VISUAL UROFLOWMETRY: A VIABLE SCREENING TOOL FOR LOWER URINARY TRACT SYMPTOMS?

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Certificate

This is to certify that the work incorporated in this dissertation entitled "**VISUAL UROFLOWMETRY: A VIABLE SCREENING TOOL FOR LOWER URINARY TRACT SYMPTOMS?**" is a bonafide work done by **Dr. Nirmal T.J** in partial fulfillment of the rules and regulations of MCh Branch IV (Genitourinary Surgery) examination of the Tamil Nadu Dr. MGR Medical University, Chennai to be held in August 2010.

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Contents

INTRODUCTION

Introduction

While a pressure flow voiding study is the definitive measure of bladder outlet obstruction, uroflowmetry is a simple, noninvasive test which provides valuable information. Flow rate measurement represents a reproducible way to quantify the strength of the urinary stream and, when used in combination with symptom scores for a small subset of patients (20%), has a high probability of correctly characterizing whether there is BOO[1]. Chancellor and colleagues[2] found that flow rate recording cannot distinguish between BOO and impaired detrusor contractility as the cause for a low peak flow (Qmax). Qmax appears to predict surgical outcome in some studies. Although considerable uncertainty exists, patients with a Qmax greater than 15 ml/s appear to have somewhat poorer treatment outcomes after prostatectomy than patients with a Qmax of less than 15 ml/s[3].

Uroflowmetry and measurement of post void residue (PVR) are recommended as diagnostic tests in the initial assessment of men with LUTS and should be performed prior to prostatectomy (AUA 2003, EAU 2004 guidelines for BPH). However, Lloyd and Kirk[4] have shown that as few as 28% of surgeons performing resection always carry out uroflowmetry with 46% using it only occasionally or never. This may be attributed to the inconclusive evidence supporting its use. Measurement of urinary flow rate requires sophisticated equipment and in a developing country like India, a major deterrent to setting up a uroflowmetry clinic is the prohibitive cost involved. Hence there is a need to develop a simpler tool which would not only objectively quantify urinary flow but also be cost-effective enough to be made accessible to all practising urologists.

Taking of a good history is the starting point in making the diagnosis of BOO. However, there is an element of subjectivity in the patients’ perception of flow symptoms. In the IPSS scoring system, the patient assesses how often the flow is weak. In others, e.g. Madsen and Iverson, the patient judges whether his stream is strong, weak or variable. Hence, the reliability of the patients’ judgement requires quantitative study. The Brian Peeling diagram[5] consists of a multiple choice pictorial representation of different urinary flow strengths. The patient is asked to mark the flow trajectory on the Brian Peeling diagram which best represents his own flow. We decided to use a modification of this simple, inexpensive tool to assess patients’ urinary flow and compared it with the peak flow rate (Qmax) measured by a uroflowmeter.

REVIEW OF LITERATURE

Review of literature

Evolution of Uroflowmetry

The first attempt to obtain an objective measurement of urinary flow rate was made in 1897 by Rehfisch[6]. The technique was based on the principle of air displacement and involved the timing of the onset and completion of micturition. The course of micturition was recorded on a kymograph, but details of flow rate, voided volume, and micturition time could not be obtained. Palm and Nielsen[7] later modified the air displacement technique by incorporating a “hot wire” into the instrument and used it to evaluate bladder function in children. In this case, air displaced by the urine was directed through a transducer consisting of a nylon block containing a tantalum wire. The displaced air cooled the wire which was fixed at a constant temperature of 300°C, and the electrical energy required to maintain this temperature was proportional to the urine flow. Another displacement technique was also used by Holm[8] but different from the hot wire models by feeding the displaced air to an anesthetic rota-meter calibrated to give a direct reading of the flow rate. The drawbacks to methods based on air displacement are that the apparatus has to be completely airtight and maintained at constant ambient temperature.

After the initial studies of Rehfisch, the measurement of urinary flow was largely neglected for 25 years until 1922 when Schwartz and Brenner[9] expressed flow rate in terms of the cast distance of the stream. They instructed their subjects to urinate, with the stream directed horizontally at the meatus, into a number of containers arranged in a row in front of them. From the volume of urine falling into successive vessels ant the time taken to void, they were able to plot a “propulsion curve” and calculated that the volume expelled per unit time was approximately 20 ml/s. Ballenger and his associates in 1932[10] advocate the use of the distance that the urinary stream can be projected as an index of progressing prostatic obstruction. They recognized the futility of such an exercise for the purpose of comparing flow rates between different individuals, but suggested that it might be a useful means for any one man to detect a reduction in the strength of his urinary stream. Thus they advised men of “forty-five or fifty years of age to make a test, from time to time, preferably when alone in the country or out by the barn.” The method of measuring the cast distance of the stream was also used by Morales and Romanus[11].

An even simpler approach, namely direct observation of the urinary stream without taking any measurements has also been advocated as a means of assessing voiding ability in male children[12]. It would be fair to say that many urologists not in possession of a uroflowmeter have resorted to this method at some stage of their career. However, although this method may provide a rough guide as to the strength of the stream, it can hardly be regarded as quantitative; and its use has not been reported for many years.

Gronwall in 1925[13] was the first worker who attempted to make direct measurements of urinary flow rates. Urine was passed into a collecting cylinder which contained a float. As the level of urine in the vessel rose, the movement of the float was recorded by a kymograph. Gronwall observed that the individual flow curves of women were steeper than those of men, and that males with prostatic obstruction produced curves with much flatter initial rises. A similar technique, based on recording the increasing weight of the voided urine was used by Drake in 1948[14]. The materials used to construct the instrument were simple indeed: the device consisted principally of a toy erector set and screen attached to one arm of a balance and a 1 litre container was connected to the other arm. By fitting a recording pen to the spring and using a kymograph calibrated to calculate in 100ml intervals, it was possible to calculate the flow rate in ml/s. The apparatus was dubbed the "uroflometer" and the recordings it produced, "uroflograms". The method allowed the computation of average flow rates, and by taking measurements from the steepest portion of the voiding curve, the maximum flow rate could also be determined. This method was improved and extended by Kaufman[15] by the addition of and automatic starting mechanism and was used to obtain more than 5,000 measurements of flow rates[16]. However, the instrument was inaccurate for voided volumes less than 200ml and led Stewart[17], who also used the instrument, to conclude that uroflowmetry was of limited value in the diagnosis of obstruction of the lower urinary tract. It seems that Drake also was dissatisfied with his flowmeter, regarding it as complicated, and later invented a simpler "more professional-appearing" contrievance[18]. It consisted of a small half cylinder into which the patient voided. This "weir" was mounted above a larger half cylinder divided into five chambers. Holes were placed in the weir at varying heights such that, depending on the flow rat, the urine emptied into different compartments in the lower cylinder. Each of the compartments corresponded to a different minimum flow rate and only flow rates in excess of 20 ml/s enabled urine to empty into all of them. Since abnormality was defined as the inability to get urine into all the chambers, a flow rate of 20 ml/s was designated as the watershed of normality. The method required a minimum volume of 200 ml to obtain accurate data and was later used by von Rutishauser and Lederman[19], although its use has since been abandoned in favour of other techniques.

The use of the weight of voided urine as a measure of flow rate was adapted and improved by von Garrelts[20]. A pressure transducer (electromanometer) at the bottom of a collecting cylinder gave a measure of the increasing urine volume in the cylinder, and this was recorded on a time scale. Electrical derivation of the pressure enabled a direct determination of the rate of flow throughout micturition. Von Garrelts used this instrument for an extensive series of studies on normal males[21], urethral stricture, and prostatic disorders[21], but later modified it[23] so that the hard copy of the recording could be obtained instantaneously (the original one had to be photographically developed). This version used a container suspended on a spring which moved an iron core in a coil. This version had previously been used by Ross and Nixon[24].

Klein et al [25] substituted an electronic balance for the pressure transducer used in previous flowmeters, thereby overcoming what they stated were problems associated with the use of transducers. These included hydraulic resistance, difficulty in cleaning, blockages, and possible misinterpretation caused by bubbles in the urinary stream. The balance circumvented these problems by being frictionless. Gleason et al[26] also measured urinary flow rate by utilizing the changing urine weight, but did not provide details of the instrumentation. Their study distinguished itself by coupling urinary flow measurements with determinations of the energy left in the stream after transit through the urethra. This was achieved by measuring the impact force of the urinary stream on a vertical disk with a force transducer. Although novel, this concept was not subsequently pursued by others.

One of the more popular notions was to measure the time taken to void a given volume of urine. This approach obviously provides a measure of average, rather than peak flow rate. Johanson in 1953[27] was the first to employ the principle, and he found that a minimum volume of 200 ml was necessary to obtain meaningful results. Helmstein[28] varied the approach by measuring the amount of urine voided during the “best eight seconds”, and Hinman[29] adopted a similar procedure, measuring the time taken to void the volume of urine between 50 and 150 ml. The urine was allowed to flow into a graduated measuring cylinder and by its conductance, automatically started a stop watch when the volume reached 50 ml. When the volume reached 150 ml, a second relay stopped the clock, the face of which was altered to allow a direct reading of flow rate. This method was used with little modification by Beck and Gaudin[30] who found it useful in the assessment of men with prostatic obstruction. Cole et al measured the volume of urine voided in the first five seconds of micturition and concluded that a volume of less than 45 ml voided in this period was indicative of significant urethral narrowing. They acknowledged that this simple test was unreliable at volumes less than 200ml. Thus, although the estimation of average flow rate by this method is simple and requires no expensive or specialized equipment, it suffers from several serious limitations including inaccuracies inherent in determining the exact time of the onset and completion of micturition and its inability to provide a permanent, continuous record of flow rate.

Apart from direct visual observation of the urinary stream, perhaps the next most simple approach to the problem of assessing flow rate is to listen. While this might enable a very broad categorization of patients with extreme symptoms, it suffers from the same lack of quantitative objectivity as just watching a patient void. In 1963 Lyon and Smith[31] devised a method which they stated “at first glance would seem too crude to be valuable”. Although this method has been quoted as being based on audio measurements, the calculation of flow rate actually entailed determining the time taken to void a measured volume and therefore gave an estimate of average flow rate in much the same way as other studies discussed previously. In this method, a tape recorder microphone was attached to a normal toilet seat form which was suspended a collecting vessel. When voiding was completed, the volume was measured, the tape recording of the sound replayed, and a stop watch used to determine the total voiding time. Thus although this technique has been cited based on audio measurements, the use of the tape recorder was in truth only a more complex means of enabling an accurate estimation of voiding time.

Subsequently, another method based on sound measurement[32] was published and was described by its authors as “simplicity itself”. Again, it involved taking a tape recording of the voiding, and “by converting the kinetic energy of the velocity head from the force of the urinary stream into sound energy upon a magnetic tape and rectifying this audio voltage", it was possible to obtain a graphic voiding curve. The flow rate was obtained by adding a time bade to the graph.

In 1967 Koontz and Rowan[33] published an article describing a flowmeter which enabled the measurement of changes in urinary flow rate per second. Although rather ingenious, the method was simple in concept and consisted of a carousel divided into 60 compartments, each of 50 ml capacity. The subject voided into a funnel placed above the carousel which turned one complete revolution per minute, and form the volume of urine collected into each compartment it was possible to plot a curve showing the flow rate in ml/s. There were obvious drawbacks to this technique, the most obvious on being the inconvenience of having to measure the volume in each container and to construct the flow curve manually. Other disadvantages included the need to empty and clean the carousel after each void and the obvious problems which would result when patients' flow rates exceed 50 ml/s or when they took longer than sixty seconds to finish voiding.

A flowmeter which operated on the rotameter principle was also used by Susset et al[34], and although this instrument reportedly gave a permanent continuous tracing form 0 to 60 ml/s, it was not described in any detail in their article.

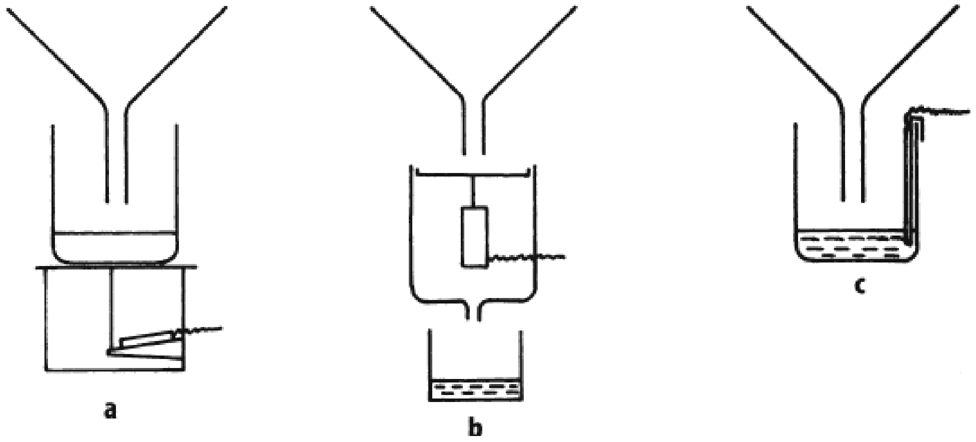
Around 1975, a uroflowmeter based on an entirely new principle became commercially available. Manufactured by Disa, the machine has become generally known as the “rotating disk” flowmeter. A transducer consisting of a lightweight, rimmed plastic disk is mounted on the shaft of a D.C. motor. Urine hitting the disk tends to slow its speed of rotation, and the electrical energy necessary to maintain a constant disk velocity is proportional to the mass flow rate of urine. A stringent technical and clinical evaluation of this instrument performed by Rowan et al[35] is worthy of note. Their investigation showed that inaccuracies inherent in measuring low flow rates with this machine were probably insignificant for most routine clinical applications, but that serious errors resulted at high flow rates when the urine struck the grid intersections or the edge of the rotating disk. These problems have since been largely circumvented by the substitution of the grid with a large collecting funnel which directs the urine stream to the center of the disk.

One of the more sophisticated physical principles adapted to the measurement of urinary flow rates is that of electromagnetism. A flowmeter described by Cardus et al[36] used and electromagnetic blood flowmeter to measure instantaneous urine flow rate. At first, patients were connected directly to the probe of the flowmeter by means of specially constructed latex rubber adapters. However, the adapters were not easy to use and gave rise to artifacts in the measurements, and the method was modified for use with a funnel which obviated the need for the adapters. The advantages of this technique were that it gave an instantaneous response and provided an accurate and permanent recording of the complete flow curve and increasing volume of urine.

A novel approach to the assessment of voiding ability was introduced by Bryndorf and Sondoe[37] who expressed their results in terms of the velocity of the urinary stream, variations in which were recorded on an 8 mm film at the rate of 8 pictures/s. Determination of the stream velocity was made from every fourth picture. If a horizontal jet was recorded, as was intended, the horizontal cast distance and the vertical distance from the urethra to the base were measured from the developed film, and the equation derived by Schwartz and Brenner[9]. Deviations from the horizontal were accounted for mathematically. This technique suffered from some of the more common drawbacks inherent in other methods, and in addition, was obviously unsuitable for the female patients.

Nonetheless, photography of the urinary stream was later used by Zinner et al[38] following their earlier discovery[39] that the human urinary stream breaks into drops within a few centimeters of leaving the meatus. They noted that the drops formed “spatial, temporal, volume, and velocity patterns” which could be measured by light-beam interruption methods. The data from their drop spectrometer were fed directly to a computer for analysis, or stored in an analogue or digital form on tape for further handling. An oscilloscope was used to provide and immediate visual readout. The velocity of each drop in the stream was measured by and analogue computer incorporated into the drop spectrometer circuitry. Once again the technique although ingenious did not provide an immediate permanent record, and its cost and sophistication, and the expertise required for interpretation of the results, rendered it unsuitable for routine clinical and office use. However, its potential as a urodynamic tool secured its place in urologic research, and the method was later[40] used to obtain the characteristic voiding patterns of normal and obstructed males. In this case the technique was extended to give an instantaneous paper tracing of micturition by connecting the drop spectrometer to a PDP 11/10 computer coupled to and X-Y plotter.

The requirement of a computer with the drop spectrometer technique was a presage of the future involvement of computers in urodynamic research. The Currently available flowmeters and their principles are illustrated below.

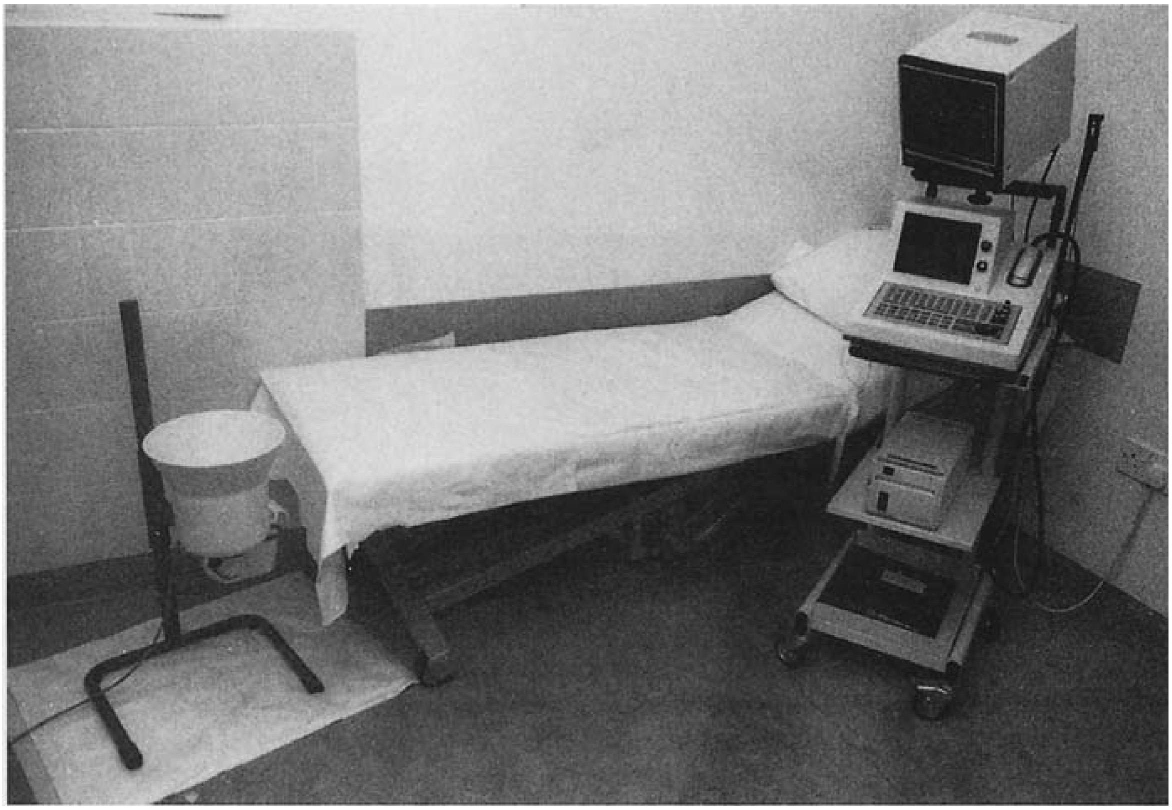


Types of Uroflowmeters: (a) weight transducer, (b) rotating disc and (c) capacitance

Accuracy of Uroflowmeters

Uroflowmetry measures the flow rate of the external urinary stream as volume per unit time in milliliters per second, (ml/s). The ICS Technical Report[41] made technical recommendations with respect to uroflowmetry, but did not compare different flowmeters by specific testing.

The desired clinical accuracy may differ from the technical accuracy of a flow meter. The ICS Technical report recommended the following standards: a range of 0–50 ml/s for Qmax, and 0–1,000 ml for voided volume, maximum time constant of 0.75 s; an accuracy of + 5% relative to full scale, although a calibration curve representing the percentage error over the entire range of measurement should be made available. Furthermore, as most flowmeters are mass flow meters (e.g., a weight transducer or rotating disk), variations in the specific gravity of the fluid will have a direct influence on the measured flow rate. For example, urine of high concentration may increase apparent flow rate by 3%. With X-ray medium, the flow rate may be overestimated by as much as 10%. These effects should be corrected by calibration software.

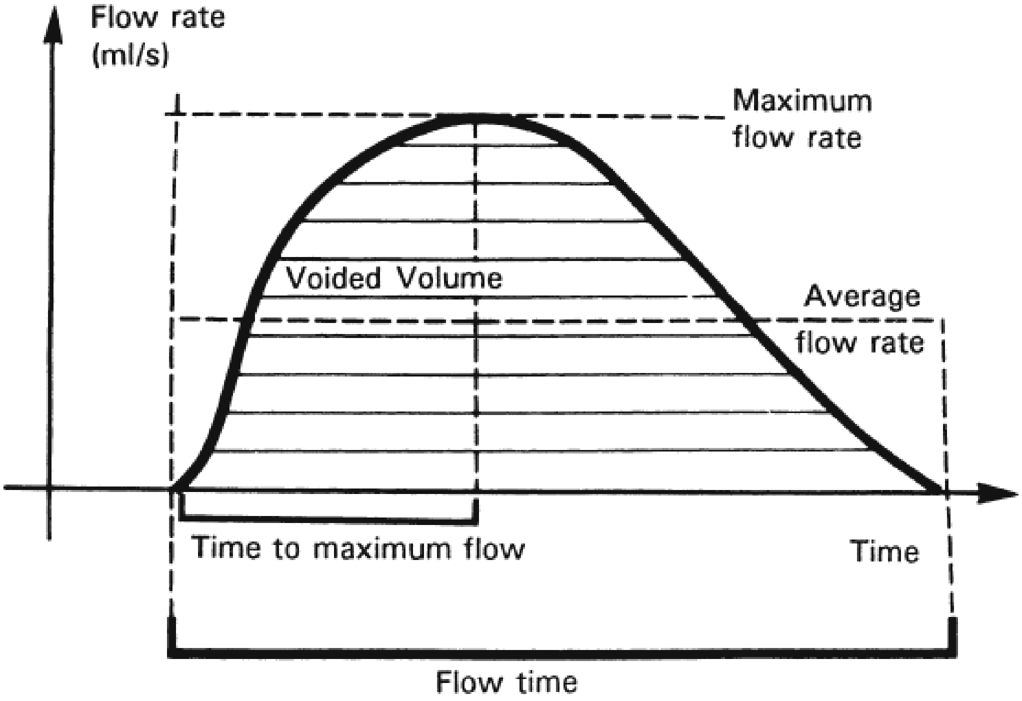


Uroflow clinic layout: The flowmeter and commode are at the foot of the couch with the ultrasound machine at the head of the bed.

Good Urodynamic practices[42]

Adequate privacy should be provided and patients should be asked to void when they feel a “normal” desire to void. Patients should be asked if their voiding was representative of their usual voiding and their view should be documented. Automated data analysis must be verified by inspection of the flow curve, artifacts must be excluded, and verification must be documented. The results from uroflowmetry should be compared with the data from the patient’s own recording on a frequency/volume chart. Sonographic estimation of post-void residual volume completes the noninvasive assessment of voiding function

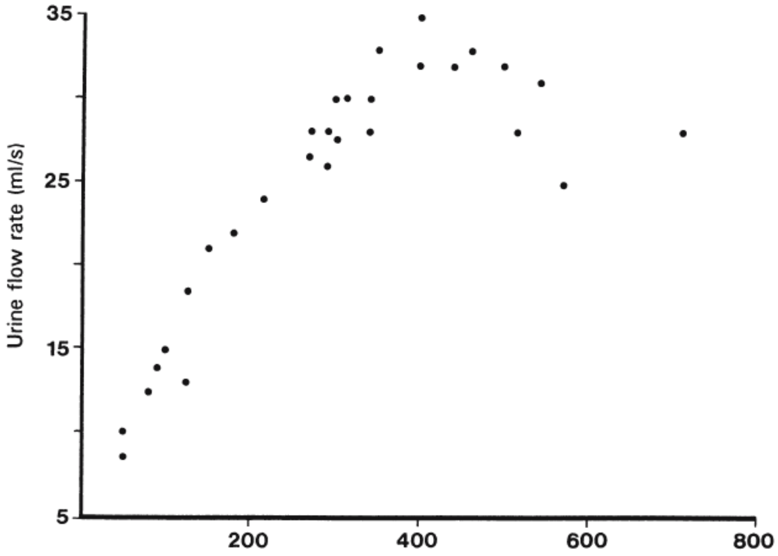
Normal flow



Terminology relating to the description of urinary flow (International Continence society report, 1988)

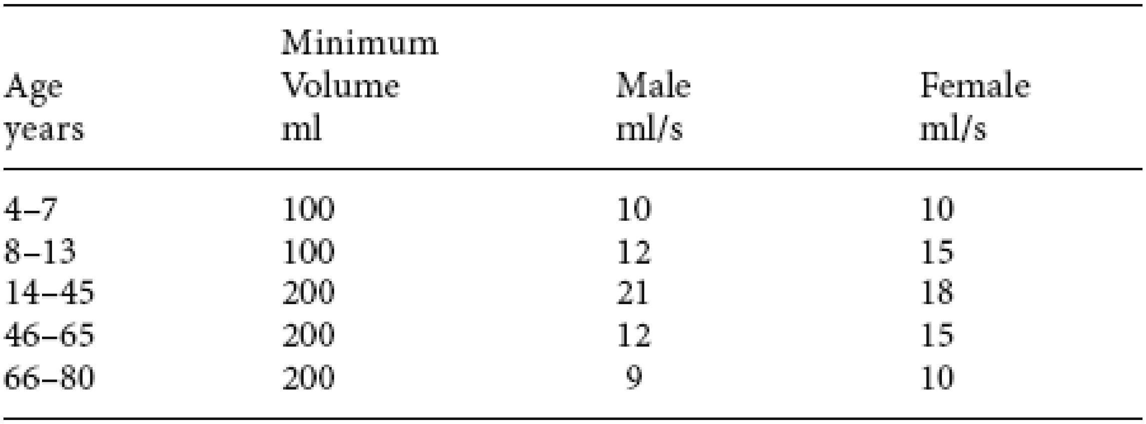
When considering the normality of flow rates, the patient's age and sex and the voided volume should be taken into account. In addition to the numerical data derived from any flow trace, the shape of the trace is also important.

In *normal flow*, the flow curve has a "bell" shape. Maximum flow is reached in the first 30% of any trace and within 5 seconds from the start of flow. The flow rate varies according to the volume voided



Maximum flow rate plotted against the volume voided for a large number of voids in one individual normal case.

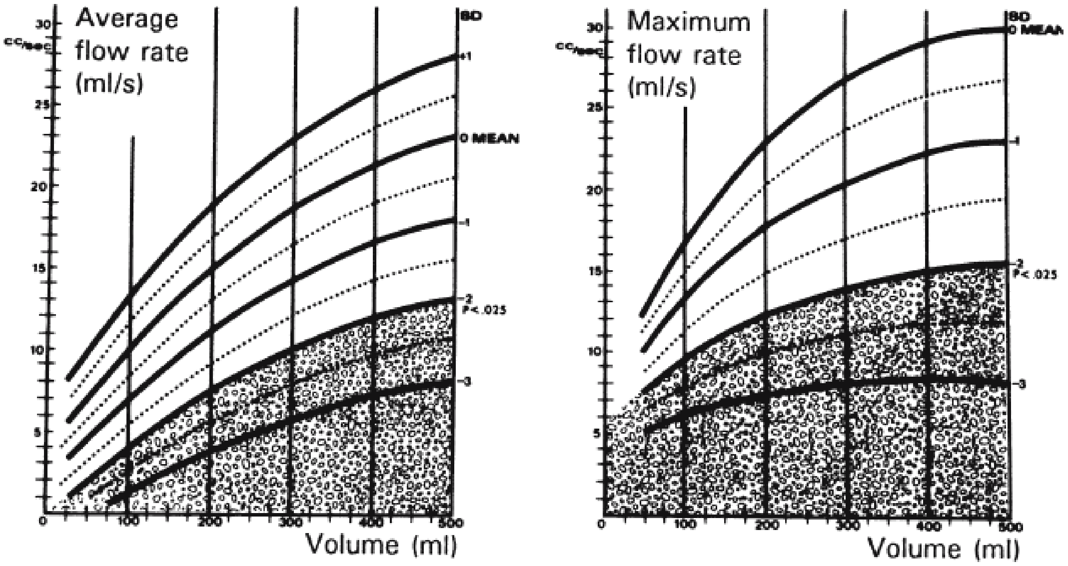
At more than 400 ml, the efficiency of the detrusor begins to decrease and *Q*max is lower. Flow rates are highest and most predictable in the volume range between 200 ml and 400 ml.



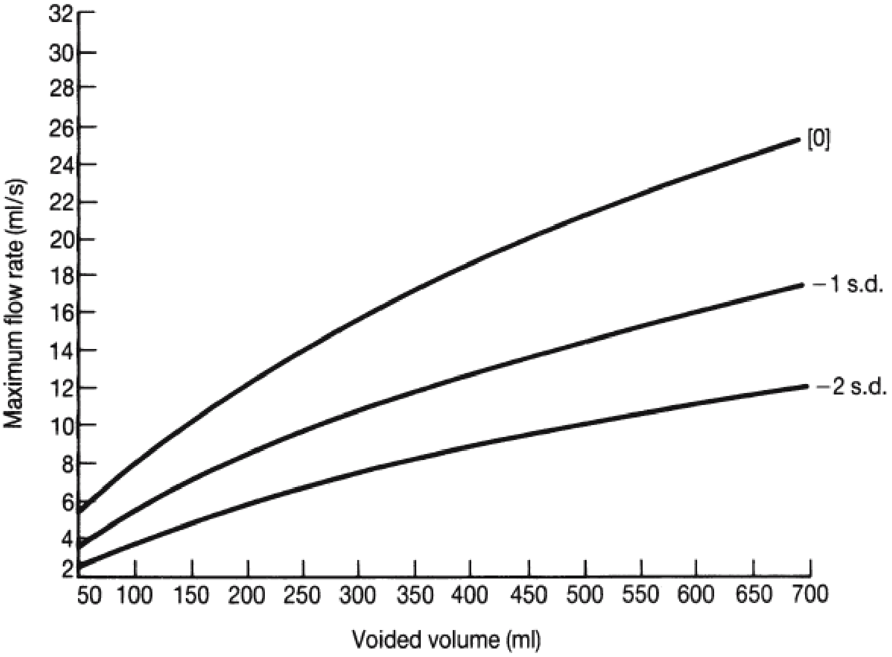
Age years	Minimum Volume ml	Male ml/s	Female ml/s
4–7	100	10	10
8–13	100	12	15
14–45	200	21	18
46–65	200	12	15
66–80	200	9	10

Lowest acceptable maximum urine flow rates according to age and sex for minimum voided volumes

A variety of nomograms are available and these relate maximum flow rate to voided volume taking sex and age into account.



Siroky normogram for men under 55 years (Siroky et al. 1979)[43]

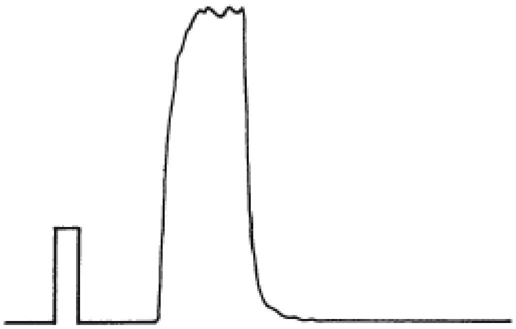


Bristol normogram for men over 55 years

Various authorities have produced such nomograms, including Von Garrelts 1958); Backman (1965); Gierup (1970); Siroky et al (1979); Kadow et al (1985) and Haylen (1990).

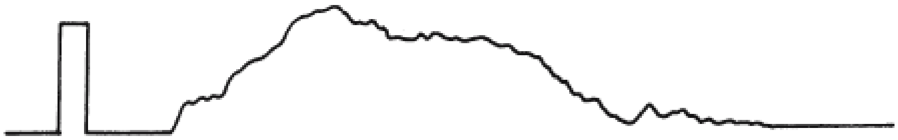
Abnormal flow patterns

Urine flow results from the interaction between the expressive forces (detrusor contraction plus any abdominal straining) and urethral resistance. Hence urine flow rates have limitations which must be appreciated. In free uroflowmetry, the shape of the flow curve may suggest specific types of abnormality, but reliable, specific, and detailed information about the cause for abnormal voiding cannot be derived from a flow curve alone. Only when uroflowmetry is combined with intravesical and abdominal pressure recordings does it become possible, from the pressure—flow relationship, to analyze separately the contributions of detrusor contractility and bladder outlet function to the overall voiding pattern.



Detrusor overactivity

Bladder outlet obstruction



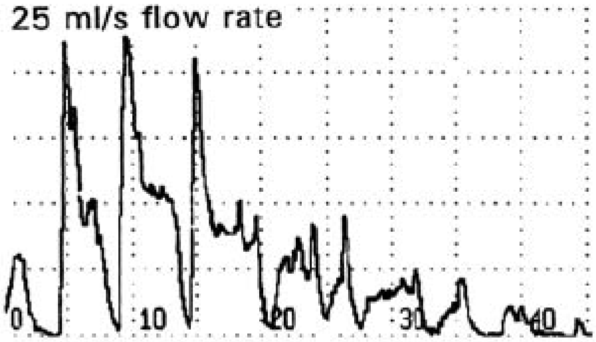
Detrusor underactivity

Straining

Fluctuating detrusor contraction

Irregular trace secondary to Artefacts

"Cruising" caused by a man moving his stream in relation to the central exit from the collecting funnel



"Squeezing" due to patient intermittently compressing the end of his penis during voids

Recommendations for Uroflowmetry

In order to facilitate the recording of urine flow rate and pattern recognition of flow curves, it is recommended that graphical scaling should be standardized as follows:

● One millimeter should equal 1 s on the x-axis and 1 ml/s and 10 ml voided volume on the y-axis.

With respect to the technical accuracy of uroflowmeters, it is meaningful for routine clinical measurements to read flowrate values only to the nearest full ml/s and volumes to the nearest 10 ml.

In order to make electronically-read Qmax values more reliable, comparable, and clinically useful, we recommend internal electronic smoothing of the flow rate curve.

It is recommended that:

● A sliding average over 2 s should be used to remove positive and negative spike artifacts. If curves are smoothed by hand, the same concept should be applied. When reading Qmax graphically, the line should be smoothed by eye into a continuous curve so that in each period of 2 s, there are no rapid changes. Such a smoothed, clinically-meaningful maximum free flow Qmax will be different (lower) from the peak value in the flow rate recording of electronic instruments currently available.

It is recommended that:

● Only flow rate values, which have been 'smoothed', either electronically or manually, should be reported.

If a maximum flow value is determined electronically by simple signal peak detection without the recommended electronic smoothing, it should be labeled differently, Qmax.raw. Such raw data has meaning only if a detailed specification of the type of flowmeter used is given. The interpretation of any dynamic variation (signal patterns) in free flow will rely on personal experience, can be only descriptive, and in general will remain speculative.

For the documentation of the results of uroflowmetry, the following recommendations are made:

- Maximum (smoothed) urine flow rate should be rounded to the nearest whole number (a recording of 10.25 ml/s would be recorded as 10 ml/s);
- Voided volume and post void residual volume should be rounded to the nearest 10 ml (a recording of a voided volume of 342 ml would be recorded as 340 ml);
- The maximum flow rate should always be documented together with voided volume and post void residual volume using a standard format: VOID: Maximum Flow Rate/ Volume Voided/Post Void Residual Volume.
- If a flow/volume nomogram is used, this should be stated and referenced.

Uroflowmetry in men

Uroflow in groups of normal younger men was primarily described one to two decades ago[44, 45, 46, 47, , 48, 49, 50, 51]. From these studies on younger normal persons, one can deduce that Qmax declines 1 to 2 ml/s/5 years and to a certain degree depends on the voided volume. Some agreement exists about normality, because Qmax greater than 15 ml/s is considered normal, whereas Qmax less than 10 ml/s is considered abnormal. Gammelgaard[51] described a decline in Qmax from 35 ml/s at the age of 14 years to 15 to 20 ml/s at the age of 50 years. Siroky and Krane[53] found that the normal voided volume in young men was 250 ml +/- 100 ml. From the papers of Chancellor et al[2], Cucchi[54], Jorgensen et al[55], and Susset[56] it can be concluded that acceleration in young men is 3.21 ml/s/s and that it, as well as other flow variables, declines as a person grows older. Adding acceleration to the other flow variables, however, does not alter the fact that it is not possible to differentiate detrusor dysfunction from bladder outlet obstruction on the basis of uroflowmetry.

Studies of populations of normal men over the age of 50 years[57, 58, 59, 60, 61, 62, 63, 64, 65, 66] show that Qmax declines when compared with younger men and varies between 11.8 and 36 ml/s with a median value between 12.6 and 20.1 ml/s and voided volumes of 150 to 200 ml. According to Jorgensen et al[64, 65], median Qmax reaches 10.5 ml/s at the age of 50 years versus 5.5 ml/s at the age of 80 years. Furthermore only 50% voided more than 200 ml. Forty percent to 50% of the flow curves were normal at the age of 50 years, versus only 10% at the age of 80 years.

Over the years many studies have been performed based on patients with different degrees of prostatism. From these investigations one can conclude that Qmax declines with advancing age. Residual urine increases but not as a direct consequence of the declining Qmax. Several nomograms of the Qmax/volume relation have been constructed[43, 65, 67, 68] but the only true nomogram is a three-dimensional Qmax/volume/age nomogram. The clinical relevance of Qmax-nomograms is limited, however, because differentiation between normal and abnormal voiding in elderly men is almost impossible on the basis of uroflowmetry. Further, the diagnosis of infravesical obstruction per se does not predict risk of detrusor or renal impairment in patients suffering from benign prostatic hyperplasia. Flow-curve patterns seem to have some prognostic value with regard to the need for surgery, but they fail to differentiate between the obstructed and unobstructed bladder outlet[69].

It is widely accepted that in patients with relative indications for prostatectomy, both symptoms and urodynamic evaluation should be considered. To demonstrate preoperative infravesical obstruction, one has to perform pressure-flow studies. From a realistic point of view, however, it appears justified to restrict pressure-flow studies to benign prostatic hyperplasia patients with Qmax over 10 ml/s. This approach would direct the need for full urodynamic investigation in 40% of benign prostatic hyperplasia patients with relative indications for treatment. Only 12% of these would require surgery for obstruction[70].

Uroflowmetry is an easily performed non-invasive investigation. It describes voiding disabilities objectively and the shape of the curve may even give some hints as to the cause of the disability. Two or more measurements should be performed and the investigation should be supplemented by adding information about residual urine and by keeping a voiding diary.

Uroflowmetry in women

Uroflowmetry in women is characterized by the shorter urethra and no resistance, such as that caused by the prostate gland in the male. Thus, the only factor influencing normal female uroflow is the voluntary part of the sphincteric mechanism. Normal uroflow is described only briefly in the literature[72, 73, 74, 75. 76]. Thus, one can conclude that in the normal uroflow in women Qmax reaches 20 to 36 ml/s. The flow curve is bell shaped, but flowtime is shorter than in men. Qmax is not dependent on age.

Pregnancy does not seem to influence uroflow, but stress incontinence does seem to decrease Qmax, although the shape of the curve is more characteristic, resembling curves from men with lower urinary tract symptoms. Urodynamic investigation, as a part of preoperative evaluation of women with incontinence, has been shown to improve cure rate[77].

In conclusion, the value of uroflowmetry in women is of some significance. The investigation is easy to perform and is a natural part of a urodynamic evaluation. If combined with a voiding diary it may give valuable hints as to further examinations needed to guide the most appropriate treatment.

Uroflowmetry in children

Urodynamics for years has had a well-established place in evaluating lower urinary tract dysfunction in children[78]. Especially uroflowmetry (Qmax) has been advocated in screening and posttreatment control owing to its simplicity and noninvasiveness. Several studies on uroflowmetry variables[79, 80] have correlated flow variables with voiding volumes in both sexes and with age or body surface area. Interestingly, it was shown that in more than 90% of children the flow-curve patterns were identical to those of the normal adult bell-shaped flow curve. In the screening for functional infravesical obstruction or detrusor-sphincter dyssynergia in neurologically normal children, uroflowmetry proved inefficient as a single modality, whereas the combination of uroflowmetry with pressure-flow electromyogram study and residual urine measurement yielded a consistent diagnosis, the incidence being approximately 20%[78, 80].

Uroflowmetry as a single modality has only modest value in pediatric urology except in screening for occult voiding dysfunction. In a comprehensive study on nocturnal monosymptomatic enuresis[81], it was shown that micturition disorders are not present in this disease entity. Similarly in children with vesicoureteral reflux, the cornerstone is not uroflowmetry but sophisticated overnight studies with monitoring of the bladder pressure[82]. In the evaluation of patients with neurogenic bladder dysfunction, cystometry and 24-hour ambulatory urodynamic studies are preferable with special emphasis on the bladder leakpoint pressure as a predictor of risk of impairment of upper urinary tract[83, 84].

Post void residue

Postvoid residual (PVR) urine is the volume of fluid remaining in the bladder immediately after the completion of micturition. Studies indicate that PVR urine normally ranges from 0.09 to 2.24 ml, with the mean being 0.53 ml[85]. Seventy-eight percent of normal men have PVRs of less than 5 ml, and 100% have volumes of less than 12 ml[86].

PVR measurement can be performed by noninvasive (ultrasound) and by invasive (catheterization) methods. The most common method is by ultrasound.

Invasive techniques are accurate if performed correctly but carry a small risk of discomfort, urethral injury, UTI, and transient bacteremia (which has not been quantified in the literature). In addition to standard diagnostic ultrasound instruments for abdominal scanning, there are much smaller, portable, and less expensive devices to measure PVR (e.g., the BladderScan). Its reported accuracy is comparable with more expensive ultrasound units and catheterization. With this device, the mean difference between estimated PVR and “true” PVR (i.e., by catheterization) was 6.9 ml in 39 measurements taken in 20 children with neurogenic bladders[88]. In 164 measurements in adult patients, the correlation coefficient was 0.79[89].

The test-retest reliability of PVR volume is poor, regardless of the techniques used. Although repeated measurements may minimize the error, this is either costly (noninvasive techniques) or uncomfortable (invasive techniques) for the patient. Birch and coworkers[90] reported that of 30 men with BPH, 66% had wide variations in PVR when three measurements were done on the same day. In 34% of patients, there was no difference among the three measurements. In 58%, at least two volumes were significantly different. In 8% of patients, all three were different. In most patients, two measurements were statistically similar whereas the third one yielded quite different results. Bruskewitz and colleagues[91] found similarly wide variations of the measured amount when they performed repetitive measurements of PVR (repeated two to five times) by in-and-out catheterization on 47 men before prostatectomy. They also found no correlation between the amount of residual urine and any cystoscopic or urodynamic findings, symptoms, or the presence or absence of a history of UTIs.

Most clinical studies demonstrate minimal correlation between PVR and baseline measurements of symptoms, flow rate, or urodynamic measures of obstruction. However, Neal and associates[92] found a significant association in 253 men between PVR, age, “below normal” Qmax, and high urethral resistance. Low voiding pressure, however, did not correlate well with PVR. The authors concluded that outflow obstruction is related to the development of increasing amounts of PVR urine. In the AUA Outcome Study, Barry and colleagues[93] found a significant correlation between high PVR and low flow rates but no correlation with IPSS.

Traditionally, urologists have assumed that increasing amounts of PVR denote BPH progression and are thus an “indication” for surgery. This concept underlies the common inclusion of PVR in each individual government's appropriateness criteria. Unfortunately, data are lacking to support the predictive value of PVR. Andersen[94] studied 104 men with BPH and reported two patterns of BPH progression. The slow course was characterized by the development of high levels of PVR that resulted in decompensation of the detrusor muscle and eventually led to urinary retention. The fast course was associated with uninhibited detrusor contractions (UDCs). The amount of PVR, the presence of UDCs, and symptoms correlated poorly in the study. Nevertheless, Andersen recommended PVR as a safety parameter when measured longitudinally throughout the clinical course of a patient with prostatic obstruction.

Jensen and coworkers[70] examined the prognostic value of PVR and 14 other clinical and urodynamic variables in relation to outcome of surgery in 120 men with clinical BPH. They found PVR the second best predictor of outcome, after pressure-flow studies. However, the combination of these two predictors did not allow the authors to correctly predict the outcome in any of 14 patients who failed treatment.

Data from the Veterans Affairs (VA) Cooperative Study Group randomized trial comparing TURP with watchful waiting demonstrated that PVR does not predict the outcome of surgery, and there was little evidence to support criteria that require a certain amount of PVR before surgery is justified. Additionally, high PVR did predict a slightly higher failure rate for watchful waiting. However, the majority of men with large residual urine volume did not require surgery during the 3-year duration of the trial. In summary, PVR is best viewed as a “safety parameter.” Men with significant PVRs should be monitored more closely if they elect nonsurgical therapy.

AIMS

Aims

The aim of this study was to compare patients' visual assessment of urinary flow with uroflowmetry.

Objectives

To compare the patients' visual assessment of urinary flow guided by the modified Brian Peeling diagram consisting of a multiple choice representation of various flow trajectories with

- Age
- Peak flow (Qmax)
- International Prostate Symptom Score (IPSS), and
- Post void residue (PVR)

Materials and methods

Materials and methods

This prospective study was conducted in the uroflow clinic of the Urology department. The study design and methodology was approved by the Ethics Committee and the Institutional Review Board. All patients were explained the nature of the study and an informed consent in the patient's own language was obtained.

Adult males, 18 years of age and older with lower urinary tract symptoms (LUTS) attending the uroflow clinic at the department of Urology were recruited. Patients were asked to fill the IPSS questionnaire and answer a multiple choice pictorial representation of flow trajectory. This was done immediately before performing the uroflowmetry.

The flow protocol was unchanged from our standard practice. Uroflowmetry was carried out in a lockable toilet with auto start to remove dependence on the operator. Patients were asked not to strain or waggle their stream. The Dantec Urodyn 1000 rotating disk model was used after calibration. The index test was interpreted independently of the reference standard and without knowledge of the results. The uroflowmetry traces (reference standard) were assessed by an experienced observer to determine the ''true" Qmax taking into account "wag" and "straining" artefacts. Those unable to produce a flow volume of > 150ml were excluded.

Immediately following the uroflowmetry, post void residue (PVR) was measured using transabdominal ultrasonography.

Statistical methods:

A pilot study was conducted with 25 educated patients. The correlation between patients' visual assessment of flow and the measured peak flow (Qmax) was calculated. The pearson's correlation coefficient was found to be 0.81. A sample size of 60 was calculated for a power of 90% and an α error of 5%. A total of 100 patients were studied.

Formula for calculating sample size:

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\left[\frac{1}{2}\ln\left(\frac{1+r_1}{1-r_1}\right) - \frac{1}{2}\ln\left(\frac{1+r_0}{1-r_0}\right)\right]^2}$$

α= significance level

1-β= power of study

r1= sample correlation coefficient

r0= population correlation coefficient

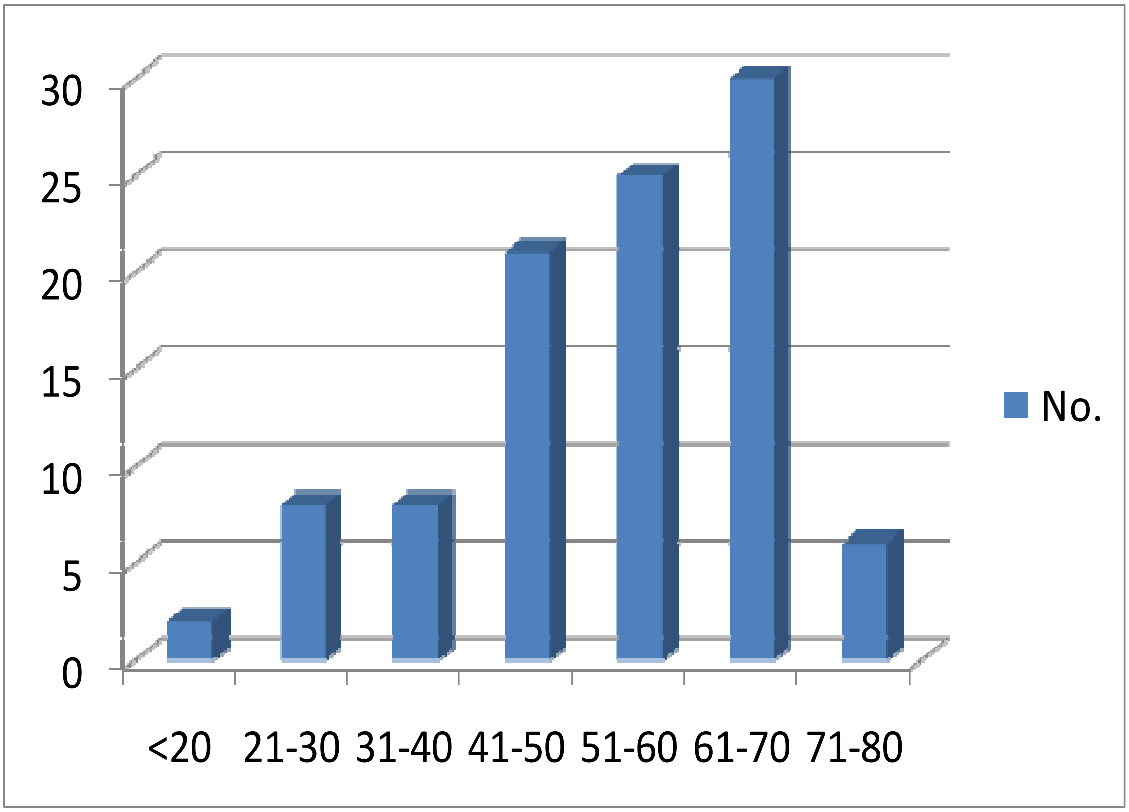
Statistical analysis:

Descriptive statistics were obtained to summarise all study variables. Relationship between patients' visual assessment and uroflowmetry was obtained using spearman's correlation. The presence and frequency of various lower urinary tract symptoms were recorded using the IPSS. The test results were compared with each of these symptoms to look for any correlation using spearman's correlation. The significance of correlation between patients' history and visual flow scores was determined using the Pearson chi-square test.

RESULTS

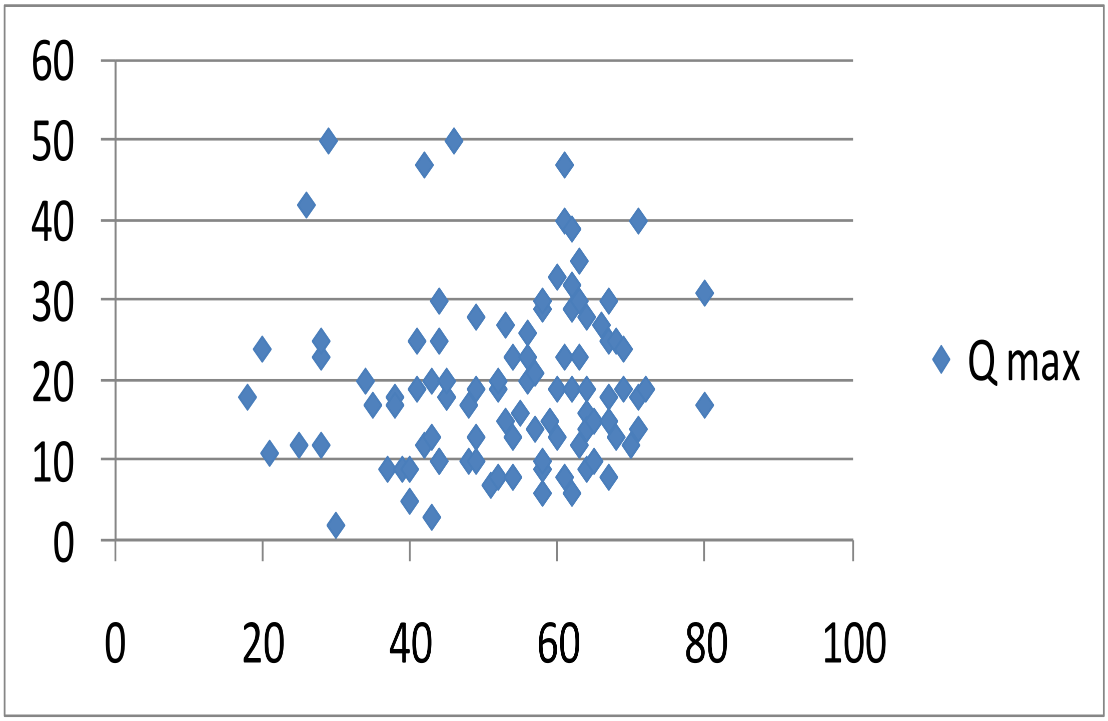
Results

General demographics



A total of 100 patients were studied. The mean age of patients was 53 years. The median age was 56 years with a standard deviation of 13.78. Majority of the patients were over 50 years of age.

Correlation with age



There was an inverse correlation between age and Peak flow (Qmax) measured by the uroflowmeter. This was found to be significant ($p < 0.01$). However, eventhough there was an inverse correlation between Visual flow analogues marked by the patients and age, it was not significant ($p = 0.05$).

Correlation with history

Poor flow (n)	Visual analogue	%	p
YES (69)	≤ 3	82.5	<0.001
NO (29)	≥ 4	70	

Of the 100 patients in this study, 69 gave history of poor flow. Majority (82.5%) in this group marked visual flow analogues of 3 or less.

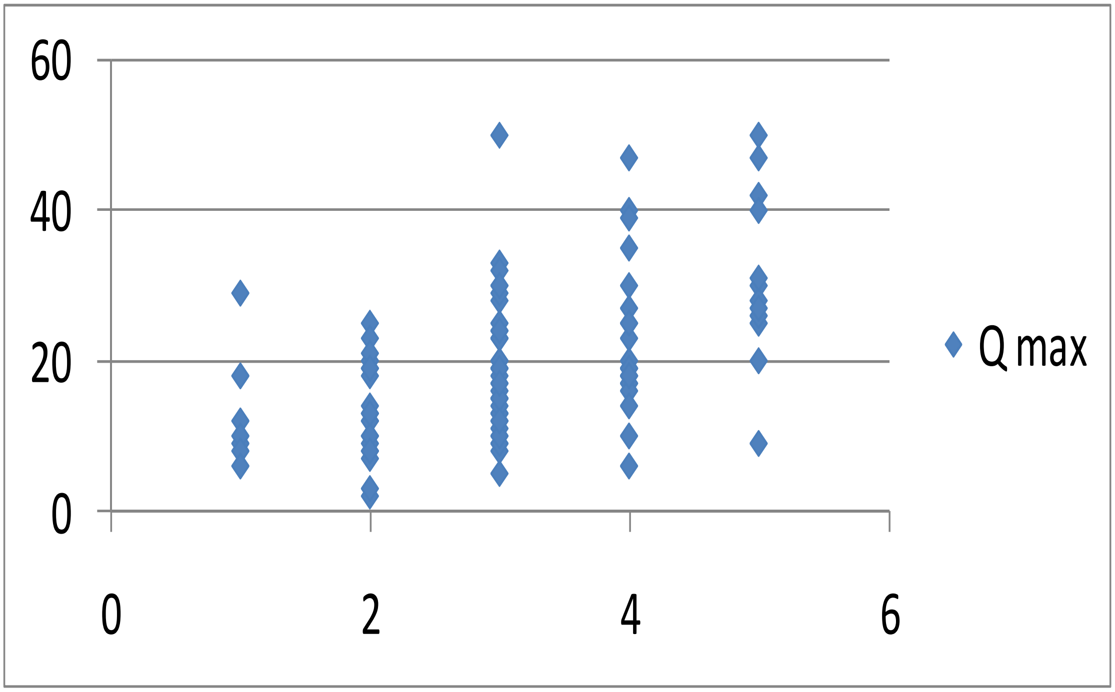
Majority (70%) of the remaining 29 patients who did not have poor flow historically marked visual analogues of 4 or more. This difference was found to statistically significant ($p < 0.01$)

Duration of symptoms

	n	Visual analogue	%	p
Is flow diminished compared to 10 years ago	**YES (64)**	**≤ 3**	**80**	**<0.001**
	NO (21)	**≥ 4**	**55**	

Of the 100 patients studied, 64 had perceived a decrease in flow within the past 10 years and 80% in this group marked visual analogues of 3 or less. However those who didn't perceive any change in flow within the past 10 years marked visual analogues of 4 or more. This difference was statistically significant ($p < 0.01$)

Correlation with peak flow



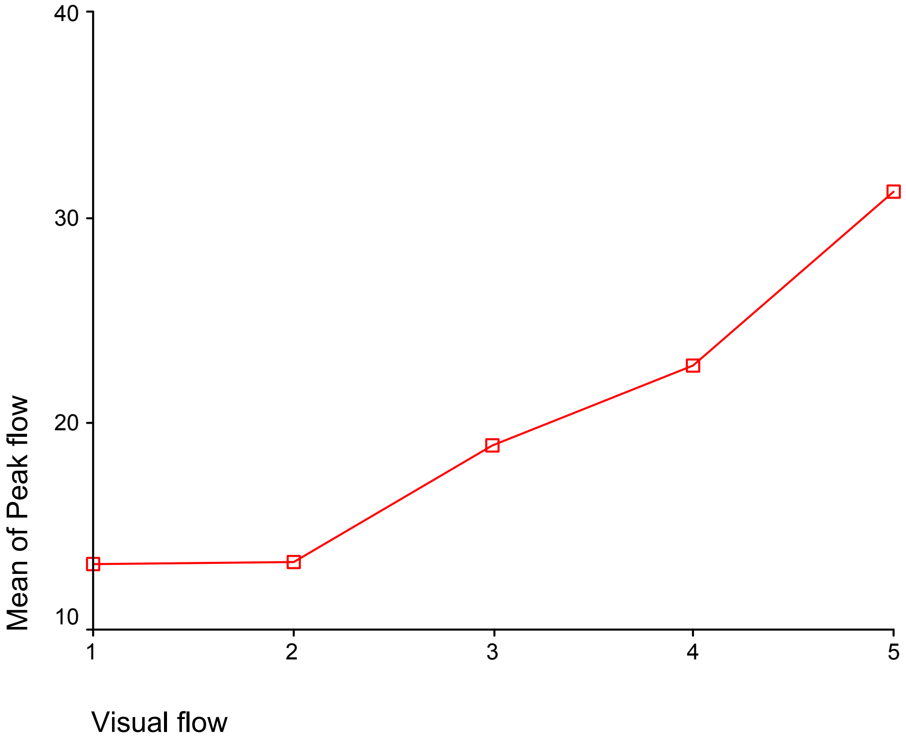
There was a significant correlation between between visual flow analogues and Qmax ($p < 0.01$). This correlation was found to be stronger in those who gave history of poor flow ($p < 0.01$) compared to those with a negative history ($p < 0.05$).

Visual analogue and Qmax

Visual analogue	Mean Q max (ml/s)	Standard deviation
1	13.14	7.96
2	13.30	6.47
3	18.92	8.79
4	22.83	10.06
5	31.25	11.71

This table shows the calculated mean Qmax value representative of each visual flow analogue score along with their standard deviations.

Visual analogue and Qmax



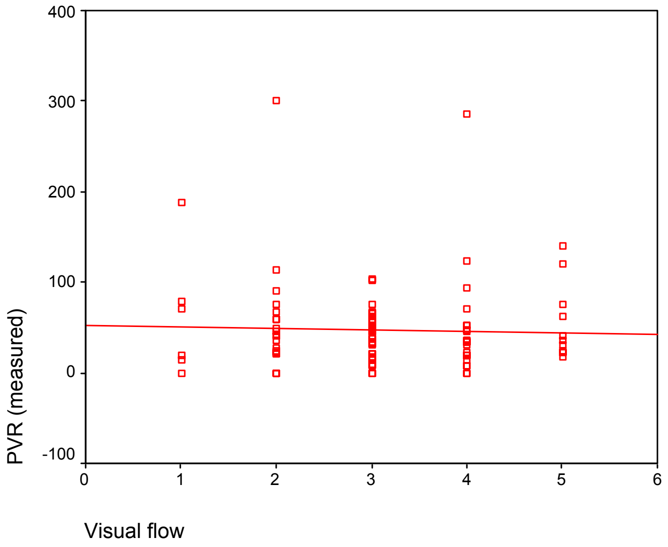
The difference between the mean Qmax values calculated for each visual analogue score was found to be significant ($p < 0.01$). However, there was considerable overlap between the values especially for Visual analogue scores 1 and 2. The Pearson correlation coefficient r is 0.50.

Correlation with IPSS

IPSS	**p**
Weak stream	< 0.003
Incomplete emptying	< 0.001
Total IPSS	< 0.002
QOL	< 0.001

Visual flow analogues had a significant inverse correlation with weak stream, incomplete emptying and total IPSS. Quality of life (QOL) scores also showed significant correlation with visual analogue scoring.

Correlation with PVR



There was an inverse relation between Visual flow analogues and PVR. However this correlation was weak and statistically insignificant.

Visual analogue	Mean PVR (ml)	p
≤ 3	50	No significance
≥ 4	46	

Role of education

Education	p
1-5 std	No significance
6-12 std	< 0.01
Graduate	< 0.01

The correlation between visual analogue scores and Qmax was significant in those who had received high school education or higher.

DISCUSSION

Discussion

This study compares measured maximum flow rates (Qmax) with patients' visual assessment of flow using a multiple choice pictorial representation of flow trajectory[5]. The Visual analogue scores marked by patients were also compared with their responses to 2 questions about the strength of their flow 1) do you have poor flow? 2) Is your flow diminished compared to 10 years ago?

We found that there was significant correlation between history and visual analogue scoring. 82.5% of those who gave history of poor flow marked flow analogues of 3 or less and 80% of patients who noticed a decrease in flow within the past 10 years also marked flow analogues of 3 or less. The corresponding Qmax values for visual analogues 1, 2 and 3 were calculated to be 13.14, 13.30 and 18.92 ml/s respectively. In general, patients seemed to underestimate their flows.

Scott and coworkers[95] and Shoukry and associates[96] found that Qmax correlated better than symptoms with the presence or absence of obstruction as determined by pressure-flow studies. Abrams and associates[57] studied the value of uroflowmetry before prostatectomy. Failure rates for surgery were found to decrease with the addition of flow rate measurement to symptom assessment in preoperative evaluation. Qmax appears to predict surgical outcome in some studies. In a study by Jensen et al, which included men studied with flow rates before and 6 months after prostatectomy[97], subjective evaluation revealed an overall symptomatic improvement rate of 80% after surgery. The difference in success rates for men falling above or below the cutoff value of Qmax = 10 mL/s was not significant (p = 0.2). When a Qmax cutoff of 15 mL/s was used, success rates for men above or below the cutoff value differed significantly. Hence, if a Qmax of > 15 ml/s were to represent unobstructed flow, in our study, patients who marked visual analogues of 1 and 2, lay below this cut off.

This study fails to show Visual Uroflowmetry as a reliable estimator of poor flow when correlated with measured Qmax. The Pearson correlation coefficient r was 0.05. The low p value (< 0.01) represents a statistically significant difference in the measured mean Qmax representing each visual analogue but hides the fact that there is considerable overlap between values. For example, the patients who marked a visual analogue of 1 had a mean Qmax value of 13.14, a standard deviation of 7.96, and a maximum value of 26 and a minimum value of 6. The reasons for this wide variation in patients' assessment may be manifold. The symptoms of obstruction have a slow onset and the patient's memory of what a good flow is like may be blurred. Furthermore, Golomb et al[98] have demonstrated significant circadian variations which were more marked in the group with symptomatic bladder outlet obstruction than in the control group, so the patient might not have an impression of typical flow strength.

The severity of patients' symptoms is still an important factor in determining whether to perform a prostatectomy. The International Prostate Symptom Score (IPSS), which is identical to the AUA Symptom Index, is recommended as the symptom scoring instrument to be used for the baseline assessment of symptom severity in men presenting with LUTS[1, 87.] Diokno et al[99] found little correlation between severity of symptoms and urodynamic finding. Anderson et al[94] found that the only symptom that correlated with a urodynamic finding was the sense of incomplete emptying which correlated with residual volume. Interestingly, in our study, we found significant correlation between visual analogue scores and all the voiding symptoms represented in the IPSS including incomplete emptying. However, when visual analogues were compared with measured PVR, even though there was an inverse correlation, it was not statistically significant.

Most clinical studies demonstrate minimal correlation between PVR and baseline measurements of symptoms, flow rate, or urodynamic measures of obstruction[96]. However, Neal and associates[92] found a significant association in 253 men between PVR, age, “below normal” Qmax, and high urethral resistance. Low voiding pressure, however, did not correlate well with PVR. The authors concluded that outflow obstruction is related to the development of increasing amounts of PVR urine. In the AUA Outcome Study, Barry and colleagues[92] found a significant correlation between high PVR and low flow rates but no correlation with IPSS.

We also studied whether the level of education of a patient had any bearing on the correlation between visual flow and Qmax. It was interesting to note that the correlation actually improved with level of education. This may reflect a higher degree of awareness amongst the educated, better ability to understand instructions and reproduce a more accurate representation of their flow. Though visual uroflowmetry was developed keeping in mind a population unable to afford uroflowmetry, prevalence of illiteracy in our rural population is a significant handicap which may prevent effective utilization of this tool.

The motivation for this study has been the knowledge that a significant number of prostate resections are still done without access to uroflowmetry. Lloyd and Kirk[4] surveyed 46 respondents performing prostatectomy in Scotland of whom 33 were urologists and 15 were general surgeons: 36 had access to uroflowmetry, 13 used it with all patients, and 14 used it frequently and 9 occasionally. 10 had no access to uroflowmetry. The situation in a developing country like ours may actually be much worse where the prohibitive cost of setting up a uroflowmetry clinic and the perceived lack of clinical utility of such an investigation prior to prostatectomy may contribute to the frugality of its use.

In conclusion, our study shows that Visual Uroflowmetry had significant correlation with patient's history, Qmax, voiding symptoms of the IPSS and QOL scores. Though it is not reliable enough to replace conventional uroflowmetry, it objectively quantifies a patient's perception of his flow. It is a rapid and inexpensive tool which can be used to screen patients with LUTS. Further large scale studies are required to validate this tool and explore its use for follow up of patients following medical/ surgical therapy.

Strengths and limitations of this study

This study was conducted in a preselect patient population i.e. adult males with LUTS attending the Uroflow clinic. Hence the results of this study cannot be extrapolated to the general population.

Many Indian men squat to void. The Brian Peeling diagram[5] shows various flow trajectories of a patient voiding in the standing position and may not have been relevant to many in the patient population studied. Flow trajectories have been depicted assuming a horizontal holding position of the penis. However, it is unlikely that all the patients in our study practiced a uniform holding position of the penis during micturition and the impact this had on assessment of flow trajectory is difficult to assess.

The International Consensus Committee on BPH recommends obtaining at least 2 flow rate recordings each ideally with a voided volume of greater than 150 ml to improve the validity of the test[100]. Our study was based on a single uroflow recording and may not be representative of the patient's actual flow. We excluded all patients who were unable to void more than 150 ml. A number of patients who are not able to void a sufficient volume may have severe obstruction and are more likely to need quantification of symptoms prior to intervention.

The introduction of electronically read flow variables has introduced pitfalls in the evaluation of uroflowmetry results. The mictiograph reads the absolute maximum value uncritically, while observers evaluate the curve and neglect insignificant spikes or obvious artifacts. These spikes often are caused by the person directing the flow to different parts of the mictiograph funnel (the wag artifact). Urodynamically trained staff thus disagree with the electronic evaluation presented. The median difference in the maximum flow rate (Qmax) readings was shown to be 18.5% and was most pronounced in flow curves of abnormal shape and with low Qmax. In our study, even though all the uroflow traces were interpreted by a single experienced urologist, it may not have been representative of the patient's actual flow.

The sample size of this study was calculated by a pilot study of 25 educated patients not representative of the population of patients studied. Hence further studies with larger sample size need to be conducted before visual uroflowmetry can be validated as a screening tool.

CONCLUSIONS

Conclusions

In conclusion, self assessment of urinary flow using Visual Uroflowmetry showed significant correlation with peak flow, total IPSS and voiding symptoms in the IPSS like weak stream and incomplete emptying. Significant correlation was also seen between patients' assessment of flow and QOL as marked in the IPSS. The correlation between visual analogues and Qmax improved with level of education. Hence Visual uroflowmetry may be used as a rapid and inexpensive tool for screening patients with LUTS.

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Annexure

Informed consent document

The department of urology at CMC, Vellore is conducting a study on uroflowmetry. Uroflowmetry involves the electronic recording of the urinary flow rate throughout the course of micturition. It is a common test used in the diagnostic evaluation of patients presenting with symptoms of bladder outlet obstruction. An abnormally low flow rate may be caused by an obstruction due to enlargement of the prostate, urethral stricture or due to poor function of the bladder. However, uroflowmetry is expensive, time consuming and may not be available everywhere. The main purpose of this study is to see whether a patient's self assessment of urinary flow strength is comparable with uroflowmetry.

If you agree to participate in this study, a doctor/ nurse will ask you to fill a questionnaire which will score your urinary symptoms. You will also have to choose a flow pattern which closely resembles your own from a multiple choice pictorial representation of flow trajectory. This will be followed by measurement of your flow rate using the uroflowmeter.

Your decision not to participate in this study will not affect the care you will receive at the clinic in any way. Even if you do agree to become a study participant, you can withdraw from the study at any time (verbally) without affecting the care that you will receive. The study is unlikely to expose you to any risk or cause you discomfort.

There will be no immediate benefits from your participation in this study. If the study results are acceptable in terms of accuracy, it will provide a cheap and rapid method to screen patients with urinary symptoms coming to the clinic. There will be no monetary compensation for this study, but routine medical consultation and appropriate referral services will be available.

The records concerning your participation are to be used only for the purpose of this research project. Any information obtained in connection with this study will be kept strictly confidential. Only members of the study team will have access to information. You can withdraw from the study at any time without affecting your present or future medical care at the clinic.

When the researchers have analysed the data, the results and the explanation of its implications will be published for everyone's information. The identity of the participants will not be revealed.

All study related queries and problems if any should be communicated to
Dr. NIRMAL T.J, DEPARTMENT OF UROLOGY, CMC, VELLORE. Tel: 0416-2282111.

Informed consent

Study Title: Comparison of patients' assessment of urinary flow strength with uroflowmetry

Study Number:
Subject's Initials: _________ Subject's Name: ________
Date of Birth / Age:_______
Please initial box
(Subject)
(i) I confirm that I have read and understood the information sheet dated _________ for the above study and have had the opportunity to ask questions. [ ]
(ii) I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. [ ]
(iii) I understand that the members of the research team, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published. [ ]
(iv) I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s) [ ]
(v) I agree to take part in the above study. [ ]

Signature (or Thumb impression) of the Subject/Legally Acceptable Representative:_____________
Date: _____/_____/______
Signatory's Name: _________________________________

Signature of the Investigator: ________________________
Date: _____/_____/______
Study Investigator's Name: _________________________

Signature of the Witness: ___________________________
Date:_____/_____/_______
Name of the Witness: ______________________________

Questionnaire

Name:

Hospital no:

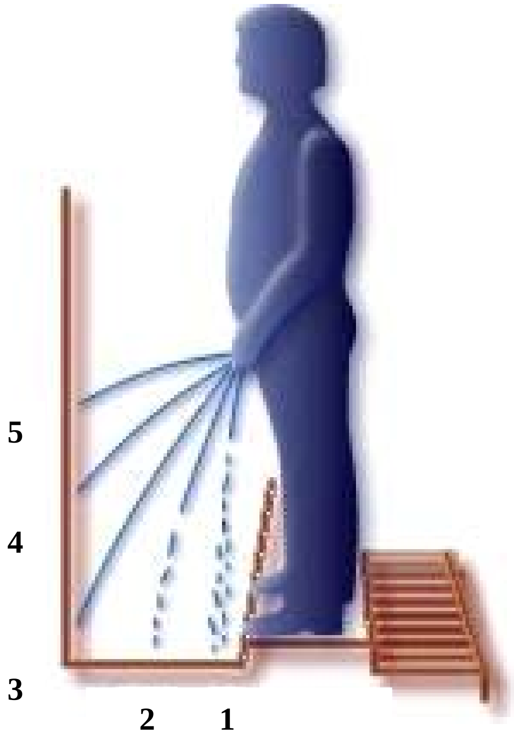
Age:

Education: (1) 1-5 std (2) 6-12 std (3) Graduate (4) Post graduate

Poor flow: YES / NO

Is the force of your flow diminished compared to 10 years ago: YES / NO

Post void residue: YES / NO



IPSS - International prostate symptom score

Name:　　　　　　　　　　　　　　　　　　　　Date:

	Not at all	Less than 1 time in 5	Less than half the	About half the time	More than half the	Almost always	**Your score**
Incomplete emptying Over the past month, how often have you had a sensation of not emptying your bladder completely after you finish urinating?	0	1	2	3	4	5	
Frequency Over the past month, how often have you had to urinate again less than two hours after you finished urinating?	0	1	2	3	4	5	
Intermittency Over the past month, how often have you found you stopped and started again several times when you urinated?	0	1	2	3	4	5	
Urgency Over the last month, how difficult have you found it to postpone urination?	0	1	2	3	4	5	
Weak stream Over the past month, how often have you had a weak urinary stream?	0	1	2	3	4	5	
Straining Over the past month, how often have you had to push or strain to begin urination?	0	1	2	3	4	5	

	None	1 time	2 times	3 times	4 times	5 times or more	**Your score**
Nocturia Over the past month, many times did you most typically get up to urinate from the time you went to bed until the time you got up in the morning?	0	1	2	3	4	5	

Total IPSS score	

Quality of life due to urinary symptoms	Delighted	Pleased	Mostly satisfied	Mixed – about equally satisfied and dissatisfied	Mostly dissatisfied	Unhappy	Terrible
If you were to spend the rest of your life with your urinary condition the way it is now, how would you feel about that?	0	1	2	3	4	5	6

Total score: 0-7 Mildly symptomatic; 8-19 moderately symptomatic; 20-35 severely symptomatic.

Master Data Sheet

Sno	Name	Hospno	Age	Education	Flowsubj	Duration	PVRsubj	Visflow	Peakflow	Meanflow	Voidtime	Flowtime	Timepeak
1	Narayan Acharya	525637D	49	1	1	1	2	2	18	12	48	41	5
2	Maria Gregory	503336D	43	2	1	1	1	3	24	14	72	72	19
3	Radhir Prasad	525401D	56	4	1	1		3	11	6	65	65	5
4	Nirmal Das	504876D	26	2	1	1	1	2	12	8	85	49	19
5	Sheik Shamsheer	485167D	44	1	2	2	2	5	42	21	31	31	2
6	Devapalan	740169B	65	3	1	1	1	3	12	6	79	74	19
7	Rathindra Nath	525449D	58	4	1	1	1	3	23	16	29	28	13
8	Sapan Sahoo	524419D	55	2	1	1	2	2	25	14	25	25	8
9	Indranath Lahiri	490421D	39	3	2	2	1	3	50	27	72	25	2
10	Motilal	446597C	54	3	1	1	1	2	2	4	116	63	0
11	Pradip Kumar	903977C	59	3	2	2	2	5	20	13	44	43	21
12	Ranganathan	505776D	67	2	2	1	1	3	17	14	15	15	5
13	Merajuddin	520948D	44	1				5	9	3	175	166	127
14	Saran Kumar	39556D	49		1	2		1	18	9	77	32	15
15	Venkatesan	081514D	69		2	2	1	4	17	7	28	28	15
16	Renugopal	939903B	62	1	1	1	1	3	9	3	71	58	2
17	Rabindra Nath Da	523792D	69	3	2	2	2	3	5	3	81	79	7
18	Gauranga Chandr	524873D	64	2	1	1	1	1	9	4	227	130	18
19	Partha Gupta	516672D	20	2	2	2	2	4	25	15	36	36	9
20	Shib Nath	525502D	54				2	4	19	14	37	37	11
21	Shambu Nath	377766D	56	3	2			4	47	22	21	21	9
22	Murugan	515655D	43	2	1	1	1	1	12	7	87	85	26
23	Durai Pandi	515994D	28	3	1	1	1	3	13	10	59	51	3
24	Mani Mohan	917299C	61	3	1		1	2	3	3	162	85	65
25	Damodar Dholey	409139D	45	1	1	1	1	3	20	14	60	60	11
26	Suhrid Baran	523970D	57		1	1	1	4	10	5	31	29	7
27	Sourav Kumar	521667D	25		2		1	5	25	12	79	73	16
28	Anupam Acharya	521526D	28	3	2	2	1	4	30	18	59	59	16
29	Madhu Sudhan	522087D	40	2	1	1	1	2	10	5	70	70	25
30	Jose	413562B	62	3	1	1	2	4	18	9	101	78	15
31	Shamsunder	522079D	63	1	2	2	1	3	18	9	101	61	59
32	Jagadamba	522552D	61	3	1	1	1	2	20	9	50	43	20
33	Nepal Chandra	516542D	44	3	2	2	2	5	50	35	33	33	9
34	Anand	115461B	34	3	1	1	1	1	10	5	70	70	27
35	Ahmed Hussain	383962D	58	2	2	2	2	4	17	10	51	45	6
36	Dilip Kumar	520949D	66	3	1	1	2	3	10	6	31	31	6
37	Amit Banerjee	800038C	28	3	2	2	1	3	28	20	60	58	5
38	Arjun Kumar	523760D	52	3	1	1	1	2	13	7	57	55	7
39	krishna Kumar	313927C	64	3	1	1	2	3	19	10	29	29	9

Sno	Name	Hospno	Age	Education	Flowsubj	Duration	PVRsubj	Visflow	Peakflow	Meanflow	Voidtime	Flowtime	Timepeak
40	Murugesan	615817C	62	1	1	1	2	2	7	3	71	60	21
41	Dhritiswar Mitra	521833D	44	3	1	1	1	3	19	11	110	83	14
42	Sanjay Kumar	707359C	40	3	1	1	2	4	20	14	68	68	6
43	Venkatesan	508706D	64	1	1	1	2	2	8	3	142	98	97
44	Ratan Chandra	430521B	71	2	1	1	2	3	15	9	25	23	5
45	Nagai Mohamma	210872D	18	2	1	2	2	4	27	20	23	23	8
46	Sankari Prasad	521469D	65	3	1	1	2	3	13	5	72	57	12
47	Ramesh Prasad	710302C	51	2	1	1	1	3	8	5	91	91	24
48	Dilip Gorai	522158D	37	2	1	1	2	2	23	14	63	63	21
49	Bablu Sen	520682D	21	2	1	2	2	3	16	8	60	53	12
50	Md. Nashiruddin	515352D	48	2	1	2	1	3	20	10	65	44	5
51	Selvamoorthy	476092D	42	2	1	1	2	5	26	19	22	22	9
52	Kali Krishna	522106D	67	3	2	2	2	3	23	7	46	44	4
53	Deepak Vishwaka	476487D	38	2	1	1	1	2	14	8	62	53	8
54	Sundaram	924925O	63	4	2	2	2	2	21	9	57	54	7
55	Subramaniam	517357D	58	2	1	1	1	3	9	6	59	59	12
56	Vinayagam	447644D	42	2	1	2	2	3	29	19	39	38	8
57	Rashid	522608D	41	1	2	2	2	5	30	21	23	23	5
58	Biju C.Y	516378D	30		1			3	10	6	67	67	3
59	Ismail	492709D	56	1	1			4	6	3	67	59	11
60	Shankar	315504C	68	1	1	1	2	3	15	8	123	121	17
61	Prasun Kumar	359288D	57		1	1	1	2	19	15	20	20	8
62	Indrajit	052874C	58	3	1	1	1	3	33	20	29	29	10
63	Anup singh	552407D	67		1	1	1	3	13	6	33	32	10
64	Arun Kumar	573859D	49		1	1	1	1	8	6	66	63	10
65	John Abraham	570331D	62		2	2	2	4	40	26	21	21	7
66	Jitendra Singh	362735D	48		2	2	2	5	47	20	16	16	7
67	Paulose	548086D	45		2	2	2	4	23	10	30	30	14
68	Siya Ram Sharma	536100D	54		1	1	2	4	39	27	31	31	7
69	Vikas Mittal	479311D	29		1	1	2	3	32	32	25	25	9
70	Manas Mukherje	296874D	61	3	1	1	2	1	29	10	92	70	6
71	Kishore kumar	568207D	53		1	1	2	4	19	10	52	50	6
72	Sudhakar	576160D	67		1	1	1	1	6	5	50	33	24
73	Dwarkanath	396682A	63	3	2	2	2	4	35	19	36	34	4
74	Satyanarayana	536274D	80		1	1	2	2	12	6	56	39	8
75	Ajay Rangam	576209C	52		1	1	2	3	23	10	32	32	7
76	Shiv shakti	418405D	35		1	1	2	3	30	14	81	81	6
77	Arifulla Shah	163508D	61		1	1	2	4	16	9	96	92	22
78	Govindasamy	987004C	70	2	2	1	2	4	19	12	15	15	5

Sno	Name	Hospno	Age	Education	Flowsubj	Duration	PVRsubj	Visflow	Peakflow	Meanflow	Voidtime	Flowtime	Timepeak
79	Gajapati Rao	536079D	53		2	2	2	5	28	18	13	13	4
80	Yumnam	553583C	68		1	1	2	2	9	6	37	30	25
81	Sunil	179955C	45		1	1	1	3	14	5	90	60	27
82	Purnachandra	542762D	64		1	1	2	3	15	10	56	43	7
83	Emmanuel	534230D	71	3	1	1	2	2	10	6	43	43	4
84	Swapan kumar	534969D	46	3	2	2	2	5	27	15	31	25	6
85	Chellayan	537437D	67		2	2	2	3	30	18	26	24	3
86	Rev.Thomas	537445D	80	3	1	1	2	4	25	15	30	29	8
87	Thirumalai	897010B	63	3	1	1	1	3	15	12	57	50	47
88	Srinivasan	525058D	60	3	1	1	1	4	18	8	27	20	2
89	Nikunja behari	531834D	72	3	1	1	2	2	8	4	53	35	19
90	Satyananda Monc	534800D	43		1	1	1	3	25	15	37	32	4
91	Amiya Sau	531537D	71	3	1	1	2	2	13	8	26	25	6
92	Thomas	982663B	64		1	1	1	2	19	12	23	22	7
93	Md Mazmul	535643D	41	2	1	1	1	3	24	16	49	45	15
94	Sheik Mansoor	134152D	52	2	1	2	1	3	12	5	50	37	9
95	Ujjal Nair	324015D	38	2	2	1	2	5	40	19	56	49	7
96	Gurmit singh	488206D	60	2	2	1	2	4	14	8	54	53	10
97	Srinivasan	525058D	60	3	1	1	1	4	18	7	27	20	2
98	Raghunandan	532587D	62		2	2	2	3	19	10	33	29	12
99	Amal Kumar	523479D	49		2	2	2	5	31	20	34	34	13
100	Rajamani	267726D	58	2	1	1	1	3	17	7	53	47	12

Sno	Voidvol	Incomplete	Frequency	Intermittency	Urgency	weakstream	Straining	Nocturia	QoL	TotIPSS	PVRobj
1	523	0	0	2	0	1	0	2	5	5	24
2	1041	0	0	0	0	5	4	2		11	62
3	409	4	5	4	5	5	5	4	6	32	45
4	409	5	5	5	4	5	0	2		26	300
5	663	0	0	0	0	0	0	0	1	63	63
6	498	0	0	2	0	0	4	2	4	8	75
7	455	1	2	0	0	1	0	0	3	4	58
8	349	0	5	0	0	2	0	2	4	9	49
9	701	0	5	1	5	0	0	2	4	13	67
10	284	4	4	2	0	3	2	3	5	18	114
11	569	0	0	0	0	0	0	1	1	1	31
12	221	0	0	0	0	0	0	3	0	3	32
13	625	0	1	0	1	0	0	3	0	5	
14	291	4	0	0	0	2	0	1		7	
15	208	0	1	0	4	0	0	3	2	8	94
16	191	5	4	5	3	4	3	5	6	29	
17	309	0	0	1	0	0	0	3	3	4	104
18	539	3	0	4	4	4	0	3	5	18	188
19	552	1	2	3	2	3	2	2	3	14	34
20	526	0	0	5	3	5	5	3	6	21	48
21	468	0	0	1	0	0	0	0	0	1	35
22	671										14
23	515	0	2	0	1	4	3	0	5	10	15
24	265	3	4	3	4	3	0	2	3	19	42
25	842	5	2	5	4	5	4	3	1	25	59
26	171	2	1	1	2	3	1	3	5	13	123
27	896	5	3	5	4	4	5	1		27	22
28	1079	0	0	0	0	0	0	1	0	1	22
29	420	4	1	2	4	0	4	2	5	17	59
30	736	0	0	1	0	0	0	1	2	2	34
31	552	3	2	1	0	2	4	1	4	13	32
32	425	5	2	2	5	4	2	4	5	24	40
33	1169	1	0	0	0	0	0	1	0	1	18
34	414	4	2	1	1	5	5	1	5	19	0
35	487	0	1	0	0	0	0	1	2	2	52
36	187	0	0	0	0	0	0	1	1	1	10
37	1174	1	1	0	0	0	1	1	5	4	66
38	390	3	2	1	4	1	0	1	3	12	76
39	309	0	0	1	1	0	0	3	3	5	0

Sno	Voidvol	Incomplete	Frequency	Intermittency	Urgency	weakstream	Straining	Nocturia	QoL	TotIPSS	PVRobj
40	228	0	2	2	2	3	1	3	3	13	0
41	985	2	1	3	0	2	1	0	2	9	21
42	960	0	1	4	0	2	1	4	2	12	0
43	374	5	2	1	0	0	3	3	5	14	0
44	219	0	0	4	3	4	0	4	3	15	33
45	469	0	1	0	2	1	2	0	0	6	0
46	333	4	1	5	0	5	5	3	6	23	48
47	484	0	0	0	1	1	2	0	1	4	15
48	938	5	4	3	5	5	0	2	6	24	0
49	455	2	1	2	0	4	2	3	6	14	0
50	474	3	4	2	0	2	0	1	4	12	49
51	409	0	0	0	1	0	0	2	0	1	75
52	344	0	1	1	5	0	0	3	4	10	7
53	444	5	1	5	5	3	0	3	5	22	59
54	500	0	0	0	0	0	0	2	0	2	28
55	357	0	1	2	2	1	0	1	1	8	49
56	744	0	1	2	0	3	3	0	5	9	37
57	484	0	5	5	0	0	0	0	3	10	35
58	419	2	5	1	5	0	0	3	6	16	15
59	217	0	5	5	5	5	0	1	5	21	286
60	966	0	1	2	0	5	5	2	3	15	59
61	297	4	3	4	5	5	0	4	4	25	67
62	588	4	4	0	4	4	2	2	5	20	10
63	186	5	5	5	1	5	0	5	6	26	
64	410	4	5	5	4	5	5	3	6	31	78
65	667	0	0	0	3	3	0	3	3	9	35
66	290	0	0	0	0	0	0	1	0	1	40
67	321	0	0	0	0	0	0	2	0	2	15
68	834	0	0	0	0	0	0	1	0	1	19
69	687	1	1	0	3	2	2	5	3	14	10
70	720	1	1	0	0	0	1	4	4	3	20
71	564	0	4	0	3	0	0	1	2	8	70
72	188	4	3	3	3	4	4	3	5	24	70
73	651	2	2	4	3	3	2	2	3	18	31
74	229	0	5	0	5	0	0	5		15	36
75	357	0	2	0	5	0	0	1	2	8	51
76	1086	1	2	0	0	0	0	1	2	4	40
77	831	5	5	0	0	0	0	3	2	10	53
78	285	1	2	1	0	0	0	4	1	8	46

Sno	Voidvol	Incomplete	Frequency	Intermittency	Urgency	weakstream	Straining	Nocturia	QoL	TotIPSS	PVRobj
79	245	0	0	3	5	0	0	1	1	9	23
80	196	0	1	1	0	0	0	2	2	4	46
81	316	5	4	5	0	5	5	3	5	27	56
82	434	2	2	1	0	0	0	3	5	8	66
83	270	5	3	5	3	4	0	5	3	25	21
84	393	0	0	0	0	0	0	1	1	1	24
85	429	0	5	0	4	4	5	4	5	22	17
86	454	2	1	2	2	2	3	4	3	16	20
87	663	1	1	2	0	0	0	2	4	6	31
88	155	2	1	2	5	3	2	2	5	17	8
89	157	1	1	1	1	2	1	3	3	10	21
90	475	2	1	2	0	2	0	2	3	8	34
91	224	4	0	0	5	5	3	5	2	22	91
92	277	1	1	1	2	2	1	3	3	11	23
93	745	1	1	2	4	5	2	1	6	21	16
94	209	5	4	5	5	0	0	2	6	21	21
95	985	5	3	5	4	5	0	1	6	23	140
96	457	0	1	0	0	0	0	3	3	4	19
97	155	2	1	2	5	3	2	2	5	15	8
98	295	0	1	0	0	1	0	3	4	5	
99	692	2	1	2	1	2	1	3	5	12	120
100	326	5	5	5	5	3	0	5	6	27	102