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Title (type in CAPITAL LETTERS)	MODEL BASED INTERPRETATION OF PRESSURE-FLOW DATA

Aims of Study

Measurement and grading of urethral resistance has a great clinical importance. Its measurement by standard urodynamic techniques is not simple. Pressure-flow studies (PFS) have become a standard test for lower urinary tract obstruction and constriction. The concept of urethral resistance measurement remains confusing and has not been defined uniquely despite several rigorous analyses and reviews of methodologies [1,2].

Pressure-flow studies produce data reflecting both detrusor and urethral characteristics. The aim of this study was to delineate between bladder contractility and urethral resistance and assess both dynamic urethral resistance and time-dependent elasticity. Assuming that the temporal behavior of urethral elasticity is a key to changes in urethral resistance during pressure changes, a lumped-parameter model of the urethra was developed to link between these two variables.

Methods

Due to its elasticity the urethra responds to pressure resulting in diameter changes. Flow limitation results from rapid velocity change due to constriction in the flow-controlling zone. Thus, the input of the model contains an elastic element and it is linked with the input pressure to determine cross-section area and the flow is related to a pressure loss element according to Bernoulli's equation. Pressure loss due to Inertia of the fluid can be neglected since it is very small in narrow tubes.

Bernoulli's equation $P_1 + \frac{\rho v_1^2}{2} = P_2 + \frac{\rho v_2^2}{2}$, where P is pressure, ρ is density and v is velocity, can be rewritten in the form: $P = \frac{K}{A^2} Q^2$ after substituting v with Q/A, where Q is flow rate and A is cross-section area [3]. Thus, urethral resistance can be indicated by $R = \frac{P}{Q^2} = \frac{K}{A^2}$ and A can be isolated: $A = \sqrt{\frac{KQ^2}{P}}$.

The opening pressure (P_0) that is defined as the pressure when the urethra opens is assumed to depend on urethral elasticity E as follows: $P_0 = aE$. Thus, the straight line that is used to express pressure-cross-section relation: $P = E \cdot A + P_0$ can be written as: $P = E(A + a)$ and the elasticity factor E can expressed as $E = \frac{P}{A + a}$. The constant a is estimated at the beginning of voiding before the urethra relaxes and the first second of micturition is used to normalize this elasticity index to 100% at the beginning of the analysis process. Pressure-flow data from 10 male patients were analyzed using this model.

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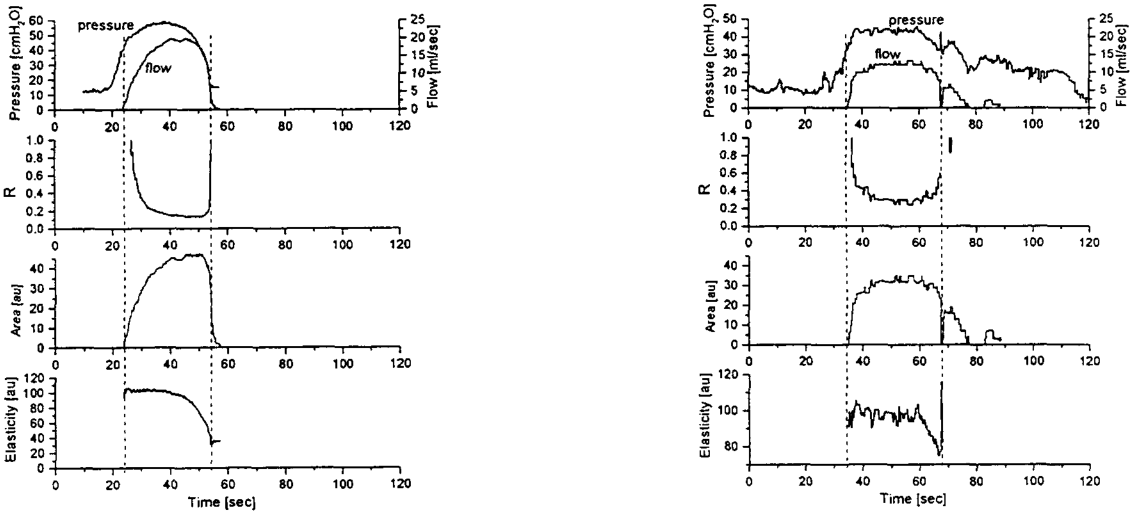
Results

The figure shows an example of analysis of two patients. The left panel is normal whereas the panel on the right depicts an abnormal pattern. The analysis shows that the resistances is both cases are similar, however, compared to the normal data set, where the elasticity factor drops to 30%, the right panel shows that the elasticity factor drops only to 80% of its original value. This demonstrates the ability of the model to predict both resistance and elasticity changes during micturition. In all patients the model was in agreement with conventional diagnostic urodynamic criteria of PFS.



Conclusions

PFS involve measurement of urethral input pressure and urethral output flow. Therefore, the lumped-parameter model contains elements that are directly related to these variables and exclude internal variables that are related to internal dynamics and cannot be directly observed neither from the input nor from the output. In addition, the importance of elastic tube analysis has been stresses by several researchers. The lumped-parameter model with two elements describes the dynamics of the pressure-flow relations and defines urethral resistance and an elasticity factor. Both parameters may be useful in clinical diagnosis. More work is done to obtain statistically meaningful conclusions.

References

1. Griffiths D, Hofner K, van Mastrigt R, Rollema HJ, Spangberg A, Gleason D. Standardization of terminology of lower urinary tract function: pressure-flow studies of voiding, urethral resistance, and urethral obstruction. International Continence Society Subcommittee on Standardization of Terminology of Pressure-Flow Studies. Neurourol Urodyn 1997;16(1):1-18.
2. Mastrigt R van, Kranse M. Analysis of pressure-flow data in terms of computer-derived urethral resistance parameters. World J Urol 1995;13(1):40-6.
3. Binder, RC. Fluid Mechanics. Ed.5 Englewood Cliffs, NJ, Prentice Hall, 1973.