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VOLUME DEPENDENCE OF MAXIMUM AND AVERAGE FLOWRATE

Aims of Study

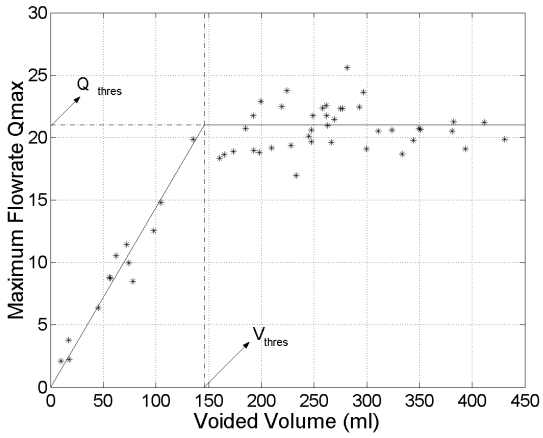
In an earlier contribution to the ICS [1] the voided volume dependence of average flowrate was studied. A threshold volume was introduced to characterise this dependence. Below the threshold volume the average flowrate increased with voided volume, above it, it was more or less constant. This finding conflicts with the existing nomograms for normalising maximum flowrates [2, 3]. However, it was based on the measurement of average flowrates with an unconventional device rather than on maximum flowrates with a standard flow transducer. We therefore started a full-scale study with a conventional measurement device to explore the volume dependence of the flowrate in individual volunteers.

Methods

At least 25 flowrate curves of thirteen volunteers (eight men and five women) without a history of obstruction or other micturition complaints were monitored with a Dantec® rotating disc flow transducer. The flow transducer was placed in a small room and served as an alternative lavatory in the working environment. The volunteers operated the flow transducer themselves.

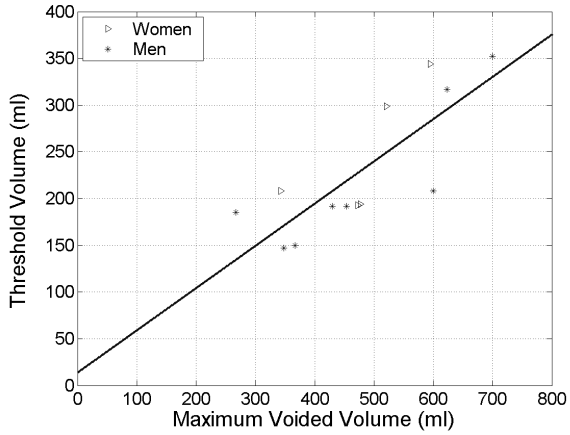
We studied the dependency of various flowrate parameters on a number of volume parameters. These included the dependency of maximum flowrate Q_{max} on the volume left in the bladder at the moment Q_{max} is reached, the dependency of Q_{max} on the voided volume and the dependency of the average flowrate Q_{ave} on the voided volume.

For every volunteer scatter plots were made in which the relationships between these parameters were assessed. The relationships were quantified by fitting two straight lines to the data: an ascending line through the origin ending at a threshold volume and a horizontal line indicating a maximum value of the maximum flowrate (Q_{thres}) from this point on. The data were fitted using a least squares procedure in MATLAB™. The figure shows an example of a result.



Results

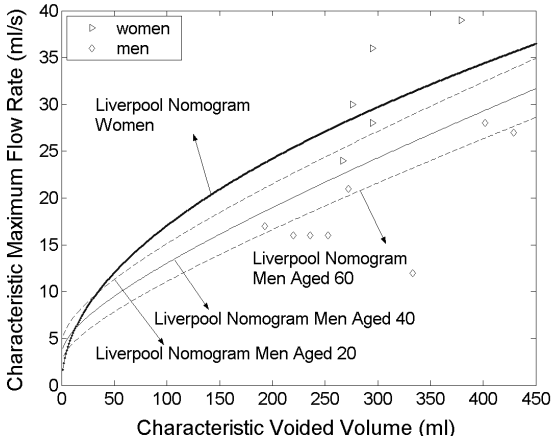
The volume dependence of the flow measurements of all volunteers, irrespective of age or sex, showed the same pattern as the figure. The dependency of threshold volumes calculated from maximum flowrates ($V_{thres.max}$) and average flowrates ($V_{thres.ave}$) on the maximum voided volume $V_{void.max}$ of the volunteers was investigated. The next figure illustrates this dependency of $V_{thres.ave}$ on $V_{void.max}$. The threshold values thus seem to increase with higher maximum voided volume. Pearson's correlation coefficient (R^2) for $V_{thres.ave}$ was 0.64. If one outlier value was removed, the $V_{thres.max}$ values could also be fitted with a straight line (R^2=0.51) and the fit for $V_{thres.ave}$ improved (R^2=0.76).



Conclusions

The data indicate that the volume dependency of the flowrate suggested in standard nomograms does not give an accurate description of this dependency in one individual. This means, in clinical evaluations these nomograms should not be used for correction of the volume dependency of the flowrate. Rather, the evaluation of flow curves should be restricted to those above the threshold volume. For our volunteers, 304 ml was the highest threshold volume found. This was below the maximum voided volume of all volunteers.

Standard nomograms are based on the measurement of one flow curve in many volunteers. This procedure however cannot account for the dependency on volume of flowrate within one individual. In order to test whether the form of nomograms reflects differences between individuals rather than a dependency of flowrate on voided volume within individuals, we plotted one characteristic value of the volume dependency of the flowrate of all volunteers in the Liverpool Nomograms [3]. Like most standard nomograms, they show a power law dependency of maximum flowrate on voided volume. We plotted Q_{thres} as a function of the average voided volume of the measurements above the threshold volume. Though we do not have enough data yet, the figure shows that our data might be compatible with the nomograms.



Our measurements imply that standard nomograms do not reflect the volume dependence of the flowrate in one individual, but a variation in flowrates between individuals. The relation of the threshold volume to individual properties such as bladder capacity or the sensory threshold for urge needs further investigation.

Anyhow, the power law correction for volume should not be used in the evaluation of flow curves. Instead, flow curves above the threshold should be used, or several measurements should be made. The use of a disposable flowmeter [4] would help to facilitate such a procedure.

[1] Neurourol. Urodyn. 13: 386-387, 1994.
[2] J. Urol. 122: 665-668, 1979.
[3] Br. J. Urol. 64: 30-38, 1989.
[4] Neurourol. Urodyn. 21: 48-54, 2002.