

NEAR-INFRARED SPECTROSCOPY OF THE URINARY BLADDER DURING VOIDING IN MEN WITH LOWER URINARY TRACT SYMPTOMS: A PRELIMINARY STUDY

Hypothesis / aims of study

Near-infrared spectroscopy (NIRS) is a non-invasive imaging technology that detects hemodynamic changes in the bladder wall [1]. The study aims to determine the difference in response of NIRS of the bladder during voiding between men with and without bladder outlet obstruction (BOO). And to determine the diagnostic value of NIRS in men with lower urinary tract symptoms (LUTS).

Study design, materials and methods

A prospective case series study included men with LUTS. To obtain an 80% probability of detecting a difference of 3 $\mu\text{mol/l}$ in NIRS amplitudes between the obstructed and the unobstructed groups; a 2-tailed alpha level was set at $\alpha = 0.05$ and a standard deviation of 3, the sample size needed was found to be 33 patients. Patients completed International Prostate Symptom Score (IPSS) questionnaire, prostate volumes were measured sonographically. Patients underwent pressure flow study (PFS) with simultaneous NIRS of the bladder. Amplitudes of deoxy-hemoglobin (HHb), oxy-hemoglobin (O₂Hb), and total hemoglobin (Hb_{sum}) were calculated at Q_{max}, relative to baseline (fig 1). Patients were urodynamically classified as obstructed or unobstructed. Recursive partition analysis (RPA) [2] was performed to reclassify patients using NIRS amplitudes, followed by combined data of NIRS amplitudes, prostate volume, IPSS, and Q_{max} to determine the best predictor(s) of BOO.

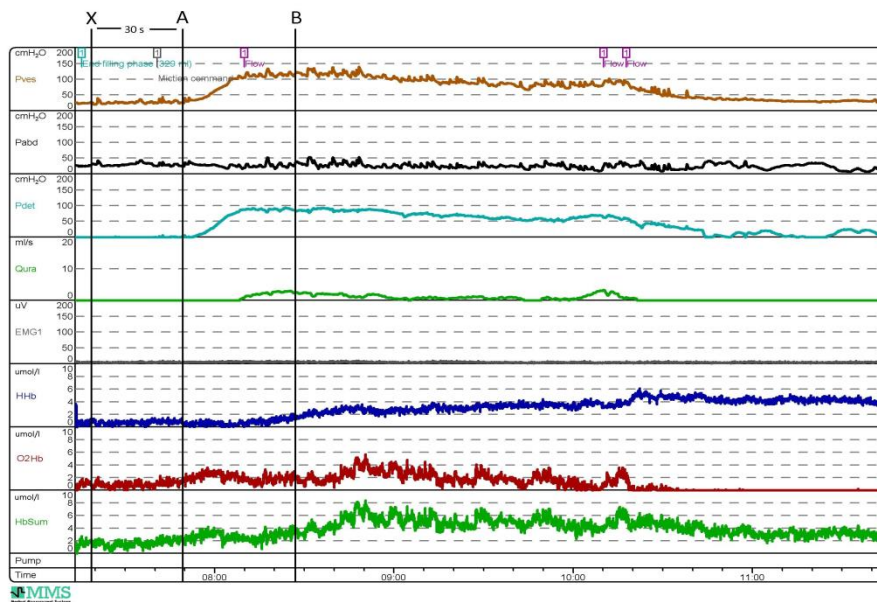


Fig. 1. An example of voiding session without potential motion artifacts. Pressure flow study with simultaneous near-infrared spectroscopy (NIRS) of a man with LUTS bladder outlet obstruction. Thirty seconds of baseline were averaged between points "X" and "A" for all NIRS parameters. The amplitudes of change in deoxy-hemoglobin (HHb), oxy-hemoglobin (O₂Hb), and total hemoglobin (Hb_{sum}) were calculated as out the result of subtracting the averaged 30 s baseline from the values at point "B" for each NIRS parameter.

P_{ves} = vesical pressure, P_{abd} = abdominal pressure, P_{det} = detrusor pressure, Q_{ura} = urinary flow rate. FS = first sensation, SD = strong desire, MCC = maximum cystometric capacity.

Results

Thirty-six patients were included. PFS classified 28 patients as obstructed and eight unobstructed. The median HHb and Hb_{sum} amplitudes were significantly higher in obstructed group. RPA of NIRS relative amplitudes correctly reclassified 89% of patients [AUC: 0.91]. RPA of the combined IPSS, prostate volume, PVR, and Q_{max} correctly reclassified 72% of patients [AUC: 0.84]. When NIRS amplitudes were added to this combination; RPA revealed a significantly ($P < 0.001$) higher rate of correct reclassification in 89% of patients with 89.3% sensitivity and 88% specificity for obstruction [AUC: 0.96]

Interpretation of results

The median amplitude of change in HHb was significantly higher in the obstructed group. This overall trend may reflect a pathophysiologic phenomenon of increased oxygen extraction during more powerful detrusor muscle contraction with progressive muscle fatigue.

In spite of this overall trend of NIRS data to be higher in the obstructed group, there was some overlap between the obstructed and unobstructed groups as shown in figure 2. Doppler ultrasound studies [3] have shown a high arterial resistive index in

patients with BOO. These studies attributed their findings to ischemic changes in the bladder wall due to BOO. We think that time factor and chronicity of BOO needed to develop this proposed ischemia should be taken in account. Meaning that it may not occur in patients with recent history of LUTS/BOO.

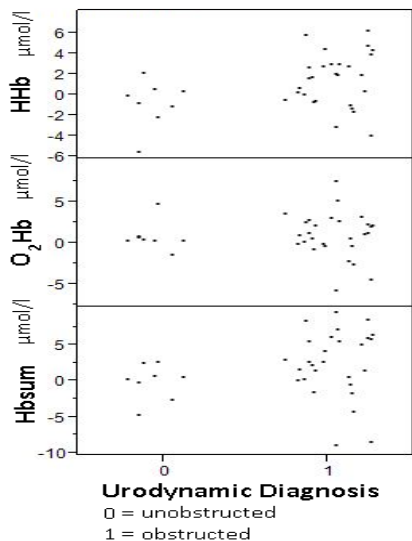


Fig. 2. Box-Plot amplitudes of deoxy-hemoglobin (HHb), oxy-hemoglobin (O_2Hb), and total hemoglobin (Hb_{sum}) based on presence or absence of obstruction according to standard urodynamic diagnosis. Despite the overlapping, NIRS parameters were significantly higher in obstructed patients compared to unobstructed patients.

Concluding message

NIRS data can be of diagnostic value for BOO in men with LUTS either alone, or in combination with other non-invasive parameters.

References

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2. Breiman L FJHORASCJ. *Classification and Regression Trees* 358. Belmont, CA. Wadsworth International Group; 1984.
3. Belenky A, Abarbanel Y, Cohen M, Yossepowitch O, Livne PM, Bachar GN. Detrusor resistive index evaluated by Doppler ultrasonography as a potential indicator of bladder outlet obstruction. *Urology.* 2003;62(4):647-50.

Disclosures

Funding: European Urological Scholarship Programme **Clinical Trial:** Yes **Public Registry:** No **RCT:** No **Subjects:** HUMAN **Ethics Committee:** local Ethics Committee of Radboud University Nijmegen Medical Centre (2009/188) **Helsinki:** Yes **Informed Consent:** Yes