Urodynamics - Basic concepts

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Urodynamic studies still remains a controversial investigation in the assessment of patients with urinary incontinence.[1,2,3] A systematic review on the correlation between clinical and urodynamic diagnosis in classifying the type of urinary incontinence by van Leijsen et al in 2011 makes interesting reading. The review concluded that there is a significant reclassification of patients with clinically diagnosed stress urinary incontinence (SUI), mixed urinary incontinence (MUI) and urge urinary incontinence (UUI) after performing urodynamic studies. In patients with clinically diagnosed MUI, urodynamic SUI was more common.[4] In 2002 the International Continence Society (ICS) published the first report on ' Good Urodynamic Practices' which focussed on the basic concepts of uroflowmetry and pressure-flow studies, and also what constitutes good urodynamic practice as a result of poor quality control from multi-centre trials. Adherence to good urodynamic practise is essential in order to improve the reliability of the study.[5] Currently the National Institute of Clinical Excellence recommend urodynamic studies to be performed when: failure to conservative treatment, in patients with complex symptoms or failed previous surgery.[6]

Urodynamic studies are a unique set of investigations which rely on the expertise of the observer to obtain accurate information during the test. It is therefore of paramount importance that the investigator has a clear understanding of the aim of the investigation i.e. reproduce the patient's complaint by asking the correct urodynamic question. This is a challenge to both the patient and clinician since it is a physiological act that is performed in an unphysiological environment. It is also important that the investigator is able to interpret the results in order to confirm or refute the diagnosis. The following article is aimed to update you on the basic principles of urodynamic studies, focussing specifically on uroflowmetry and cystometry.

'Urodynamic studies', include the following investigations:

1. Uroflowmetry
2. Cystomery
3. Ambulatory monitoring
4. Urethral function tests
5. Pad tests

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Urodynamic equipment

Choice of equipment differs between units but manufacturers usually provide training on the type purchased. Calibration is an important part of setting up and this will be done by the service engineer at installation. Calibration should be checked by the clinician at least on a monthly basis. To check the calibration of the flowmeter, pour a known volume into the measuring jug and check against volume recorded.

The standard equipment consists of a flowmeter (rotating disc type or the weight transducer), a commode with a funnel, external pressure transducers which are connected to double lumen fluid filled catheters (6-8 Fr), and a rectal catheter. 0.9% saline is usually used as the filling medium and transducers are zeroed to atmospheric pressure at the beginning of each study.

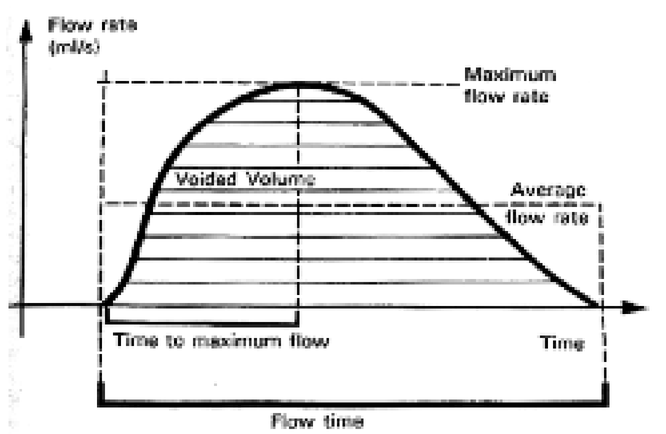
Uroflowmetry

A patient information sheet on the choice of urodynamic study to be performed must be given to the patient before the study. A urine dipstick must be done prior to beginning the study to screen for urinary tract infection.

A uroflow study is the simplest component of urodynamic studies since it is non-invasive and requires simple equipment. It measures flow rate and pattern and the following parameters are commented upon: (Figure 1).

- Flow rate- refer to the volume of urine expelled per unit time (ml/s)
- Voided volume – total volume expelled (ml)

Figure 1: A normal uroflow curve with a rapid upstroke followed by a rapid decline. The curve is not always symmetrical



- Maximum flow rate (Qmax)-maximum value of the flow rate- usually between 20-36 ml/s in women
- Flow time- time over which measureable flow occurs
- Average flow rate (Qave) – Voided volume divided by flow time
- Time to maximum flow- time of onset to time of maximum flow

A uroflow study screens for bladder outlet obstruction, and it is therefore important that a 3 day frequency volume chart is done prior. The patient is instructed to have a comfortably full bladder and is then asked to sit on the commode. Once the clinician is set to start the patient is instructed to urinate and is advised to be still so as to improve accuracy.

Reference ranges can be determined by using either the Liverpool or Siroky normograms. Figure 1and 2 demonstrates a normal uroflow pattern which is described as 'bell-shaped'. It is generally accepted that maximum flow is achieved within the first 30% of the trace and within 5 seconds from the onset of flow. The trace is dependent on the voided volume and therefore a voided volume of 200-500ml is recommended.

In patients with detrusor instability very high maximum flow rates may be achieved very quickly (1-3 sec), and is described as a 'supranormal' curve (Figure 3 and 4), and in patients with bladder outlet obstruction, a slow continuous flow with a low maximum and reduced average flow (Figure 5 and 6). After a uroflow the residual urine must be measured either with a bladder scan or with a catheter.

Figure 2: A normal uroflow. A cystometry was performed after the uroflow and thus a urine dipstick was done before the study, the flow rate used was 50ml/ min of 0.9% saline. A residual is routinely performed after the flow

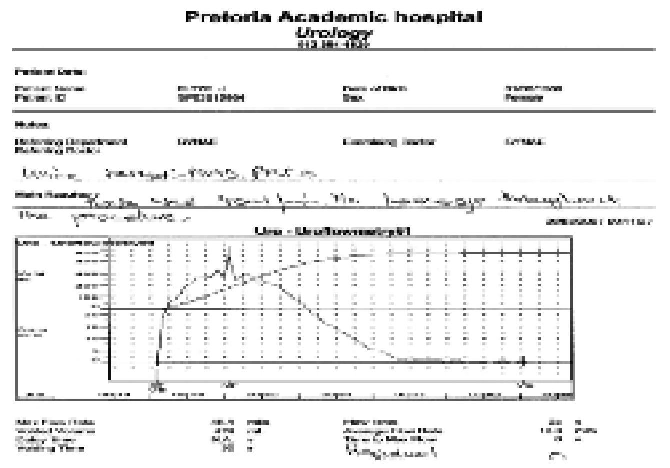


Figure 3: A supranormal uroflow pattern in patients with detrusor overactivity

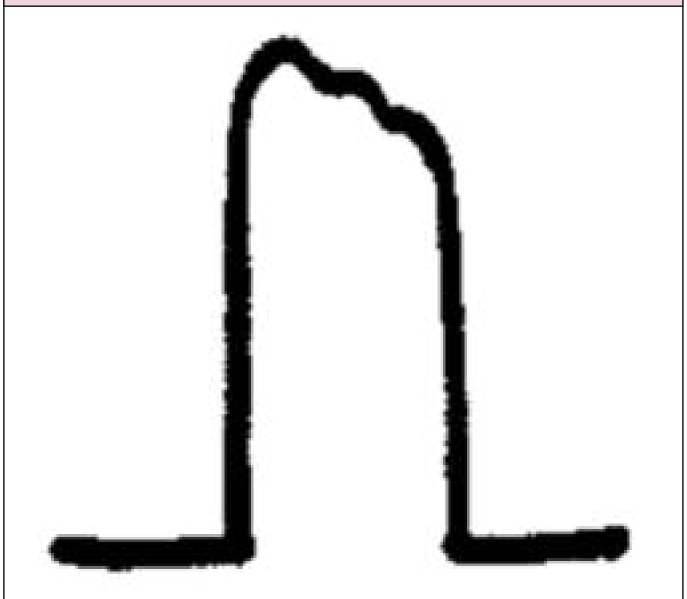


Figure 4: Early maximum flow rate, but note the volume voided is low i.e 66 ml, and therefore the flow will need to be repeated

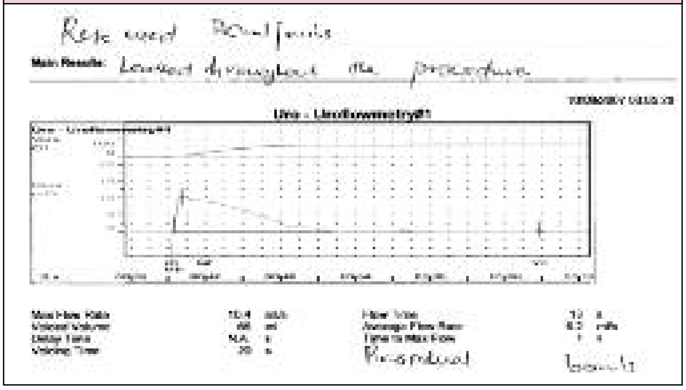
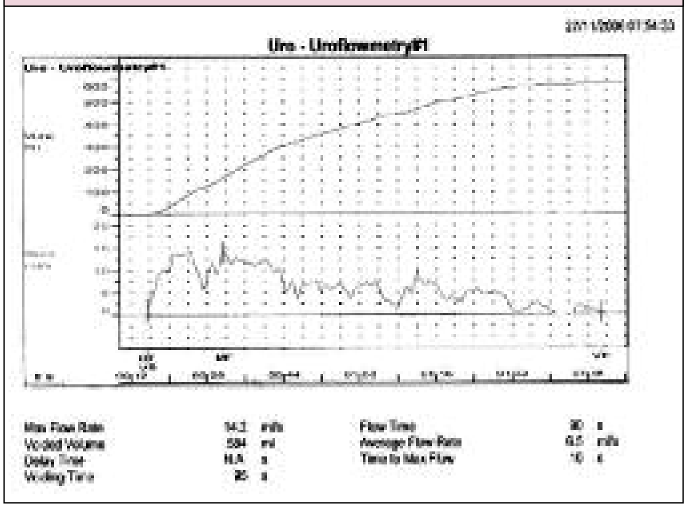


Figure 5: Flow pattern in cases with bladder outlet obstruction

Figure 6: A slow continuous flow with a low maximum and reduced average flow



Pressure Flow studies: Cystometry

Cystometric studies measure the pressure volume relationship during the storage and voiding phase, and usually follows after a uroflow study. While a uroflow will indicate whether the patient has a normal voiding pattern, it does not say anything about the storage phase of voiding. Once the fluid-filled lines are prepared and correctly fixed, and the external transducers zeroed and set at the level of the superior border of the pubic symphysis, the test can begin. Catheterisation takes place in the supine position, but the filling phase occurs in the sitting position in our unit, since we think that the sitting position is a close representation of everyday bladder stresses.

The ICS recommendations for baseline pressures at the onset of filling cystometry is as flows: For P ves-5-50 cmH$_2$0, Pabd-5-50 cmH$_2$0 and Pdet -5-15 cmH$_2$0. For quality control the patient is asked to cough first before filling begins, and this should show a rapid rise in the abdominal and vesical pressure traces. The detrusor pressure is calculated by subtracting the abdominal pressure trace from the vesical pressure trace i.e. Pdet = Pves – Pabd. When the amplitude of the Pves and Pabd are equal filling can begin. The usual filling rate is between 50-100ml/min in neurologically intact individuals, but in cases with marked detrusor overactivity and neurologic patients the rate will need to be reduced. During filling the patient is usually asked to cough every minute, there should be a continuous dialogue between patient and clinician and bladder sensation is then recorded throughout the study.

- First sensation-usually occurs at 50% of cystometric capacity
- Normal desire at -75% cystometric capacity
- Strong desire at – 90% cystometric capacity
- Urgency – a sudden compelling desire to void

A normal detrusor muscle should show no change in pressure during filling. In cases with detrusor overactivity, phasic contraction will be noted on the detrusor line during filling and which may or may not be associated with incontinence. These phasic contractions can either be spontaneous or provoked (Figure 8). In cases of SUI, leakage is observed during the filling phase in the presence of raised abdominal pressures without a detrusor contraction. Urodynamic SUI is best demonstrated with the patient either sitting on the commode or standing. During the cystometry provocative manoeuvres maybe performed to elicit overactivity like opening the tap, or walking in cases with SUI. At the end of the filling phase the voiding phase is done. Catheters are then removed, and advise the patient that mild discomfort might be experienced for a few hours later and they should drink plenty water. If bladder symptoms persist longer a culture will need to be done.

Figure 7: A typical pressure flow study with the 3 lines indicated- Pdet, Pves and Pabd. Note FD refers to first desire and ND, normal desire

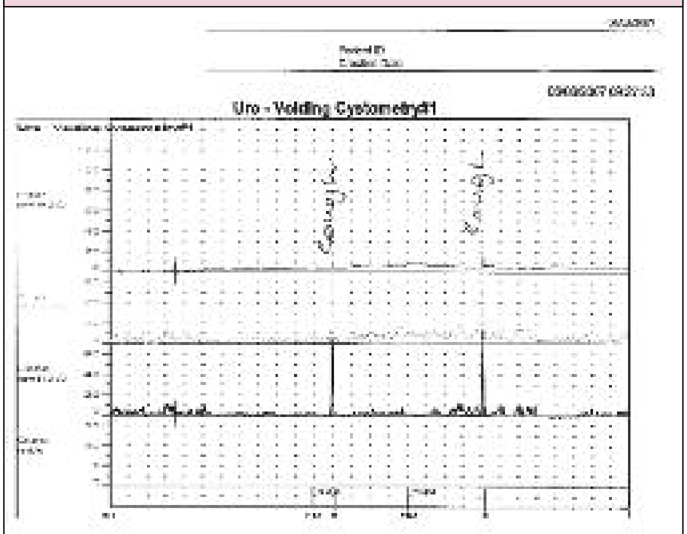
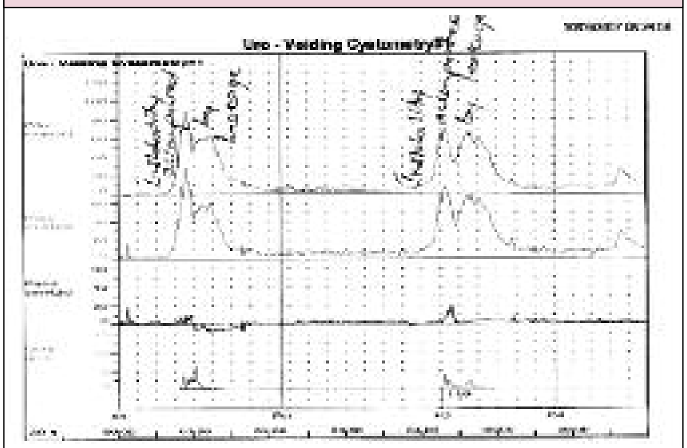


Figure 8: Phasic detrusor contractions accompanied by urinary incontinence



Conclusion

A uroflow is an excellent simple screening test in a variety of patients, but often this will be followed by cystometric studies in order to obtain a better understanding of detrusor and urethral function. The study by van Leijsen et al indicates a poor correlation between clinical diagnosis and urodynamic diagnosis. To improve the accuracy and reliability of the test, the investigation should be conducted by the clinician who took the history and examined the patient, as well as the adhering to good urodynamic practice. It is a personal recommendation the clinicians undertaking this investigation regularly attend workshops to optimise their skills.

References

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- *Further reading: Urodynamics Illustrated. Ranee Thakar, Phillip Toozs-Hobson, Lucia Dolan eds. London: Richard Baber, 2011.*