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AN ATTEMPT TO EVALUATE THE HYDRODYNAMIC CHANGES IN THE URETHRA BEFORE AND AFTER TRANSURETHRAL PROSTATECTOMY USING UROFLOWMETRY

<u>Aims of study</u>
The changes in hydrodynamic parameters in the urethra before and after transurethral prostatectomy (TURP) were evaluated using uroflowmetry, and the changes in voiding conditions due to adenoma resection were studied.

<u>Materials and methods</u>
A total of 44 uroflowmetry curves from 22 patients before and after TURP were approximated using a voiding model (1,2). The voiding model was prepared on the assumption that pressure difference as the driving force in the urethra is used for the inertial force that accelerates the urine, frictional resistance which is proportional to the urine flow and the elastic resistance which is proportional to urinary volume. P' was the pressure difference between the internal and external urethral orifice, and P was the integration value of P' during voiding. The work (W) used for voiding in the urethra was calculated by integrating pdV, using pressure (p) and changes in voided volume (dV). Numerical calculation was actually done. For the inertial, frictional and elastic components of the parameters, the suffixes i, f and e were added, respectively. For example, P=Pi+Pf+Pe and W=Wi+Wf+We. The urethral loss coefficient (LC), (Pf+Pe)/Wi, was regarded as the mean urethral resistance. As there are coefficients that cannot be determined in uroflowmetry because pressure is not actually measured, comparative analyses were made by taking the Pi coefficient as 1 and standardizing P and W.

<u>Results</u>
The results are shown in Table 1. Urethral resistance (LC) after TURP significantly decreased to 3.16 from 7.52 before TURP. Pi, kinetic energy utilization rate (Wi/W), kinetic energy (Wi) and maximum urine flow (Qmax) significantly increased after TURP.

<u>Interpretation of results</u>
When an adenoma is resected by TURP, bladder outlet obstruction (BOO) is improved and urethral resistance (LC) is decreased. The intravesical pressure is effectively transmitted to the urethra, and the pressure utilization rate (Pi/P) is improved. As the pressure difference utilized for inertia in the urethra (Pi) is also increased, Qmax is increased. In addition, Wi is increased, and inertial kinetic energy utilization rate (Wi/W) is improved.
The relation between standardized Pi and Qmax was as follows:
Qmax=0.58*Pi-2.88 r=0.941 … equation 1.
The relation between standardized Wi (mJ) and $Qmax^2$ was as follows:
Wi=0.083*(0.5*Qmax^2)+0.59 r=0.991 … equation 2.
The relation between standardized pressure (P), LC and Qmax was as follows:
P=0.44*(LC*Qmax^2)+10.2 r=0.985 … equation 3.
Equation 2 reflects the premise that "kinetic energy is proportional to the square of Qmax" and is dynamically consistent with the assumption that "kinetic energy is proportional to the square of velocity when the mass is constant." Equation 3 indicates the relation of pressure, urine flow and resistance and expresses the phenomenon consistent with the premise that "resistance force is proportional to the square of velocity in turbulent flow." When the uroflowmetry curve is approximated using the voiding model, the coefficient expressing the characteristics of the curve for each patient as well as the temporal changes in pressure and urine flow can be calculated. The relation of the obtained pressure and urine flow satisfies the known relation of kinetic energy, urine flow, resistance force and velocity as mentioned above. When an appropriate model can be adapted to the uroflowmetry curve, the relevance between urethral pressure and urine flow can be described, although the intravesical pressure cannot be calculated. Furthermore, we can see that the shape of the uroflowmetry curve expresses voiding conditions (3). It is thus a non-invasive method that can objectively express the changes in voiding conditions such as before and after surgery, before and after medication, between sexes and according to age. Moreover, by arbitrarily changing the coefficient of the voiding model, it is possible to simulate changing voiding conditions.

<u>Concluding message</u>
We were able to describe the changes in voiding conditions before and after TURP using uroflowmetry. The sufficient decrease in urethral resistance due to adenoma resection effectively transmitted the intravesical pressure to the urethra, increasing the pressure that can be used for inertia and increasing urine flow.

<u>References</u>
1.Hinyokika Kiyo(1995)41;27-32
2.Int J Urol(2004)11;885-889
3.Hinyokika Kiyo(2006)52;7-10

Table 1 Changes in the parameters before and after TURP

	unit	Before TURP	After TURP	p-value
Pi	cmH20･s	12.0	25.2	3.8E-06*
P	cmH20･s	208	332	NS
Pi/P	%	8.24	14.7	0.0041
LC	cm^-3･s	7.52	3.16	0.0035*
Wi/W	%	4.84	8.17	0.017
Wi	mJ	4.00	17.1	2.6E-05*
Qmax	cm^3･s^-1	9.36	18.1	2.6E-05*

Pi, P, Wi and W are standardized levels. *exponential regression (paired t-test)

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