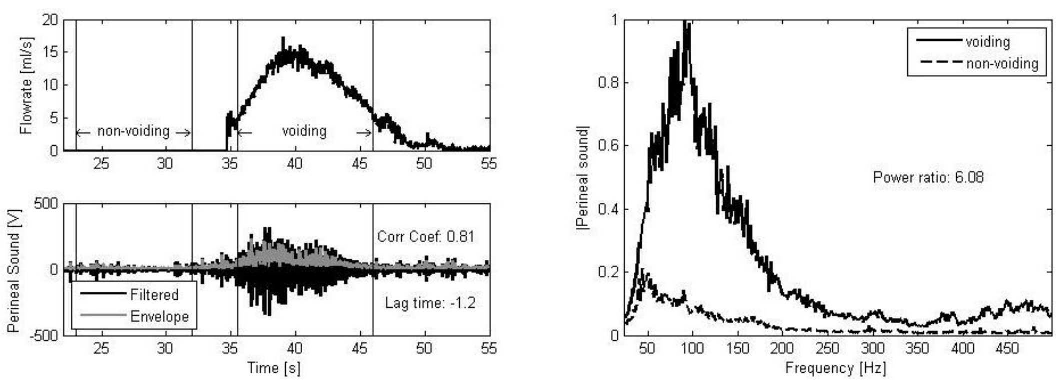

Fig.1. Flowrate (top left) and the filtered sound signal with enveloping curve (bottom left) vs. time. The power spectra (right) during the non-voiding and voiding interval time interval are compared using the power ratio.

For each measurement the sound amplitude was quantified by computing the enveloping curve of the sound signal. First the sound signal was band pass filtered between 25 and 500 Hz. The enveloping curve was computed by applying a Hilbert transformation to the filtered sound signal and rectifying the transformed signal. Subsequently, both the flowrate signal and enveloping curve were low pass filtered at 20 Hz.

The correlation between the flowrate and the envelope (Fig.1. left) was calculated using normalized cross correlation, were 1 indicates maximum positive correlation and 0 no correlation. The enveloping curve was then shifted 0.1 seconds in time with respect to the flowrate signal and the correlation coefficient was calculated again. The correlation was calculated for all time shifts between ± 40 seconds. The maximum correlation coefficient and corresponding time shift were used to assess the quality of the measurement. A good measurement was assumed to have a cross correlation coefficient above 0.4 and a lag time between ± 2 seconds.

The increase of the power spectrum during voiding (Fig.1. right) was quantified by Fourier transforming the sound signals in two manually selected time intervals (Fig.1. left). The non-voiding interval was determined by selecting an interval before or after voiding, with little or no sound and zero flowrate. The voiding interval was selected as the time period with a flowrate larger than approximately half the maximum flowrate. The increase in power was expressed as the ratio of the areas under the curve. A good measurement was assumed to have a power ratio larger than 1.5.

<u>Results</u>

The median age (range) of the patients was 68 (29-82) years. The total number of studies was 67, because one patient was examined on two occasions. 61 VUDEs could successfully be performed and 6 examinations failed. 31 patients were diagnosed as not obstructed, 18 as equivocal and 12 as obstructed.

Twelve perineal sound recordings were discarded; 3 due to technical errors and 9 due to a lack of silent time interval so the power ratio could not be determined. The results of the remaining 55 recordings are depicted in Fig.2. According to the correlation criteria, 10 perineal sound recordings were qualified as 'good' measurements and 45 as 'bad'. According to the power ratio criterion, 28 perineal sound recordings were qualified as 'good' measurements and 27 as 'bad'.

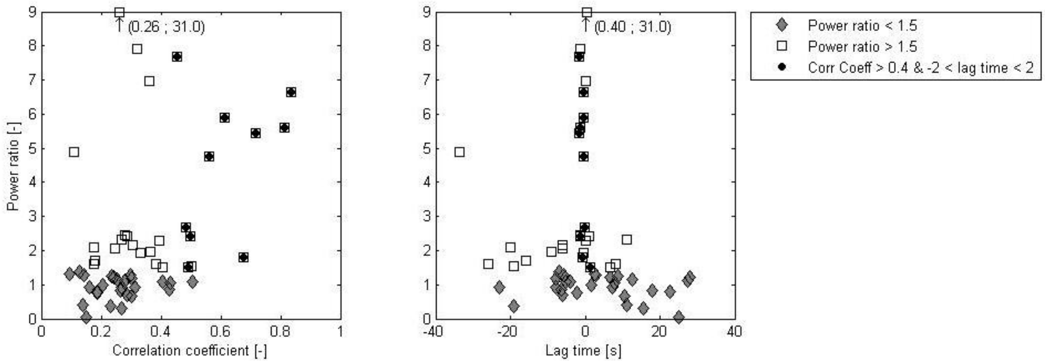

Fig.2. Power ratio vs. correlation coefficient (left) and the power ratio vs. lag time (right)

Interpretation of results

Figure 2 compares the results of both quality criteria. The left plot shows that the power ratio is correlated to the correlation coefficient between flowrate and sound. However the correlation criterion (10 good measurements out of 55) is more stringent compared to the power ratio criterion (28 out of 55).

The difference in qualification can be explained by the fact that the power ratio is based on a silent time interval and the voiding interval. As a result it is not sensitive to noise outside these intervals. Conversely, the correlation criterion is sensitive to noise during the whole measurement.

The right plot shows that the lag times of the recordings with a larger power ratio are concentrated around zero seconds, while lag times of recordings with a low power ratio are scattered. This confirms the assumption that the lag time should fall between -2 and 2 seconds. Revisiting the left plot, it can be seen that all lag times meeting this criterion have a correlation coefficient larger than 0.4.

Unfortunately both quality criteria show that not all perineal sound recordings were successful. Therefore the setup needs to be improved to raise the success rate. The developed quality parameters can be used as indicators to verify improvements.

Concluding message

We developed quality criteria to assess the success rate of perineal sound recordings in LUTS patients. Presently this success rate is limited to approximately 50%, depending on which quality criteria are used. Therefore the next step is improving the setup by using these quality criteria.

References

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Disclosures

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