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Residual Urine Determination in Cysto-Uroflow Metering by Electronic Evaluation of Volume Differences

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Summary. The electronic evaluation of volume differences of residual urine determination following cysto-uroflow metering takes place in three stages: 1. Integration of the bladder filling volume. 2. Integration of the micturition volume. 3. Electronic differentiation of the integrated volumes (bladder filling volume minus micturition volume equals residual urine volume). The residual urine volume can be read directly from the recorder.

Key words: Residual urine, Urodynamics, Electronic volume differentiation.

As a rule in cysto-uroflow metering the final residual urine determination is carried out by subtraction of the excreted urine volume from the instilled bladder volume. Using a new apparatus[1] this calculation can be carried out electronically and recorded as a curve after completion of uroflow metering. The measuring site should have available at least a two-channel recorder.

METHOD

A. Measurement of Bladder Filling Volume

The empty bladder is filled with physiological saline solution using a peristaltic pump. The tubing system passes to the catheter via a compensation vessel. This compensation vessel is to smooth out the pulsing movements produced by the pump in the tubing which would interfere with the measurement. Since the pump produces a certain pressure in the tubing system, after switching off the pump the saline solution would continue to flow to the bladder until pressure equilibrium was reached. Therefore an electromagnetic valve is fitted between the compensation vessel and the catheter, which on switching on the pump opens the path to the catheter or on switching off closes it. Since in this way the tubing system is always under the same pressure, during the filling time a constant flow is achieved. Exact measurement is only possible in this way (Fig. 1).

The delivery capacity of the peristaltic pump is adjustable in 10 steps and permits the filling of the bladder at 10-100 ml per minute as desired (Fig. 2). During the filling process it gives a constant, electrical reference potential whose value corresponds exactly proportionally to the delivery capacity selected in each case. This reference potential U_1 is integrated in an integrator V_1 during the filling time t_1. The value, which now appears at the output K_2 of the integrator-differentiator unit, is thus a direct measure of the volume filled. This value can also be expressed as a formula:

$$U_1 \times t_1 = U_2 \mathrel{\hat{=}} V_1 \text{ (ml)}$$

It appears on the recorder as a continously ascending filling volume curve. During the subsequent micturition the potential U_2 is stored in the integrator.

B. Measurement of the Micturition Volume

After filling of the bladder micturition takes place (Fig. 2). The urine is collected in a funnel beneath whose outlet an electrically driven disc rotates (1).

[1] Lameris, Medizintechnik GmbH, Lyoner Str. 10, D-6000 Frankfurt/M. 71, Federal Republic of Germany

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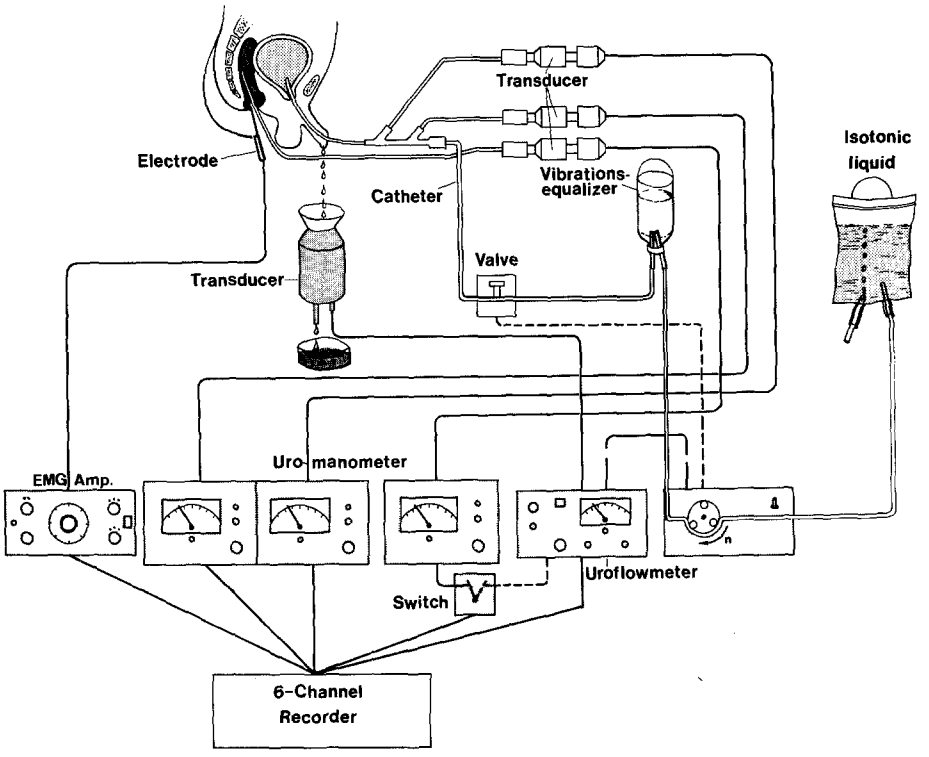

Fig. 1. Positioning of pump and compensation vessel at the urodynamic measuring site

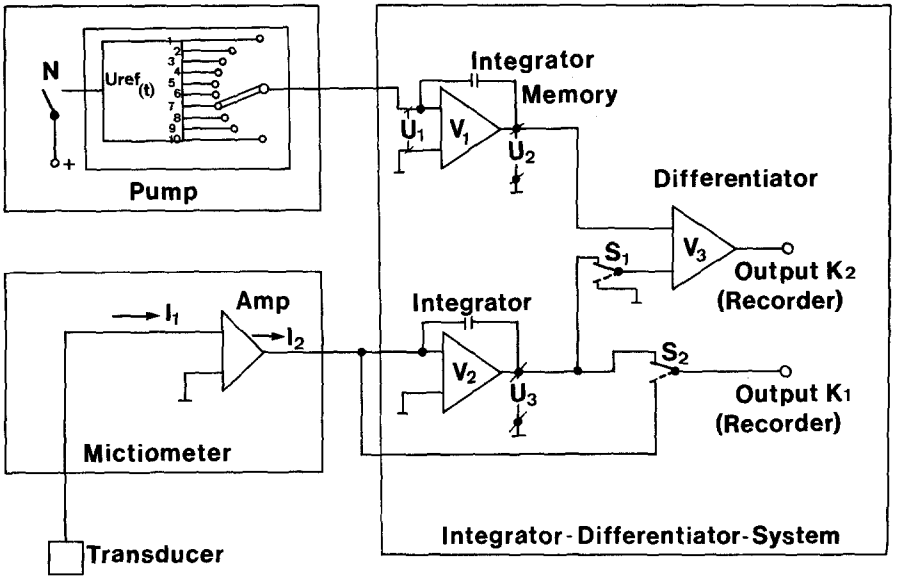

Fig. 2. The integrator differentiator unit

The flow retards the disc, resulting in a higher current consumption I_1 in order to return the rotation of the disc to its orignal rate. Current I_2 amplified in the Mictiometer[2] likewise passes to an integrator and its here transformed to potential U_3 proportional to volume V_2. During micturition current I_2, which is proportional to the flow, passes in addition via switch S_2 (in dotted position) to output K_1 and appears on the recorder as a flow curve.

C. Electronic Differentiation of the Integrated Volume

After completed micturition switches S_1 and S_2 are placed in the position marked with a continuous line (Fig. 2). Thus at the output K_1 ap-

[2] Disa Electronik A/S, DK-2740 Skovelunde, Denmark

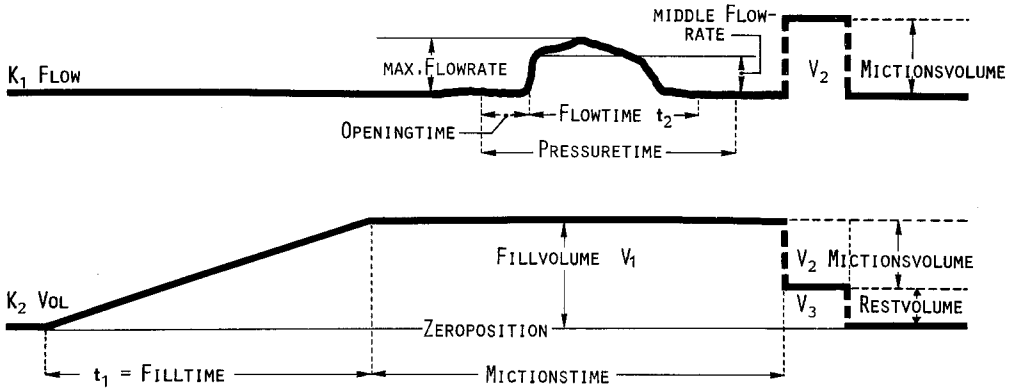

Fig. 3. Standard curve: flow and volume diagram

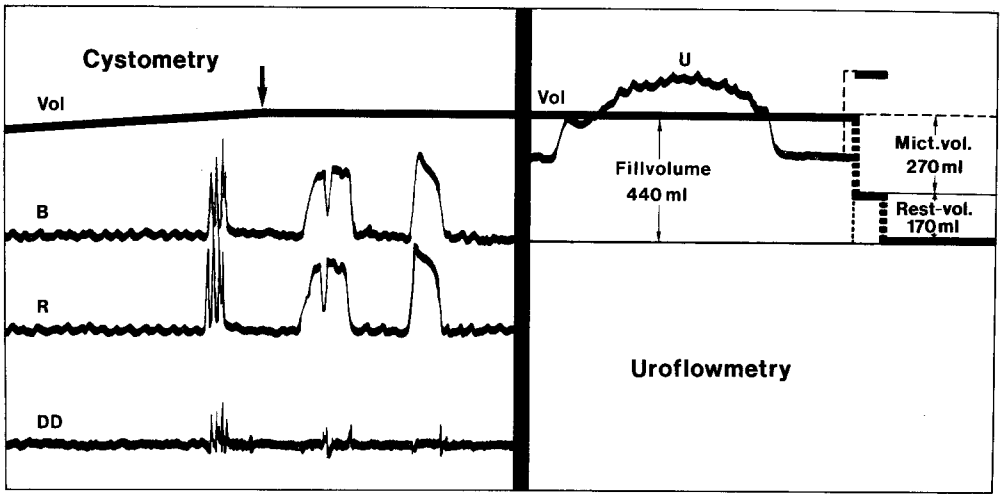

Fig. 4. Cysto-uroflow metering with final residual urine determination by electronic evaluation of volume differences. 64 year old patient with prostatic adenoma.
Cystometry: Vol, continuous volume recording; B, bladder pressure; R, rectal pressure; DD, intrinsic bladder pressure. Uroflow metering: U, uroflow

pears potential U_3, which corresponds to the micturition volume V_2. This likewise can be expressed as a formula:

$$I_2 \times t_2 = U_3 \hat{=} V_2 \text{ (ml)}$$

Potential U_3 likewise appears at the differentiator V_3. Also value U_2, which corresponds to the filling volume V_1, is passed on the V_3. Here the differentiation $U_2 - U_3 = U_4 \hat{=} V_3$ (filling volume minus micturiton volume equals residual urine volume) is now made.

RESULTS

A. Standard Curve

The recorder records the following diagram (Fig. 3):

There appears on K_1 a rectangle V_2 as a measure of the micturition volume. On K_2 which during the micturition time has maintained the level of the filling volume V_1 there now appears a jump that is proportional to the micturition volume but that is in the reverse direction. The amount now remaining to the zero line, which is subsequently again recorded, is a measure of the residual urine volume V_3.

B. Example

Cysto-uroflow metering in a 64 year old patient with a prostatic adenoma and residual urine (Fig. 4).

Bladder filling volume, bladder pressure, rectal pressure and pressure difference are recorded on the recorder. On the curve marked by an arrow the bladder capacity is reached at a

filling volume of 440 ml. The bladder compression pressure, at over 100 cm measured on the water column, it within the normal range. During the filling of the bladder no pathological detrusor contractions were observed. Uroflow metering shows that the flow of urine is decreased, with a maximum rate of 13 ml/sec. After completion of micturition the micturition volume is 270 ml and the residual urine volume 170 ml.

All values can be read directly in ml since the recorder is calibrated in this way.

CONCLUSIONS

In cysto-uroflow metering the determination of the residual urine as the final measurement can be carried out using the electronic integrator differentiator unit described. The advantage of this procedure is that apart from saving time in the carrying out of the investigation this important parameter of bladder function can be integrated graphically into the whole curve diagram.

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