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A novel algorithm for the non-invasive detection of bladder outlet obstruction in men with lower urinary tract symptoms

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ABBREVIATIONS

AG, Abrams/Griffiths;
BWT, bladder wall thickness;
DO, detrusor overactivity;
DWT, detrusor wall thickness;

Abstract ***Objective:*** To determine the ability of bladder wall thickness (BWT) in combination with non-invasive variables to distinguish patients with bladder outlet obstruction (BOO).

Patients and methods: Patients completed the International Prostate Symptom Score (IPSS) questionnaire and prostate size was measured by transrectal ultrasonography (US). Pressure-flow studies were performed to determine the urodynamic diagnosis. BWT was measured at 250-mL bladder filling using transabdominal US. Recursive partition analysis (RPA) recursively partitions data for relating independent variable(s) to a dependent variable creating a tree of partitions. It finds a set of cuts of the dependent variable(s) that best predict the independent variable, by searching all possible cuts until the desired fit is reached. RPA was used to test the ability of the combined data of BWT, maximum urinary flow rate (Q_{max}), post-void residual urine volume (PVR), IPSS, and prostate size to predict BOO.

Results: In all, 72 patients were included in the final analysis. The median BWT, voided volumes, PVR, mean Q_{max}, and IPSS were significantly higher in patients who had an Abrams/Griffiths (A/G) number of >40 (55 patients) compared to those

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MCC, maximum cystometric capacity;
NPV, negative predictive value;
PPV, positive predictive value;
P_{ves}, vesical pressure;
PVR, post-void residual urine volume;
Q_{max}, maximum urinary flow rate

with an A/G number of ≤40 (17 patients). RPA revealed that the combination of BWT and Q_{max} gave a correct classification in 61 of the 72 patients (85%), with 92% sensitivity and 65% specificity, 87% positive predictive value, and 76% negative predictive value (NPV) for BOO (area under the curve 0.85). The positive diagnostic likelihood ratio of this reclassification fit was 2.6.

Conclusions: It was possible to combine BWT with Q_{max} to create a new algorithm that could be used as a screening tool for BOO in men with lower urinary tract symptoms.

Introduction

LUTS are highly prevalent in the male population and it was reported that ~62.5% of men aged ≥40 years have at least one LUTS in a study of five European countries [1]. A pressure-flow study is the standard urodynamic test for the diagnosis of BOO. However, pressure-flow studies are invasive, expensive, and time consuming. They can also cause discomfort, UTI, and haematuria [2]. The maximum urinary flow rate (Q_{max}) measured by uroflowmetry, is a poor diagnostic method for BOO [3]. Also, although the post-void residual urine volume (PVR) is increased in patients with BOO [4], an important disadvantage of both uroflowmetry and PVR measurement is that they cannot distinguish between BOO and detrusor underactivity [5].

Ultra-structural morphological changes in the bladder wall have been studied by Elbadawi et al. [6] in a number of specimens obtained from patients with BOO. The main finding of that study was an increased smooth muscle bulk, with or without interstitial collagen deposition. Therefore, it has been assumed that the measurement of this increase in bladder wall thickness (BWT) might be an indicator for the presence of BOO. Oelke et al. [7] found that the detrusor wall thickness (DWT) decreases with increase in bladder filling until a level of 250 mL is reached, then the decrease is not statistically significant.

The aim of the present study was to investigate the diagnostic value of BWT in combination with other non-invasive variables for BOO in men with LUTS. For this purpose, recursive partition analysis (RPA), a non-parametric method [8], recursively partitions data for relating dependent variable(s) to an independent variable creating a tree of partitions. The dependent variables investigated in the present study were BWT, Q_{max}, PVR, IPSS, and prostate size. The independent variable was the urodynamics diagnosis, i.e. BOO. RPA finds a set of cuts of the dependent variable(s) that best predict the independent variable, by searching all possible cuts until the desired fit is reached. Therefore, in the present study we used RPA to test the ability of the combined data of BWT, Q_{max}, PVR, IPSS, and prostate size to predict BOO in men with LUTS.

Patients and methods

In all, 98 men with LUTS were consecutively included in the study at three centres: The Radboud University MC, Nijmegen, The Netherlands; Sohag University Hospital, Sohag, Egypt; and Minia University Hospital, Minia, Egypt. Ethical approvals were obtained from the local ethics committees at the three centres, and all patients signed a written consent and completed the IPSS questionnaire. Inclusion criteria were adult men with LUTS. Exclusion criteria were patients with neurogenic bladder, history of previous prostatic surgery, or prostatic carcinoma.

Patients were asked to stop using any medication for their urological disorders for ≥3 days before the date of investigation. TRUS was performed to measure the prostate size. Dipstick urine analysis was performed to exclude UTIs.

All patients underwent a pressure-flow study (Solar, Medical Measurement Systems, Enschede, The Netherlands, Laborie Delphis KT, Toronto, Canada). A gas- or water-filled urethral catheter (6 F) and a rectal catheter were inserted to monitor vesical pressure and abdominal pressure, respectively. Water was infused at room temperature at 50 mL/min until the maximum cystometric capacity (MCC) was reached.

The BWT was measured during filling at 250 mL of bladder volume or at the MCC for patients with small bladder capacities. The bladder wall consists of bladder adventitia, which has a bright appearance on US; the detrusor muscle layer, which has a dark appearance on US; and the innermost layer is the bladder mucosa, which has a bright appearance on US [9,10]. Therefore, the inner and outer bright lines were included in the measurement of the BWT. A curvilinear 5-MHz US transducer was positioned on the suprapubic area; the BWT measurements were made on the sharpest image obtained. Then, filling cystometry was continued until the MCC was reached. Then, the patients were asked