INTRODUCTION

Lower urinary tract symptoms (LUTS), include voiding symptoms (e.g. slow stream, hesitancy, intermittency), storage symptoms (e.g. frequency, urgency, nocturia) and/or post-micturition symptoms (incomplete bladder emptying, post-micturition dribbling), represent one of the most common urinary clinical complaints in men, and its prevalence increases continuously with age ***(Drake, 2016).***

For a long period of time, men who presented with LUTS were assumed to have symptoms secondary to enlarged prostate and hence the name "prostatism." However, with understanding the pathophysiology of the interaction of the lower urinary tract, it is becoming clear over time that the prostate is not always the cause of male LUTS, and other problems could cause male LUTS in the presence of benign prostate enlargement (BPE) ***(El-Zawahry, 2016)***.

Detrusor Underactivity (DU) and Bladder Outlet Obstruction (BOO) are the two most prevalent conditions that affect the voiding phase of LUTS in elderly men ***(Jeong, 2012).***

However, because of the clinical similarity of symptoms of DU and BOO, they are discriminated only by the pressure-flow component of urodynamic study (UDS), which is the standard for diagnosis ***(Gratzke et al., 2015)***.

The invasive nature of the pressure flow study tests, with potential morbidity including urinary tract infection, and the need for specialist equipment and expertise, have limited its widespread use. The rate of urinary tract infection has been reported to be at least 3%, and the investigation is also associated with significant costs to healthcare systems. Furthermore, it is an unpleasant investigation with high reported rates of anxiety and embarrassment ***(Winters, 2012).***

UDS may not be an ideal option for a disease with a high prevalence rate. Uroflowmetry considered a reliable and noninvasive substitute for UDS focusing on the difference between maximal (Qmax) and average flow rate (Qave) which is named (DeltaQ); Our basic hypothesis is that DeltaQ would be lower in DU because of the diminished detrusor function decreasing the flow rate, both average and maximum, but higher in BOO, which has normal detrusor contraction during voiding phase ***(Lee, 2016).***

Determining whether a patient's symptoms are due to BOO or DU is important in determining the optimal management. The success rate from surgical treatments such as transurethral resection of the prostate (TURP) are inferior in patients with DU compared to those with BOO, and give the small but potentially serious complications from TURP. Correct diagnosis is important for appropriate patient counseling and selection for surgery ***(Graves, 2015).***

AIM OF THE WORK

To determine the significance of delta Q value (Qmax - Qave) in discrimination between BOO and DU, to avoid invasive study (pressure flow studies (PFSs)) and replacing it by noninvasive study (uroflowmetry).

REVIEW OF LITERATURE

Lower urinary tract symptoms (LUTS)

The male LUTS in the past erroneously called "prostatism" are simply due to a mass-related increase in urethral resistance. It is now clear that a significant portion of male LUTS is due to age-related detrusor dysfunction and other conditions such as polyuria, sleep disorders, and a variety of systemic medical conditions unrelated to the prostate-bladder unit ***(Arora and Ahlawat, 2016).***

A longitudinal survey of an unselected population of men aged 40–79 years showed that prevalence of moderate to severe symptoms was 18 % in individuals aged 40–49, increasing to 28 % in men older than 50 and rising to approximately 50 % by the seventh decade of life. Moreover, LUTS have been shown to affect more than 70 % of men older than 80 years (figure 1) ***(Briganti and Gandaglia, 2014).***

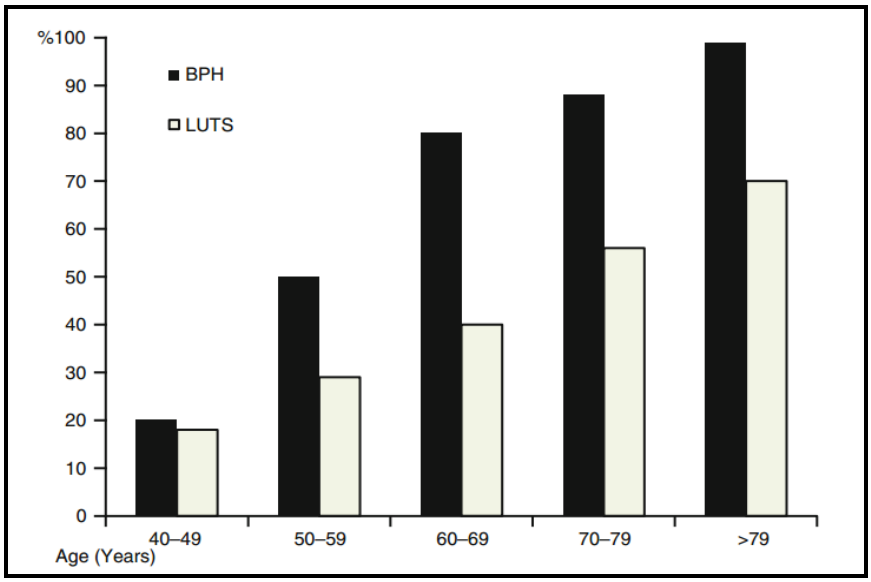

Figure (1): Prevalence of pathological benign prostatic hyperplasia (BPH) and lower urinary tract symptoms (LUTS) assessed by validated questionnaires stratified by decade of life ***(Briganti and Gandaglia, 2014).***

The pathophysiology of LUTS is multifactorial, Bladder outlet obstruction (BOO) is one of the main causes of LUTS in elderly males; but detrusor factors such as detrusor instability & impaired contractility can contribute to the development of LUTS. Nevertheless, in view of the lack of correlation between symptoms, prostate enlargement & BOO, the effect of the symptoms in the lower urinary tract remain controversial. There is a strong tendency in the world literature not to associate symptoms with the presence of obstruction ***(Chapple and Tubaro, 2014)***.

Detrusor underactivity (DU) in men is responsible for LUTS in about 10 % of patients as reported by Thomas A.W.

who investigated 2066 neurologically intact men with LUTS & reported this incidence ***(Thomas et al., 2004).***

The urinary symptoms commonly seen in men with LUTS are not specific. Urinary tract infection, urethral stricture disease, bladder cancer & primary bladder disease may mimic the symptoms of benign prostatic hyperplasia (BPH). In most cases, the differential diagnosis (figure 2) can be ruled out by the medical history or the basic evaluation. In some cases, further diagnostic evaluation is needed ***(Rosenberg et al., 2014).***

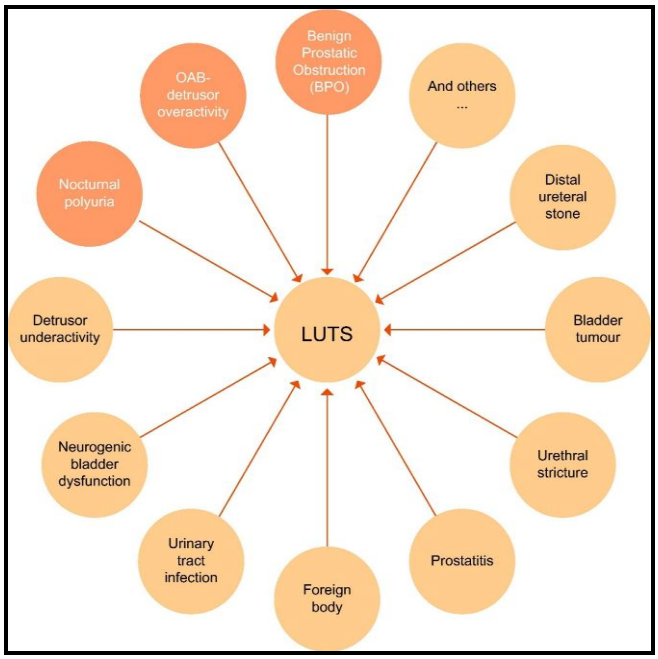

Figure (2): Shows differential diagnosis of LUTS ***(Gratzke et al., 2015).***

Many men over the age of 40 will develop histologic hyperplasia (i.e., BPH), not all will have BPE (benign prostatic enlargement by ultrasound or digital rectal examination (DRE)).

Of those who do, some will and others will not develop bladder outlet obstruction (BOO) and LUTS. It is common for men to have BPE without having LUTS and vice versa. BOO may also be present with or without LUTS and with or without BPE, and in some cases BOO exists in men with BPH (figure 3) ***(Kahokehr and Gilling, 2014).***

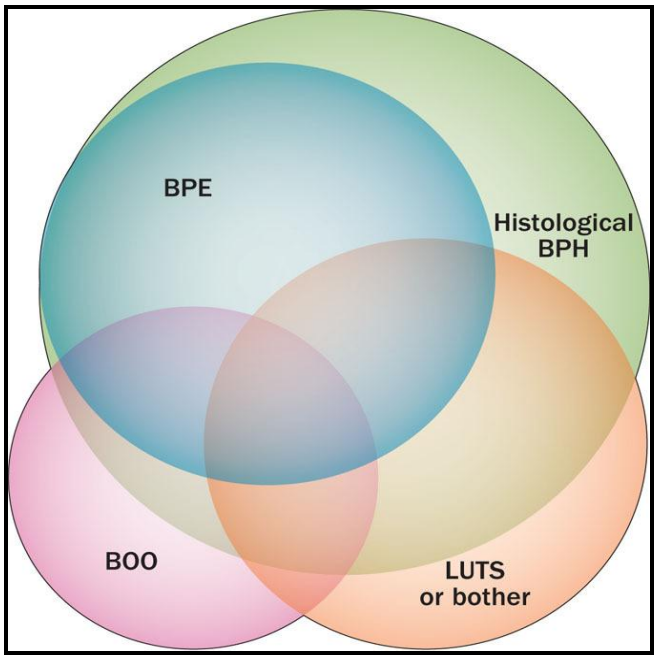

Figure (3): Shows relation between LUTS, BPE, histological BPH and BOO ***(Kahokehr and Gilling, 2014).***

The American Urological Associations Symptom Index (Score) for LUTS

Lower urinary tract symptoms divided to voiding symptoms (e.g. slow stream, hesitancy, intermittency), storage symptoms (e.g. frequency, urgency, nocturia) and/or post-

micturition symptoms (incomplete bladder emptying, post-micturition dribbling) ***(Drake et al., 2016).***

The questionnaire covers the items of frequency, nocturia, a weak urinary stream, hesitancy, intermittency, incomplete emptying & urgency. AUA symptom scores ranging from 0 to 35, with their degree of bother ratings was explored in order to create categories of men with mild, moderate & severe symptoms **(Table 1)** ***(Barry et al., 2017)***.

In the for mentioned validation studies, men with an AUA score of 7 or below more commonly rate their urinary condition as "not at all" as opposed to "a little" bothersome, those men might be considered the "mild" symptom group. Men with AUA scores from 8 to 19 generally give intermediate ratings of bother, & can be defined as a group with "moderate" symptoms. Thirdly men with AUA scores of 20, or above are generally bothered "some" or "a lot" by their symptoms, & could be considered a group with "severe" symptoms ***(Barry et al., 2017)***.

AUA symptom score

Table (1): Shows the American Urological Association symptom index for LUTS ***(Barry et al., 1992)*.**

	Not at all	**Less than 1 time in 5**	**Less than half the time**	**About half the time**	**More than half the time**	**Almost always**
1. Over the past month or so, how often have you had a sensation of not emptying your bladder completely after you finished urinating	0	1	2	3	4	5
2. Over the past month or so, how often have you had to urinate again less than 2 hours after you finished urinating?	0	1	2	3	4	5
3. Over the past month or so, how often have you found you stopped & started again several times when you urinated?	0	1	2	3	4	5
4. Over the past month or so, how often have you found it difficult to postpone urination?	0	1	2	3	4	5
5. Over the past month or so how often have you had a weak urinary stream?	0	1	2	3	4	5
6. Over the past month or so how often have you had to push or strain to begin urination?	0	1	2	3	4	5
7. Over the last month. How many times did you most typically get up to urinate from the time you went to bed at night until the time you got up in the morning?	0 none	1 (1 time)	2 (2 times)	3 (3 times)	4 (times)	5 (5 or more times)

Evaluation of Voiding Function

The urodynamic evaluation of voiding function seeks to determine the ability of the bladder to empty & the pressures required to do so.

The act of voiding is an interplay between detrusor pressure, urethral patency & sphincter relaxation; various urodynamic tests exist to assess this, including uroflowmetry, PFSs, video-urodynamic studies & electromyography ***(Abrams et al., 2013)***.

Non invasive evaluation of voiding function

Uroflowmetry (UFM):

Uroflowmetry is a non-invasive study, in which the patient voids into a flowmeter as urine flow rate is continuously measured as volume per time (ml/s) and flow is plotted with volume on the X axis and time corresponds to the Y axis ***(Abrams et al., 2009).***

It is possibly the most frequently used UDS because it is non-invasive and is usually the first study to evaluate voiding function. The UFM does not reproduce symptoms as the UDS does, it simply measures flow. In order to produce accurate results of testing, an effort to create a calm and relaxed atmosphere is paramount to reduce artifact in testing (figure 4) ***(Schäfer et al., 2002).***

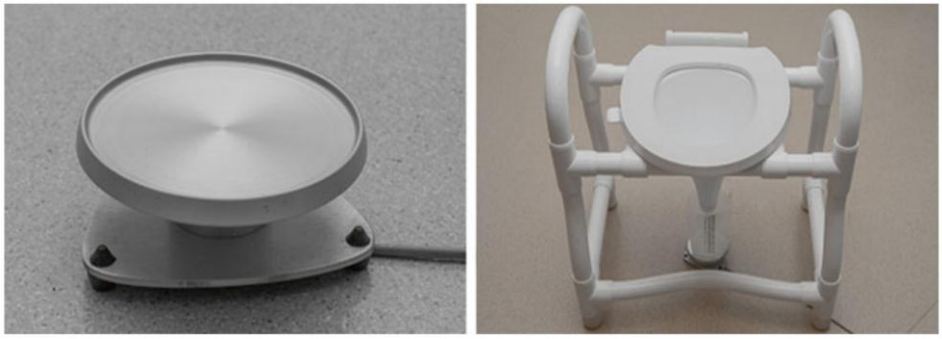

Figure (4): Uroflowmeter (right), complete voiding equipment with funnel and chair (left) ***(Storme and McCammon, 2016).***

Indications for UFM include initial evaluation of patients with benign prostatic hypertrophy, urinary incontinence, urethral strictures, recurrent urinary tract infections and neurogenic bladder dysfunction. In patients with LUTS, UFM may suggest an abnormality of voiding/emptying ***(Abrams et al., 2013).***

The preparation of the patient and the room are very important to reproduce a normal void. The patient should know he/she will void into an uroflowmetry (per their usual habit) usually standing up or sitting down. The patient should also be made aware of the importance of the exam to evaluate voiding symptoms. Ideally, the exam would be done with normal desire to void (preferably first desire to void), not under urgency. Bladder over distention could alter normal flow and increase post void residual (PVR) ***(Schäfer et al., 2002)***.

For accuracy of testing, voided volume must be over 150 ml and ideally less than 400–500 cc as the detrusor muscle may

become overstretched and contractility may decrease, consequently creating a false result. A UFM report must include the curve description, voided volume, maximum flow rate (Q Max), average flow rate (Q Ave) and post void residual (PVR) to be complete ***(Storme and McCammon, 2016).***

Standard Terminology Related to UFM ***(Abrams et al., 2013):***

- **Flow rate** is defined as the volume of fluid expelled via the urethra per unit time expressed in ml/s.
- **Voided volume** is the total volume expelled via the urethra.
- **Maximum flow rate** is the maximum measured value of the flow rate after correction for artifacts (ml/s).
- **Voiding time** is the total duration of micturition, including interruptions. When a void is completed without interruption, voiding time is equal to flow time.
- **Flow time** is the time over which measurable flow actually occurs. Men average approximately 30 s to void.
- **Average flow rate** is voided volume divided by flow time. The average flow should be interpreted with caution if flow is interrupted or if there is a terminal dribble.
- **Time to maximum flow** is the elapsed time from onset of flow to maximum flow.
- **Post void residual (PVR)** is defined as the volume of urine left in the bladder at the end of micturition determined by

either ultrasound or catheterization. If there is no demonstrated PVR after repeated free flowmetry, then the finding of residual urine during the UDS should be considered an artifact.

- **Bladder outlet obstruction (BOO)** is the general term for obstruction during micturition characterized by increased detrusor pressure and reduced urine flow rate. It is usually diagnosed by studying the synchronous values of flow rate and detrusor pressure.
- **Dysfunctional voiding** is an intermittent and/or fluctuating flow rate due to involuntary intermittent contractions of the periurethral striated muscle during micturition in neurologically normal individuals.

Normal Values: In adult males Q max ≥10 ml/s, UFM has a specificity of 70–90 %, with a (PPV) of 70 % and a sensitivity of 39–47 % to diagnosis obstruction ***(Nitti, 2005).***

Urine flow results from a detrusor contraction and urethral resistance, thus changes in flow curves imply an imbalance between these factors. While a noninvasive flow test is a good screening test for voiding dysfunction, one must remember the only way to definitively diagnose these issues is through pressure flow studies:

- **Normal Curve (figure 5)**: Is continuous and has a bell shape, Q max is reached in the first third of the tracing and within 3–10 s from the start of flow. The final phase shows a

rapid fall from high flow together with a sharp cutoff at the end of flow ***(Vignoli, 2017).***

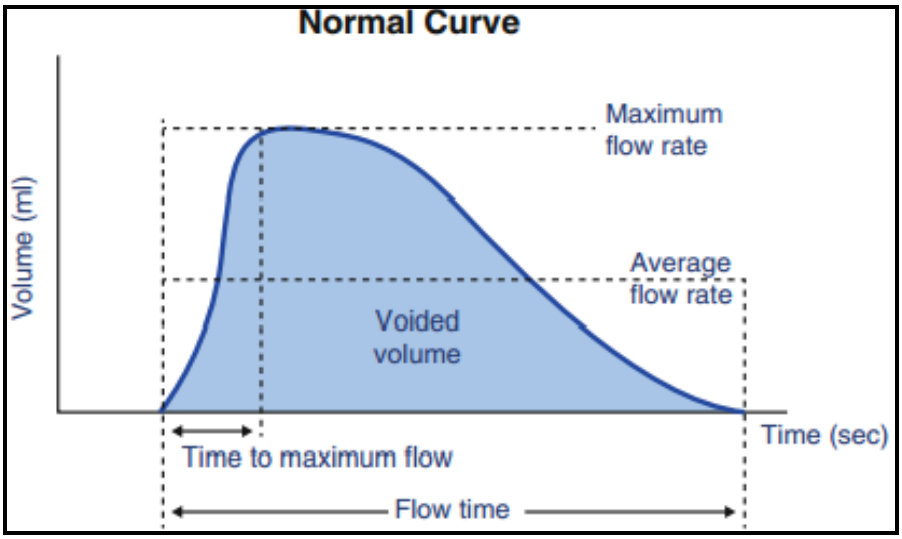

Figure (5): Illustration of normal curve, continuous and bell shape, Q max is reached in the first third and final phase shows a rapid fall from high flow together with a sharp cutoff at the end ***(Vignoli, 2017).***

- **Continuous Flow Curves (figure 6):**

1) Bladder outlet obstruction: This type of curve has an elongated shape:

   a) In benign prostatic obstruction (compressive). It appears normal in the first third but has a reduced Qmax with the latter part of the curve elongated with a terminal dribble indicating a reduction in flow rate.

   b) In the presence of urethral stricture (constrictive), the curve is plateau-shaped with little, change between Qmax and Qave.

2) With idiopathic detrusor overactivity a supra normal curve for high detrusor contraction velocities is observed. The curve is of normal shape with a very high Q max, within 1–3 s of the initial flow.

3) With detrusor underactivity the diagnosis is cystometric. UFM shows a symmetrical tracing with low Q max. The time to reach Q max is variable, and Q max may occur in the second half of the curve. If these features appear in UFM, a pressure-flow study must be done ***(Vignoli, 2017).***

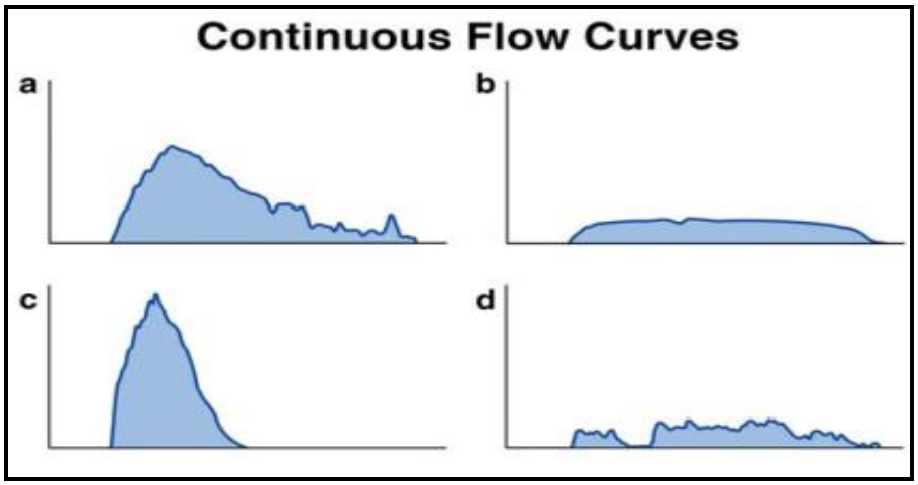

Figure (6): (a) Compressive flow curve (benign prostatic obstruction); (b) Constrictive flow curve(urethral stricture); (c) Idiopathic detrusor overactivity; (d) Detrusor underactivity ***(Vignoli, 2017).***

- **Intermittent flow curve (figure 7)**:
  - Normal patients: Saw tooth curve, similar to Detrusor sphincter dyssynergia (DSD) in neurologically normal patient, most often a result of anxiety or dysfunctional voiding.