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Review Article
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Non-invasive Urodynamic Study - The Uroflowmetry

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Introduction

The complaints of lower urinary tract symptoms (LUTS),or bladder outflow obstruction(BOO) are going up. Urodynamic evaluation is the gold standard method for diagnosing of BOO, but it is inconvenient to some extent due to embarrassment, pain, dysuria, urinary retention, macroscopic hematuria, or urinary tract infection.

Here in, we describe a simple technology with non-invasive method to diagnose BOO, named as Uroflowmetry(UFM).It is a screening study in which the patient urinates into a receptacle that measures the rate at which urine is voided. UFM not only is of diagnostic value but also a valuable tool in follow-up studies but a deciding factor on treatment. Sometimes it does not provide enough data about the abnormality in the voiding mechanism.

Materials and Methods:

Willard M Drake Jr, an American surgeon was the pioneer of the UFM machine and first published the technique of Uroflow machine use. It is a screening test in which the patient urinates into a bucket that measures the rate at which urine is voided.

Figure 1 shows a uroflowmetry machine. A complete Uroflowmetry machine has the following essential equipment. A precise Microprocessor Device, a transducer, a micturition Chair and a funnel, a beaker, and a Printer. It's use has become a universal investigation that affords a simple, safe, non-invasive and inexpensive tool for recording the way of urinary flow rate during the time of micturition.

It has some limitation which relies on careful clinical interpretation by urologist.[1] UFM can be the first window in the provisional diagnosis of LUTs. The urine flow reflects the final result of the micturition process consisting of bladder function, timely opening of bladder neck and urethral passage. Urologist should remember that flow of urine can be affected by several conditions such as environment, emotional state, abnormal anatomical condition of lower urinary tract, pelvic floor function, bladder capacity. So, interpretation of UFM curve should consider the above conditions during recording by the instrument. This primary investigation measures the flow rate, and voided urinary volume. A model flow pattern is shown in figure 1, along with key terms accepted by the ICS. [2] UFM may be done combined with Urodynamic study recording of bladder, abdominal and detrusor pressures, sphincter EMG for complete detrusor function evaluation. Diagnosis by UFM of LUTS or BOO, other examinations such as clinical history taking, physical examination, administrations of validated questionnaires, urinalysis and serum PSA level should be considered. However, parameters derived from UFM are consider to be clinically reliable if voided volume (VV) is >150 ml.[3] It is recommended that UFM be repeated to ensure reliable results before treatment is initiate.[4,5] If there is any urinary flow abnormalities UFM is performed. Such as : 1. Benign Prostatic Enlargement (BPH), Carcinoma Prostate, Incontinence of Urine, Stricture urethra, Neurogenic bladder, Sphincteric dysfunction.

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Fig.-1: *Uroflowmetry machine*

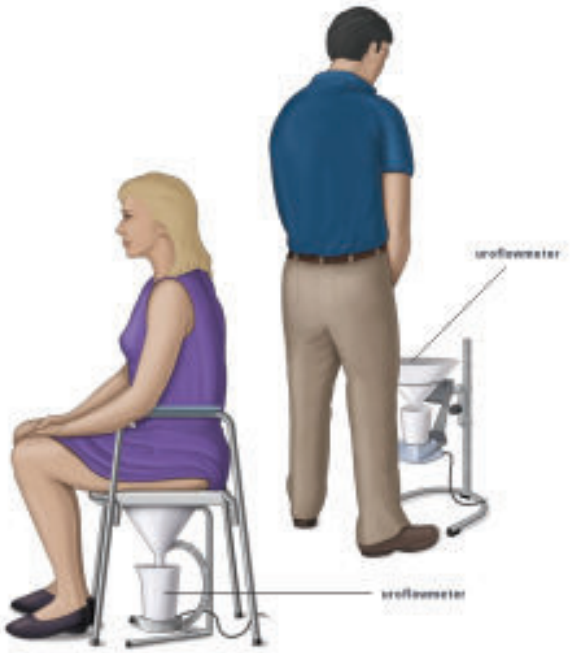

Fig.-2.*Correct standing(male), and sitting position (female)*

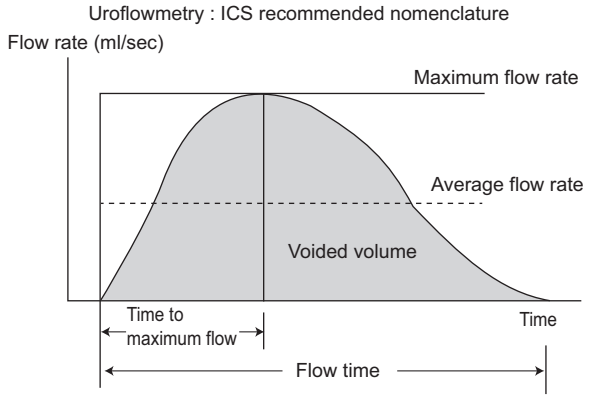

Fig.-3: *Uroflowmetry. Basic variables.*

Following are the different variables of Uroflowmetry (figure 3) :

i) Voided volume(VV): The total volume (ml) collected in the measuring jar during the voiding(recording) period.

ii) Average flow rate(Q_{ave}) (ml/sec): It is the average of the total flow during the voiding time.

iii) Maximum flow rate(Q_{max})(ml/sec): Maximum value of free flow rate, during the voiding period, also called Peak flow rate. Qmax is dependent on VV [6].

IV) Time to maximum flow rate(Q_{tmax})(second):It is the time at which Max Flow rate occurs.

V) Voiding time (Q_{vt})(second): Time taken by the person to void .It also includes post micturition drops only if the flow rate is greater than 2 ml/sec.

VI) Flow time(second) : The time taken by the patient between the start of voiding and the first time the voiding flow rate reaches zero is called the flow time.

VII) Delay time (sec): It is the total time from request to urinate until the actual micturition, or from the existence of a considerable urge to urinate until the beginning of voiding.

VIII) Delta Q(sec): Value of Q_{max} minus Qave is known as Delta Q.

Delta Q is a novel predictor capable of discriminating detrusor under activity (DU) from BOO in men with LUTS [7].

Among those variables, voided volume, Q_{max}, and shape of urinary flow curves are the most important for interpretation. An inverse relationship exists between IPSS and Q_{max} and remains the only important parameter in Uroflowmetry [8].

Q_{max} is correlated with age and voided volume than Q_{ave}. For children Q_{max} increases with age but decreases with age in the adult and elderly population. Q_{max} is higher in girls than boys [9].

Techniques for a good UFM test :

The UFM machine must be placed in a comfortable environment for the patient, as like as a good toilet, so that patient feel relax with a good environment, without anxiety, as anxiety may interfere the performance of voiding pattern. Physician should explain the procedure of conducting the UFM test to the patient. Generally, no prior preparation, such as fasting or

sedation, is required. Before performing UFM test, patient should ask to drink fluids with amounts equal to the expected bladder capacity, that is (agex30+30)ml one hour before the test.

Patient should ask to void when there is a normal desire to void. Male are asked to void in a standing or sitting position and female are asked to urinate in a sitting position with adequate foot support, a straight back and a tilted pelvis. At least two tests are usually recommended due to high variation in the test, which could lead to a misleading diagnosis [10].Correct sitting and standing position are shown in figure 2.

Results:

The ICCS recommends fives pattern of Uroflowmetry curve such as bell-shaped, tower, Plateau, staccato, interrupted.

Normal flow curve (figure 3) : Normal flow curve is represented by a bell-shaped curves. The shape may vary within limits and still be normal. When people with full bladder urine micturate, the flow rate varies from 20-25 ml/sec in men, and 25-30 ml/sec in women. Minimum voided volume should be 150ml[11].

. Variation is directly related to the urine volume voided and the patient's age. Obstruction should be suspected in any adult voiding with a full bladder at a rate of 15ml/s. A flow rate less than 10 ml/s is considered obstruction flow. From straining if intra-abdominal pressure increases, the bladder sphincter relaxation occurs without detrusor contraction, in that situation the flow rate may be normal. In other way , increased sphincteric activity or lack of complete relaxation and if detrusor contraction is increased to overcome outlet resistance, a normal flow rate can be achieved [11].

Tower: Tower-shaped curves are defined as high amplitude curves with a short duration that may be produced by over active bladder.

Plateau shave curve: It is low amplitude and even flow curve often accompanied by urethral stricture or a tonic sphincter contraction.

Staccato : This type of flow curve represents sharp peaks and troughs in the flow curve implying sphincter over activity during voiding.

Interrupted or fractionated curve: It represents discrete peaks corresponding to each strains, separated By segments with zero flow, possibly accompanied by an underactive or a contractile detrusor when contraction of the abdominal muscles creates the main force for bladder evacuation[13,14].

During interpretation of UFM curve, the scale on the vertical axis should be adjusted to 1 ml/sec and scale on the horizontal axis should be adjusted 1 sec/ml. If not adjust properly on the scale the UFM curve will be different shape for the same patient, and may give wrong information.

Interpretation of a few UFM report:

Flow curve is normal but decreased maximum flow with prolonged voiding time indicate BPH. Time is prolonged in maximum flow but maximum flow rate is decreased in bladder neck rigidity. Intermittent flow curve is seen without bladder contraction but with abdominal straining. When abrupt decrease flow rate for brief contraction of the external urethral sphincter, most likely by patient discomfort. It does not imply the existence of detrusor sphincter dyssynergia. Irregular flow curve due to detrusor contraction and abdominal straining indicate fluctuating obstruction in the lower tract.

Pitfalls of UFM : There may be pitfall if the urinary bladder is over distended during UFM test. Temporary impairment of detrusor contractility may be due to overstretching of detrusor muscle. If only one parameter such as peak flow is measure, this may give wrong information because patient may generate very high peak flow with straining abdominal muscles. It is important to measure the test value of different UFM variables to a uniform volume of urine voided. Few examples of UFM curves shown in Figure 5, a) normal ''Bell shape'' curve, normal, b) tower shape- over active bladder, c) Staccato-shaped, suggestive of dysfunctional voiding, d) Interrupted-shaped, suggestive of under active Detrusor, e) low flow and prolonged flow time is classical in BPH.

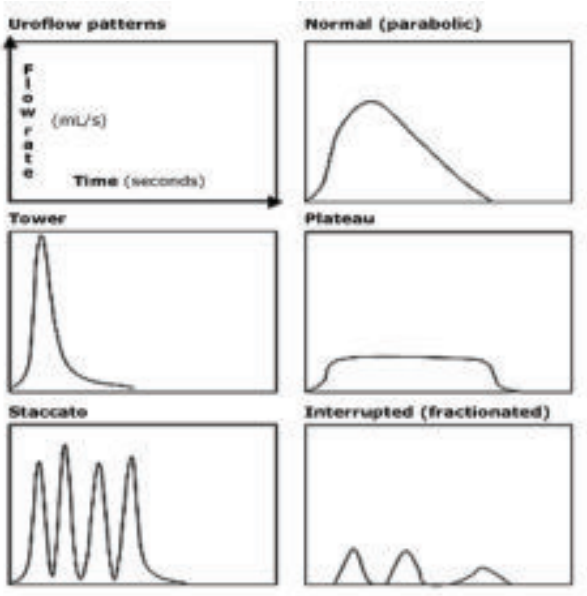

Fig.- 4 : *Flow curve morphology*

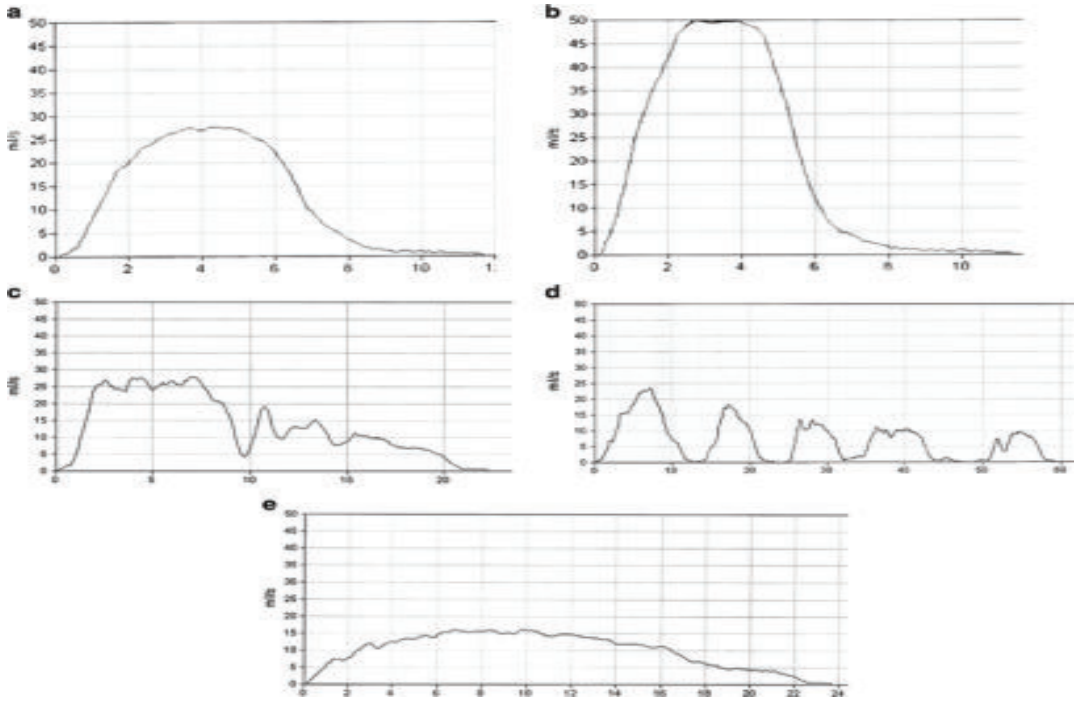

Fig.-5: *Few examples of UFM curves*

Discussion:

The important variables of the UFM test are voided volume, which should be >150 ml, and shape of the flow curve, which will be " bell shaped''. Q_{max} normal value for male is 20-36 ml/s, and in female it is more due to short urethra and less resistance during urine flow. In man Q_{max} >15 ml/s is consider normal. The flow curve is produce due to detrusor contraction strength, and bladder outlet resistance[15]. To have a normal void curve pattern, environment for normal micturition, comfortable sitting or standing position, optimum void pressure is recommended . The different values of uroflowmetry test is variable depending on age, gender ,and bladder capacity[15].In a study the sensitivity and specificity were 79% and 35% respectively [16].Final diagnosis depending only on UFM is not possible, other invasive urodynamic tests are necessary.

Sometimes repeated UFM test should be done for the same patient[17]. It is true that UFM cannot give Final decision, it is a screening, non-invasive and easy procedure test than Cystometry, EMG, Urethral

Pressure Profile, Pressure Flow Study.

Conclusion

This article provides systematic approach and a preliminary information to ensure a representative, High quality, non-invasive urodynamic study for a patient having lower urinary tract dysfunction.

Acknowledgement

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