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Development of mathematical formulas for the prediction of outflow obstruction on an individual basis: A post-hoc analysis of the flow resistive forces index (QRF) study

Eur Urol Suppl 2019; 18(1);e99

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Introduction & Objectives: In an attempt to improve the diagnostic performance of uroflowmetry, we developed mathematical formulas aiming to calculate the probability of diagnosing bladder outflow obstruction on an individual basis and assessed their clinical applicability compared to maximum flow rate (Q_{max}).

Materials & Methods: This is a *posthoc analysis* of a study we recently presented introducing the Flow Resistive Forces Index (QRF), a novel measure of urethral resistance. This index is the product of a mathematical equation developed by utilizing all the available information contained in the uroflow curve, which was found to accurately predict bladder outflow obstruction significantly outperforming Q_{max}. The study was performed in a cohort of 84 adults (61 males-23 females) with voiding symptoms, who all underwent uroflowmetry followed by pressure-flow plots and were classified according to Shafer nomogram (LinPURR) as unobstructed (0-1) or obstructed (2-6). A logistic regression model analysis was conducted (Q_{max}, QRF predictors of obstruction) and using the variables in the equation with significant contribution to prediction, we devised mathematical formulas measuring the probability (p) an individual to be diagnosed with outflow obstruction. ROC analysis was employed to determine the optimal cut-off points of the calculated probabilities (p) and evaluate the predictive performance of the equations vs Q_{max}. Statistical analyses used SPSS-22® and MedCalc® ($p<0,05$).

Results: Outflow obstruction was diagnosed in 50,8% (1 in 2) of males and 25% (1 in 4) of females (p=0,03). On logistic regression model analysis, QRF made a highly significant contribution to prediction (p=0,0003) vs Q_{max} (p=0,039) in men and a stronger but not quite significant (p=0,0761) vs Q_{max} (p=0,268) in women. Thus, the variables included in the formulas for calculating probability (p) of diagnosing obstruction were QRF, Q_{max} and constant in men while, QRF and constant in women. The optimal (p) cut-off points above which obstruction is highly likely were 0,44 in men and 0,14 in women with prediction sensitivity 90,32/100%, specificity 76,67/83,3%, accuracy 83,61/87,5% respectively. According to these criteria, obstruction was correctly predicted in 9 in10 and excluded in 8 in 10 of men (p=0,0001) while, in all and 8 in 10 of women (p=0,0003) respectively. On pairwise AUC comparisons [(p) vs Q_{max}], the difference in favor of (p) was extremely significant ($p<0,0001$] in men while, non-significant (p=0,1776) in women.

Conclusions: As the introduced novel formulas accurately predict the probability of bladder outflow obstruction diagnosis, we anticipate that with further clinical evaluation and external validation, they might become valuable tools for patient stratification and proper selection of those who need further invasive urodynamics investigation