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RELATION OF MAXIMUM FLOW RATE AND VOIDED VOLUME ESTIMATED FROM UROFLOWMETRY CURVE

Aims of Study

By approximating the uroflowmetry curve using a voiding model, the relation between maximum flow rate and voided volume was estimated and its efficacy was studied.

Methods

The uroflowmetry curves were approximated using a previously reported voiding model (1) in 161 patients. Using the coefficient of the equation of the voiding model, the following values were calculated as far as it was mathematically feasible. Maximum flow rate (MFR) and voided volume (V.V.) were first calculated from the equation. Although the urethral pressure difference upon voiding is the driving force of urination, part of it is used for inertia to move the urine and the rest is used for frictional resistance and elastic resistance. The ratio of the total sum of pressure difference used for inertia (PL) to the total sum of pressure difference upon voiding (P), PL/P, was calculated as the pressure ratio (PR, %). The energy was similarly calculated, and the ratio of the total sum of pressure difference used for frictional resistance and elastic resistance (P-PL) to the total sum of energy used for inertia (WL), (P-PL)/WL, was calculated as the urethral loss coefficient (LC, 1/ml).

Results

As for the relation between PR, MFR and LC, the product of PR and MFR correlated with LC (r=0.96, p<0.0001). As for the relation between PR, LC and V.V., the product of LC and V.V .correlated with PR (r=0.96, p<0.0001). When MFR was expressed with LC and V.V. from these two regression equations, equation 1 was obtained (r=0.82, p<0.0001).

$\ln(MFR) = 0.82 - 0.27 \ln(LC) + 0.39 \ln(V.V.)$.equation 1

Conclusions

The relation of V.V .and MFR using LC as a parameter from equation 1 is shown in the figure. Although Haylen et al (2) reported that MFR is related to V.V. and age , our results indicated that MFR is related to V.V. and LC. This quantitatively proved the phenomenon that if V.V. is the same, MFR decreases when urethral resistance increases. Moreover, this indicated that even if the change in MFR is constant, the change in LC is not. For example, upon voiding of 200 ml, the change in LC (9.4-2.1=7.3) when MFR increases from 10 to 15 ml/s and the change in LC (2.1-0.73=1.4) when MFR increases from 15 to 20 ml/s are not the same.

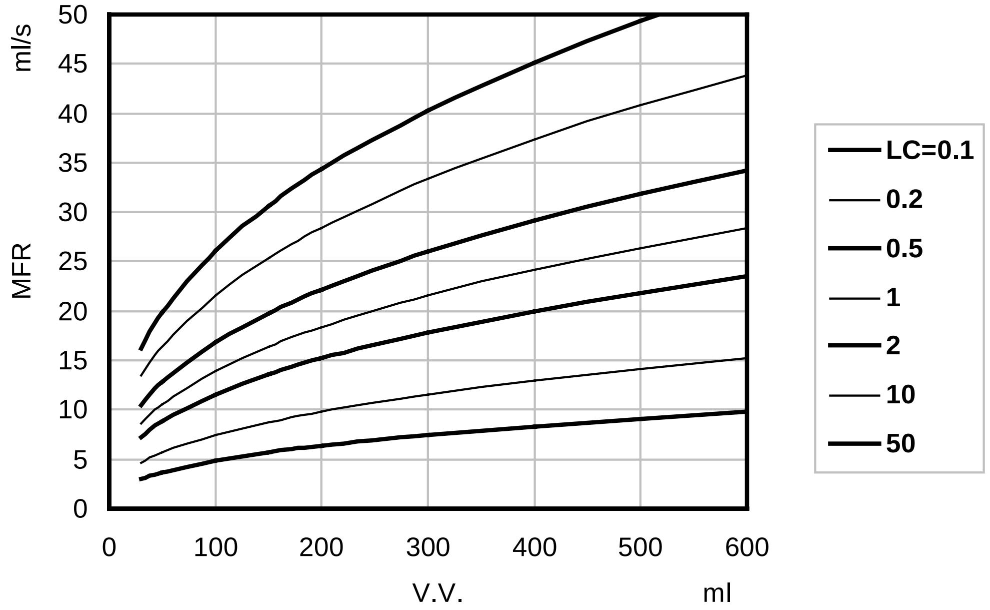
When healthy females (n=9) were studied, mean LC was 0.36 and MFR was 18.4 ml/s at V.V.=100 ml, 24.3 ml/s at 200 ml and 28.5 ml/s at 300 ml. Mean LC for healthy males (n=7, 16 in total) was 0.50 and MFR was 16.9, 22.2 and 26.0 ml/s, respectively. Mean LC for patients before TURP (n=8) was 9.4 and MFR was 7.6, 10.0 and 11.7 ml/s, respectively. Changes according to age were not included.

Since intravesical pressure increases when V.V. is large, MFR increases even if urethral resistance is large. For example, in the case of LC=0.5, V.V.=100 and MFR=16.9, but in the case of LC=1, V.V.=200 and MFR=18.4. Even if LC is large, there are cases in which MFR increases, so that when MFR is used to evaluate urethral resistance, V.V. must be the same.

Furthermore, if we suppose that urethral LC does not change in the same patient, MFR at different V.V. can be estimated. For example, when MFR is 7.5 ml/s upon voiding of 100 ml, MFR can be 8.4 ml/s upon voiding of 135 ml.

In this study, we were able to estimate the relation between MFR and V.V .from the uroflowmetry curve. Our results indicated that MFR and V.V. were related with LC as the parameter, and the values obtained from the simulation very well reflected actual values.

1. Acta Urol. Jpn. 41: 27-32, 1995
2. Br. J. Urol. 64: 30-38, 1989


ml/s
MFR
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
V.V.
ml
LC=0.1
0.2
0.5
1
2
10
50

FIGURE