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Continuous Flow Cystometry and Urethral Pressure Profile Measurement with Monitored Intravesical Pressure: A Diagnostic and Prognostic Investigation

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Summary. A technique is described for continous flow cystometry and urethral pressure profile measurement with monitored intravesical pressure. This is considered to be a reliable and valuable procedure for the investigation of detrusor and closure mechanism disorders. The urethral profile has two components, the intraurethral pressure and the functioning length. Different bladder volumes have been shown to affect the urethral profile. The normal urethra may respond to maximum bladder volume by increasing its profile components. Patients with incontinence due to defects of the closure mechanism show a decrease in these measurements at maximum bladder volume or a subnormal profile at both volumes. These findings have provided a prognostic index for the use of electronic stimulators for the control of incontinence.

Key words: Urinary incontinence, urethra, pressure, prognosis

Patients with a wide range of detrusor and bladder outlet disorders have been investigated using continous flow cystometry and urethral pressure profile measurement. The method is based on the technique devised by Brown and Wickham (1969) and subsequently modified by Harrison and Constable (1970). We employ important variations, probably the most significant being that our patients are not anaesthetised unless too young to co-operate, since it is important to correlate the patient's response with the measurements. These examinations have been performed mainly in female patients suffering from a variety of conditions which range from pelvic floor weakness and incontinence to neurogenic detrusor disorders with poor emptying. All the patients had been fully investigated by urine culture, intravenous pyelography, micturition cystography and cystoscopy. The cystometrogram and urethral pressure profile frquently provided important additional information leading to precise and successful treatment with drugs, electrical stimulators or surgery.

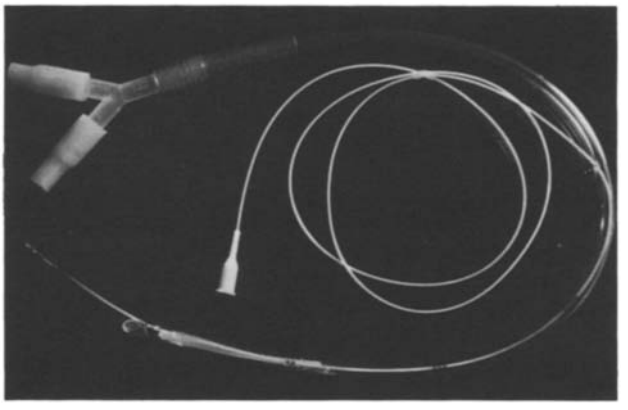

Fig. 1. Double lumen urethral catheter: The long limb is an epidural cannula (Portex Ltd., England) which is inserted into a plastic Jacques catheter via a small hole. The tip of the catheter is cut off, and the cannula led through to project by 4 cm. The end of the catheter and the side hole are sealed around the cannula by plastic cement. Two holes are bored in the Jacques catheter 3 cm from the end of the urethral limb to allow urethral pressure to be measured via these holes while bladder pressure is monitored by the cannula. A Portex Y connector is used to connect the catheter to an infusion set and to the manometer tubing

Method

The patient lies in the low lithotomy position. A special double lumen catheter, FG 10-14, (Fig. 1), is inserted and connected by manometer connecting tubes to pressure transducers which record intravesical and intra-urethral pressures. The channel for intra-urethral pressure recording also serves as the filling channel for the cystometrogram. A scheme of the recording apparatus is shown in Fig. 2.

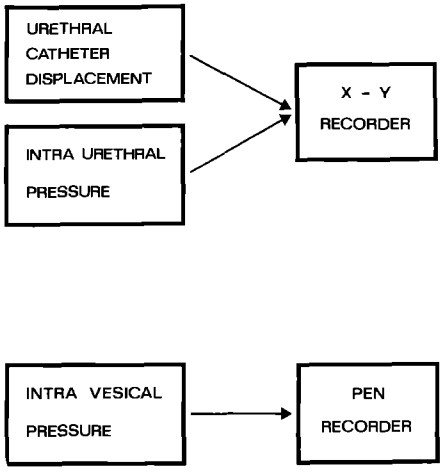

Fig. 2. Scheme of the recording apparatus

Cystometrogram. The patient voids in a normal fashion prior to positioning and catheterisation. The catheter is passed without local anaesthetic, and the residual urine is measured. The catheter is then connected to the transducers and an infusion set. Care is taken to remove all the air bubbles from the system, which is then calibrated with the level of the symphysis pubis taken as the base line. At this stage both channels are open in the bladder and the recordings are checked against each other. The bladder is filled slowly with warmed Ringer Lactate fluid at an average rate of 20 ml/min to produce a continuous cystometrogram which is sensitive enough to pick up even mild uninhibited detrusor contractions.

The patient is asked to report the first desire to void (FDV) and this is marked on the trace. Body movement produces a clearly recognisable response and seldom causes problems in the interpretation of results. Bladder filling is stopped when the need to void becomes demanding or when the bladder empties spontaneously or inadvertently.

Urethral Pressure Profile. The urethral pressure profile is measured with a low bladder volume of 25 ml and again with the bladder filled to between the FDV and the maximum functioning capacity. The catheter is mounted on a platform which is mechanically coupled to a linear displacement transducer. The output of the transducer is fed to an X-Y recorder to produce a deflection in the horizontal (X) direction proportional to the distance moved by the catheter. The output of the transducer which records the intra-urethral pressure is simultaneously fed to the vertical (Y) input of the recorder. In this way the urethral pressure profile is automatically plotted as the catheter is slowly withdrawn. During this procedure a slow flow of fluid (2 ml/min) is maintained through the urethral catheter. The intravesical pressure is recorded continuously on the pen recorder throughout the profile measurement.

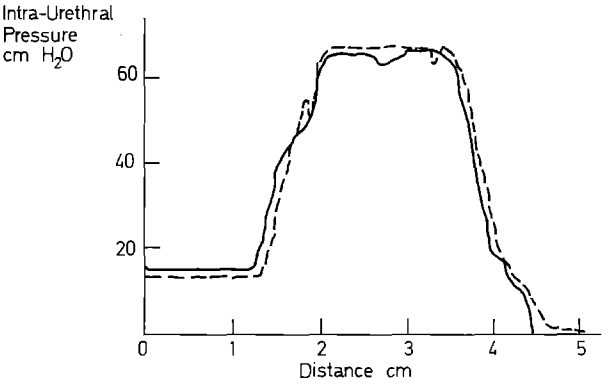

Fig. 3. Urethral pressure profile: Effect of volume. ---- Volume 25 ml —— Volume 320 ml Normal urethra: Both the intra-urethral pressure and the length over which it is exerted are normal. There is no significant change with increased bladder volume

Results from a Series of 41 Patients

Cystometrogram: In seven cases the cystometrograms showed evidence of uninhibited detrusor activity. These patients are not included in the urethral profile results since the profile deteriorates with detrusor contractions.

Urethral Profile: The normal urethral profile shows a minimum pressure of 50 cm H_2O exerted over a minimum urethral length of 0.5 cm. It may remain unchanged in shape with increased intravesical volume (Fig. 3) or show an increase in one or both components of the profile, (Fig. 4). To be significant, the change in length must be at least 0.25 cm and the change in pressure must be at least 5 cm H_2O. A profile that deteriorates with increased bladder volume is abnormal and indicates a weakness in the closure mechanism, (Fig. 5).

Table 1 shows the results in a series of 34 patients. It is striking that in the 12 patients showing a deteriorating profile with increased volume, all 12 had symptoms resulting from a deficient closure mechanism. Three of the 15 showing im-

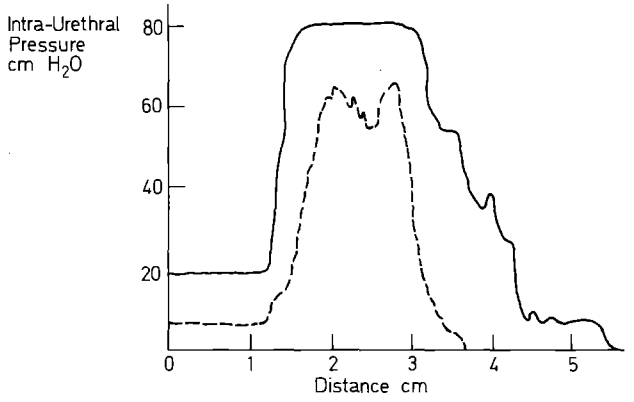

Fig. 4. Urethral pressure profile: Effect of volume. ---- Volume 50 ml —— Volume 340 ml This shows a normal urethra responding to increased intravesical volume and pressure by increasing the urethral pressure profile components

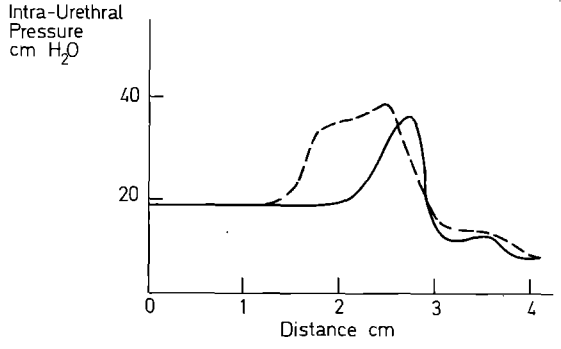

Fig. 5. Urethral pressure profile: Effect of volume. ---- Volume 200 ml —— Volume 300 ml This obese and incontinent patient shows a marked deterioration of the urethral pressure profile with increased intravesical volume and pressure

Table 1. Effect of increased volume on urethral profile measurement: Series of 34 incontinent patients

Cause of symptoms	Deterioration of profile	No change	Improvement in profile
Deficient closure mechanism	12	3	3
Detrusor dysfunction	0	4	12
Total	12	7	15

"Detrusor dysfunction" includes conditions such as cystitis and neurogenic disorders.

proved profiles with increased volume had symptoms relating to outlet deficiencies, and all three had subnormal profiles at both volumes.

Of the seven patients showing no change with volume, three had closure defects and all three had had previous pelvic surgery. Two of the three had subnormal profiles at both volumes.

Discussion

The value of cystometry is well recorded. The advantages of continuous flow cystometry are:

1. Continuous bladder pressure recording can be maintained without interrupting the flow into the bladder so that even transient uninhibited detrusor activity will be recorded.

2. A more accurate assessment of functioning bladder capacity can be made.

The results have shown that the urethral pressure and functioning length in the group with a defective closure mechanism may be within normal limits until the bladder volume is at or near capacity. At this level the urethra may show marked deficiencies, especially in functioning length. It is essential to be aware of these variations and to realise that the interpretation of the urethral profile is unreliable unless a profile has been done at both volumes. This became apparent when patients attended for repeat profile measurement in the clinic's earlier days. Obviously the procedure had to be standardised to allow comparison and this included bladder volume. The use of two bladder volumes developed from this standardisation and it was then realised that the effect of volume on the profile was of diagnostic value.

The intravesical pressure must be recorded during the whole urethral profile measurement, otherwise changes in bladder pressure due to uninhibited detrusor contractions or alterations in intra-abdominal pressure may occur and affect the urethra. For example, uninhibited detrusor contractions can cause the bladder neck to open, thus producing a deterioration in the urethral profile, (Glen and Rowan, 1972). Similar findings have been reported by Enhorning et al. (1964) using a balloon catheter. Initially a fine catheter was inserted suprapubically to record the intravesical pressure, but this was uncomfortable for many patients and made them reluctant to have subsequent examinations. To overcome this, the special urethral catheter was devised to allow simultaneous readings from bladder and urethra with the minimum distortion of bladder neck and urethra. It is considered that this system is more accurate and distorts the urethra less than balloon catheters.

The position of the patient for this procedure is one in which incontinence is least common and bladder emptying most difficult. Nevertheless, the investigation has been found to provide a

reliable indication of bladder and urethral function when used in conjunction with the usual urological investigations. The extra information obtained is of great value in the management of persisting incontinence following conventional treatment. Of the 34 patients in the series reported, 17 had had at least one operation for incontinence prior to their referral for this investigation. The diagnostic value of the profile has been recognised (Harrison, 1971; Edwards and Thomas, 1971; Tanagho et al., 1971) but its application as a prognostic index has not been described by others. Its prognostic value has been demonstrated in relation to electronic stimulators for the control of incontinence, (Glen and Rowan, 1972). The technique is currently being employed in assessing other forms of treatment including pelvic floor repair and drug therapy.

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