**Original Research Article**

**DETRUSOR MUSCLE THICKNESS AND PROSTATE VOLUME IN THE DIAGNOSIS OF BLADDER OUTLET OBSTRUCTION**

ABSTRACT

**INTRODUCTION:** Bladder outlet obstruction (BOO) is a common urologic diagnosis and it is reported to be the most common urologic problem of elderly male patients which can lead to detrusor instability in 50% to 70% of men with benign prostatic hyperplasia. This study aimed to determine the relationship between detrusor muscle thickness, prostate volume, and International Prostate Symptom Score [IPSS] in patients with BOO using ultrasound**. METHODS:** This is a prospective, descriptive comparative sonographic evaluation of the detrusor muscle thickness in participants with BOOusing IPSS as a gold standard. **RESULTS**: The most frequent age group with BOO was 60 – 69 years 32[32%] subjects. IPSS score distribution showed mild in 17 [17%] subjects, moderate in 78 subjects [78%], and severe in 5 subjects [5%] in the BOO group. The control group showed that 100 [100%] subjects fell within the mild. Statistical significance was a p-value of 0.000. Moderate and severe IPSS showed p- value of 0.006. Association between IPSS and DWT showed a value of 0.675, Association between IPSS and prostate volume had a value of 0.657, and association between DWT and Prostate volume had a value of 0.787. DWT and prostate volume each had sensitivity, NPV, and PPV of 52%, 0.53, and 0.51 for BWT and 59%, 0.63, and 0.56 for prostate volume respectively. Both parameters also showed low specificity of 48% for DWT and 44% for prostate volume. Both parametre show sensitivity of 52% for DWT and 59% for prostate volume. **CONCLUSION:** Sonographic measurement of BWT is a good tool in the assessment of BOO.

Keywords – Subjects, DWT, BOO, IPSS, Prostate volume.

**INTRODUCTION**

Bladder outlet obstruction (BOO) is a common urologic diagnosis and it is reported to be the most common urologic problem of elderly male patients which can lead to detrusor instability in 50% to 70% of men with benign prostatic hyperplasia. (1) It can lead to ascending infection which can culminate in renal failure if left undiagnosed. It can also lead to lower urinary tract symptoms (LUTS), upper and lower urinary tract dysfunction, infections, bladder stones, and decreased quality of life. (2)

The natural history of BOO spans both early and late phases. The early phase involves bladder wall thickening and bladder weight increase. Over time, as the obstruction becomes more severe, the detrusor muscle may lose some or all contractility. (2, 3) The varied aetiologies of BOO may be functional and anatomic. Functional obstructive symptoms include hesitancy, incomplete voiding sensation, decreased urinary stream, and post-void dribbling. Irritating complaints include; frequency, urgency, dysuria, and nocturia.(3) Anatomic obstruction in men usually occurs in benign prostatic enlargement or urethral stricture. BOO may be first recognized in a scenario of urinary retention

Benign prostatic hyperplasia is an important cause of bladder outlet obstruction, resulting in LUTS. (4) In the aging male population, LUTS are usually attributed to benign prostatic enlargement (BPE), however, it is now widely recognized that LUTS can be attributed to urological and neurological conditions. (1)Other prevalent conditions causing LUTS include Parkinson’s disease, cerebrovascular accident, prostate cancer, bladder cancer, urethral stricture, and overactive bladder. Nonetheless, LUTS in the presence of BPE is sufficient to establish a diagnosis of BPH.These conditions thus represent variable causes of BOO.(5)

BOO ultimately causes resistance to the urine outflow channel which results in bladder remodeling, which may be dependent on the age of onset, duration, severity, and other clinical factors. These changes involve the entire bladder wall with the detrusor muscle/wall being the most sensitive marker. (6)Bladder compensation occurs through detrusor wall hypertrophy with an increase in contractility, to sustain effective bladder emptying despite the obstruction. (7)

Urodynamic studies are considered the gold standard for diagnosis of BOO, radiologists and urologists commonly rely on less invasive studies for evaluation of BOO. Due to the high cost, availability, invasiveness, and potential morbidity of urodynamic studies. (8)

Ultrasonographic assessment has proved useful and provides reliable and quick information on detrusor wall thickness (DWT) and Prostate volume. (8) It also provides data on other significant features including intra-vesical protrusion, Doppler studies, complications like hydronephrosis, urinary tract infections, calculi, and other co-morbidities. (8) This study aimed to determine the relationship between detrusor muscle thickness, prostate volume, and International Prostate Symptom Score in patients [IPSS] with BOO using ultrasound.

**METHODS**

STUDY DESIGN

This is a prospective, descriptive comparative sonographic evaluation of the detrusor muscle thickness in participants with BOO at the University Teaching Hospital, Ituku-ozalla, Enugu. Ethical clearance was obtained from the ethical committee with reference number UNTH/CSA.329/VOL.5 before the commencement of the study. The study period was a total of 9 months.

STUDY POPULATION

The study population was adult males of 40yrs and above with symptoms of BOO as determined by IPSS. The control group was adult males of 40yrs and above who had come to the radiology department for other reasons other than BOO and did not have any symptoms. The inclusion criteria were as follows; adult male Nigerians of 40yrs and above with clinical symptoms of BOO and as determined by IPSS. The exclusion criteria were as follows; Non-Nigerians, less than 40 years of age, patients on bouginage treatment, recent genital instrumentation or pelvic fractures, and patients with neurovesical dysfunction, acute urinary retention, on continuous bladder drainage, prior pelvic surgery, and known prostate cancer.

SAMPLE SIZE

The sample size was calculated using this formula. (9)

n = (u + v)2  (r12+r2 2) / (u1 –u2) where n = sample size, u1 = 4.54mm5 (subject mean BWT), u2 = 3mm17 (control mean BWT), r1 = 1.1, r2 = 1.1, u = one-side percentage point of normal distribution corresponding to 100%, if power = 90%, u = 1.28, and v =percentage point of the normal distribution corresponding to the [two- sided] significance of level. e.g. if the significance level is 5%, then v = 1.96.

(1.28 +1.96)2 (1.12 +1.12) / (4.54 -3) = (10.4976) (2.42) / 2.3716 = 10.7 approximate of 11. A sample size of 200 was used (100 study subjects and 100 control subjects).

STUDY TECHNIQUE

The study objectives and procedure were explained to each participant and their questions were answered before they signed the consent form. Participation in the study was voluntary and anyone who did not consent was excluded without any prejudice. Each subject’s age, symptoms, duration of symptoms, and IPSS score were obtained and documented in the datasheet while maintaining confidentiality.

For the control subjects, consecutive recruitment of age matched patients without symptoms of BOO were used. These were patients who had come for an abdominopelvic scan and were amenable to the study but did not have symptoms of BOO. All the participants were scanned using an ALOKA ultrasound machine (Model SSD; SN 190605).

Each participant was asked to drink water to ensure the urinary bladder was appropriately distended. A urinary bladder volume of 150 -200 mls was considered adequate for evaluation of the detrusor muscle. (10) Participants were asked to lie supine on the couch with arms resting comfortably above their heads. Exposure was from the xiphisternum to the just below the supra-pubic region. Acoustic gel was applied to the abdomen to obliterate the air interface between the probe and the skin. With the assistance of magnification and the probe in the transverse plane, adventitia, muscle, and mucosa were identified. Two measurements of BWT were obtained and averaged from the anterior bladder wall, 1cm from the midline. (10, 11).

With the probe in the transverse plane at the suprapubic region, an image of the largest circumference of the prostate was obtained and then rotated to the longitudinal plane to capture another image. The prostate volume was estimated from the diametres of the major and minor axis using an elliptical 3-axis volume formula. (12) The presence of findings like stones, sacculations, trabeculation, and diverticulae were all noted in the datasheet and written up for the referring doctor for adequate management.

**STATISTICAL ANALYSIS**

Data obtained was entered and analyzed using IBM SPSS (Statistical Package for Social Sciences) version 20.0. Armonk, NY, USA, 2011. Results were expressed using tables for the descriptive statistics. Descriptive statistics (mean, mode, median, standard deviation, and percentages) were calculated for appropriate variables. Chi-square and Pearson’s correlation were used to evaluate associations between the IPSS, BWT, and Prostate volume. A p-value of ≤ 0.05 was considered statistically significant. Sensitivity, Specificity, Negative Predictive value [NPV], and Positive Predictive value [PPV] were calculated using Baye’s theorem [13]

**RESULTS**

The most frequent age group with BOO was 60 – 69 years [32] followed by 40 – 49 years, [27], the rest in descending order were as follows; 70 and above [21] and 50-59 years [20]. The control group was age-matched in number. **Table 1**

The distribution of radiological findings was as follows in the BOO group with the presence of trabeculations 21[10.5%], bladder stones 8 [4%], and mucosal sacculations 1 [0.5%]. While there was an absence of trabeculations of 79 [34.5%], bladder stones of 92 [46%], and mucosal sacculations of 99 [49.5%]. The control group showed no trabeculations, bladder stones, or mucosal sacculations. **Table 2**

IPSS score distribution showed mild had 17 [17%] subjects, moderate had 78 subjects [78%], and severe had 5 subjects [5%] in the BOO group. The control group showed that 100 [100%] subjects fell within the mild. There was a statistical significance with a p-value of 0.000. **Table 3**

Mild IPSS scores were seen in17 subjects while all 100 subjects in control had mild IPSS scores. Moderate IPSS scores were seen in 78 subjects with none in the control group. Severe IPSS scores were seen in only 5 subjects and none in the control group. Relationship between DWT with IPSS and Prostate volume with IPSS showed a p-value 0.006 **Table 4 & 5**

The association between IPSS and DWT showed a correlation coefficient of 0.675. The association between IPSS and prostate volume had a correlation coefficient of 0.657 while the association between DWT and Prostate volume had a correlation coefficient of 0.787. **Table 6**

DWT and prostate volume each had sensitivity, NPV, and PPV with values of 52%, 0.53, and 0.51 for DWT and 59%, 0.63, and 0.56 for prostate volume respectively. Each parameter also showed low specificity with values of 48% for DWT and 44% for prostate volume respectively. **Table 7**

**Table 1:** Distribution of BOO and Non-BOO subjects

|  |  |  |  |
| --- | --- | --- | --- |
| **Age group (years)** | **BOO group** | **Control group** | **Total** |
| 40 -49 | 27 | 27 | 54 |
| 50 -59 | 20 | 20 | 40 |
| 60-69 | 32 | 32 | 64 |
| 70 and above | 21 | 21 | 42 |
| Total | 100 | 100 | 200 |

**Table 2:** Distribution of Radiological findings

|  |  |  |
| --- | --- | --- |
| **Radiological findings** | **BOO group** | **Control group** |
|  | YES N[%] NO N[%] | YES N[%] NO N[%] |
| **Bladder stones** | 8 [4] 92 [46] | 0 [0] 0 [0] |
| **Trabeculations** | 21 [10.5] 79 [34.5] | 0 [0] 0 [0] |
| **Mucosal sacculations** | 1 [0.5] 99 [49.5] | 0 [0] 0[0] |

**Table 3:** IPSS score distribution

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| IPSS | BOO groupN (%) | Control groupN (%) | Chi-square (X2) | P value |
| Mild | 17 (17.0) | 100 (100.0) | 141.9 | 0.000 |
| Moderate | 78 (78.0) | 0 (0) |  |  |
| Severe | 5 (5.0) | 0 (0) |  |  |
| Total N (%) | 100 (100) | 100 (100) |  |  |

**Table 4:** Association between IPSS and BWT in BOO and Control subjects.

|  |  |  |  |
| --- | --- | --- | --- |
| **Detrusor muscle****Thickness (cm)** |  **IPSS** | **Chi-square** **(X2)** | **P value** |
| **MILD** | **MODERATE** | **SEVERE** |
|  | BOO | Control | BOO | Control | BOO  | Control | 10.113 | 0.006 |
| 0.10-0.39 | 6(35.3) | 73(73) | 1(1.3) | 0(0) | 0(0) | 0(0) |  |  |
| 0.30-0.49 | 11(64.7) | 26(26) | 39(50) | 0(0) | 0(0 | 0(0) |  |  |
| 0.50-0.69 | 0(0) | 1(1.0) | 26(33.3) | 0(0) | 2(40) | 0(0) |  |  |
| 0.70-0.89 | 0(0) | 0(0) | 9(11.5) | 0(0) | 1(20) | 0(0) |  |  |
| >0.90 | 0(0) | 0(0) | 3(3.8) | 0(0) | 2(40) | 0(0) |  |  |
| **TOTAL** | 17(100)  | 100(100) | 78(100)  | 0(0) | 5(100) | 0(0) |  |  |

**Table 5**: Association between IPSS and Prostatic volume of BOO and Control subjects.

|  |  |  |  |
| --- | --- | --- | --- |
| **Prostatic** **Volume****(cm3)** |  **IPPS** | **Chi-square****(X2)** | **p-value** |
| **MILD** | **MODERATE** | **SEVERE** |
|  | BOO | Control | BOO | Control | BOO | Control |  |  |
| 10.0-29.9 | 6(35.3) | 73(73.0) | 1(1.3) | 0.(0.0) | 0(0.0) | 0(0.0) | 10.113 | 0.006 |
| 30.0-49.9 | 11(64.7) | 26(26.0) | 39(50.0) | 0(0.0) | 0(0.0) | 0(0.0) |  |  |
| 50.0-69.9 | 0(0.0) | 1(1.0) | 26(33.3) | 0(0.0) | 2(40) | 0(0.0) |  |  |
| 70.0-89.9 | 0(0.0) | 0(0.0) | 16(20.5) | 0(0.0) | 0(0.0) | 0(0.0) |  |  |
| >90  | 0(0.0) | 0(0.0) | 30(38.5) | 0(0.0) | 5(100.0) | 0(0.0) |  |  |
| **TOTAL** | 17(100.0) | 100(100.0) | 78(100.0) | 0(0.0) | 5(100.0) | 0(0.0) |  |  |

**Table 6:** Pearson’s correlation between IPSS, BWT, and prostate volume

|  |  |  |  |
| --- | --- | --- | --- |
| **VARIABLES** | **IPSS** | BLADDER WALL THICKNESS (BWT) | PROSTATE VOLUME |
| BLADDER WALL THICKNESS (BWT) | **0.675\*\*** | **1** | **0.787\*\*\*** |
| PROSTATE VOLUME | **0.657\*\*** | **0.787\*\*\*** | **1** |

**\*\* Correlation is significant at the 0.01 level (2 – tailed)**

**\*\*\*Correlation is significant at the 0.001 level**

**Table 7:** Sensitivity, Specificity, Negative Predictive Value (NPV), and Positive Predictive Values (PPV).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parametres** | **NPV** | **PPV** | **Sensitivity** | **Specificity** |
| Prostate volume | O.63 | 0.56 | 59% | 44% |
| BWT | 0.53 | 0.51 | 52% | 48% |

**DISCUSSION**

Bladder outlet obstruction is a common health issue affecting men, particularly as they age, and it is often associated with benign prostatic hyperplasia [14, 15]. The severity of these symptoms can be evaluated using the IPSS, a standardized tool that assesses the impact of urinary difficulties on quality of life. Detrusor wall thickness (DWT) is an important sonographic parametre used to evaluate bladder function and frequently correlates with the severity of the disease {16]

The mean age group of 60-69 years (32%) falling between 56-65 years, aligns with typical demographic patterns for conditions related to aging. The distribution across this age range suggests a correlation with age-related factors. The mean age for the BOO group was 63 years while that for the control group was 64 years.

**Bladder wall thickness**

Bladder wall thickening results from an increased workload against an outlet obstruction and is similar to the heart where the muscular wall thickens due to valvular stenosis [17]. DWT may be affected by infection, inflammation, or tumors. The mean DWT value obtained in our study was 4.6mm and was collaborated by that reported by Matthew et al [18]. Bladder wall thickness correlates with gender, bladder filling, and BOO grade. This study showed control group with BWT of 2.1mm and it corresponds with that reported by Blatt et al [19]. The findings of Ozdedeli et al [20] and Sabri et al [21] were also comparable with that reported in the present study.Anwar et al [22] reported a significant correlation between mean DWT and IPSS in patients with benign prostatic hyperplasia.

**Positive predictive value**

Our study demonstrated a PPV of 51% which is lower than the PPV OF 95.5% and 89% obtained by Oelke et al [23] and Kessler et al [24] respectively. These authors also demonstrated that the diagnostic accuracy of BOO detection was higher with DWT than with prostate volume which is contrary to that observed in our study. The prevalence rates obtained in Africa are lower than those in the Asian continent and may account for the variation in the PPV obtained in our study.

**Correlation co-efficient**

Our study noted a correlation coefficient of 0.637 and 0.675 for prostate volume and BWT respectively whereas Oelke et al [23] reported values of 0.463 and 0.623 respectively. It is well known that intra-vesical obstruction is followed by compensatory hypertrophy of the bladder detrusor wall.

**Sensitivity and specificity**

Our study showed sensitivity of 59% and 52% for prostate volume and DWT but it is lower than that reported by Peedikayil et al [25] and Elsaied et al [7]. Peedikayl reported a sensitivity and specificity of 80% and 92% respectively for DWT [25]. These values are higher than 52% and 48% obtained in our study. The variations in the sensitivity and specificity may be because of differences in the prevalence rates across regions, racial differences, social habits (tobacco intake), and parasitic infestations localized to geographical regions.

Elsaied et al [7] found that DWT had an accuracy of (88.0%), specificity (92.6%), and positive predictive value (90.5%) among non-invasive tests. Similarly, Prakash et al [26]also noted that while DWT had the highest specificity (96.43%) and accuracy (90.57%), concluding that incorporating DWT would significantly increase the accuracy of diagnosing bladder outlet obstruction.

**IPSS Patterns**

The mean IPSS in the BOO group was 10.35 while that of the control was 0.34. The severity of clinical symptoms using the International Prostate Symptom Score (IPSS) in this study showed that a majority of participants fell into the moderate category (78%). These results indicate that a significant portion of the patients experienced moderate symptoms, which is consistent with the nature of lower urinary tract symptoms typically associated with benign prostatic hyperplasia [14]. Anilkumar et al [27] reported that IPSS has been recognized for its ability to guide treatment decisions and assess patient outcomes. Amu et al [28] recommended that IPSS be routinely employed for BPH management due to its ability to categorize symptoms. Whereas, Bassey et al [29], Ulebe et al [30], and Jindal et al [31], all show reservations about the use of IPPS as a tool to monitor the severity of symptoms. Bassey et al[29] showed that prostatic enlargement does not correlate positively with symptom severity. The present study, Ulebe etal [30], and Jindal et al[31] agree that comprehension of the IPSS among less educated subjects will influence the accuracy of the results.

This study has explored the relationship between DWT and IPSS in men with BOO, aiming to add to the body of work and increase the understanding of how these factors influence the clinical presentation and management of urinary symptoms. By examining the correlation of these variables, this study provides insights into the pathophysiology and may assist in more effective treatment strategies. A combination of clinical, sonographic, and demographic data will provide a more holistic approach to understanding and managing lower urinary tract symptoms in aging male populations.

**CONCLUSION**

Sonographic measurement of BWT is a good tool in the assessment of BOO. It showed a better accuracy for BOO when compared with Prostatic volume.

**RECOMMENDATION**

Addressing the role of sociodemographic factors in symptom progression could make for a more targeted and efficient healthcare intervention, especially in the elderly.

Data: Anonymized data could be made available upon request by the corresponding author.

Ethical approval: This was received from the institution of the study with reference number UNTH/CSA.329/VOL.5 and the study was conducted under the ethical principles of the Declaration of Helsinki.

Conflict of interest: None

Artificial intelligence: Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators were used during the writing or editing of manuscripts.

**REFERENCES**

1. McGuire EJ. Detrusor response to outlet obstruction. World J Urol. 1984; 2: 208-10.
2. Levin RM, Haugaard N, O’Connor L, Buttyan R, Das A, Dixon JS, et al. Obstructive response of human bladder to BPH vs. rabbit bladder response to partial outlet obstruction: a direct companion. Neurourol. Urodyn. 2000; 19: 609-29. [https://doi.org/10.1002/1520-6777(2000)19:5<609::aid-nau7>3.0.co;2-h](https://doi.org/10.1002/1520-6777%282000%2919%3A5%3C609%3A%3Aaid-nau7%3E3.0.co;2-h)
3. Housani F, Drake M, Adams P. (2009) The use of ultrasound estimated bladder weight in diagnosing bladder outlet obstruction and detrusor overactivity in men with lower urinary tract symptoms. Indian J Urol.2009; 25: 105-9.PMCID: PMC2684305 PMID: 19468439
4. O'Leary MP. (2003) Lower urinary tract symptoms/benign prostatic hyperplasia: maintaining symptom control and reducing complications. Urology. 2003; 62 (3 Suppl 1): 15‐23. [https://doi.org/10.1016/s0090-4285(3)00480-1](https://doi.org/10.1016/s0090-4285%283%2900480-1) PMID: 12957196.
5. Bosch R, Abrams P, Averbeck MA, Finazzi Agró E, Gammie A, Marcelissen T, et al. (2019) Do functional changes occur in the bladder due to bladder outlet obstruction? - ICI-RS 2018. Neurourol Urodyn.. 2019; 37 Suppl (S:uppl 5): S56–65. <https://doi.org/10.1002/nau.24076> PMID: 31278801; PMCID: PMC6915908.
6. Elmissiry MM, Amr GA, Abulfotooh A, Moussa AA, Ali GA. (2014) Factors determining the amount of residual urine in men with bladder outlet obstruction: Could it be a predictor for bladder contractility? Arab J Urol. 2014; 12(3): 214 - 218. <https://doi.org/10.1016/j.aju.2914.03/003>
7. ElSaied W, Mosharafa A, ElFayoumy H, ElGhoniemy M, Ziada A, ElGhamrawy H, et al. (2013) Detrusor wall thickness compared to other non-invasive methods in diagnosing men with bladder outlet obstruction: A prospective controlled study. Afric J Urol. 2013; 19(4):160 -164. <https://doi.org/10.1016/j.afju.2013.03.003>
8. Lepor H. (2005) Pathophysiology of Lower Urinary Tract Symptoms in the Aging Male Population. Rev Urol. 2005; 7 Suppl 7 (Suppl 7): S3-S11. PMID: 16986059; PMCID: PMC1477625.
9. Kirkwood BR. Essentials of Medical Statistics. Blackwell Scientific Publications; 1st Ed. London. 1988:196-7.
10. Blatt AH, Titus J, Chan L. (2008) Ultrasound measurement of bladder wall thickness in assessment of voiding dysfunction. J Urol. 2008; 179: 2275-80. discussion 2278-9. doi: 10.1016/j.juro.2008.01.118. PMID: 18423703
11. Oelke M, Hofner K, Jonas U, de la Rosette JJ, Ubbink DT, Wijkstra H. (2007) Diagnostic accuracy of non-invasive tests to evaluate bladder outlet obstruction in men: Detrusor thickness, Uroflowmetry, Post-void residual urine, and Prostate volume. Eur. Urol. 2007; 52: 827-834. <https://doi.org/10.1016/j.eururo.2006.12.023>
12. Isikay L, Turgay AK, Nuhoglu B, Ozdwmir G, Ayyildiz A, Cavumirza T, et al. (2007) Lower urinary tract symptoms, prostate volume, uroflometry, residual urine volume, and bladder wall thickness in Turkish men: a comparative analysis. Int.Urol. Nephrol. 2007; 39: 1131-35. <https://doi.org/10.1007/s11255-006-9161-y> Epub 2007 Mae 2. PMID: 17333519.
13. Irwin DE, Kopp ZS, Agatep B, Milson I, Abeams P. (2011) Worldwide prevalence estimates of Lower urinary tract symptoms, overactive bladder, urinary incontinence, and bladder outlet onstruction. BJU Int. 2011; 108: 1132-8. <https://doi.org/10.1111/j.1464-410X.2010.09993.x> PMID: 21231991.
14. Ng M, Leslie SW, Baradhi KM. (2024 Benign Prostatic Hyperplasia. StatPearls - NCBI Bookshelf. 2024. <https://www.ncbi.nlm.nih.gov/books/NBK558920/>
15. Abdelmoteleb H, Jefferies ER, Drake MJ. (2016) Assessment and management of male lower urinary tract symptoms (LUTS). International Journal of Surgery 2016 Jan 1; 25:164–71. <https://doi.org/10.1016/j.ijsu.2015.11.043>
16. Bhattarai K, Khadka H, Thapa BR, Katwal S. (2024) Association of detrusor wall thickness (DWT) with lower urinary tract symptom severity in benign prostatic hyperplasia: a cross-sectional study. Annals of Medicine and Surgery. 2024 Apr 17; 86(6):3249–54. <https://doi.org/10.1097/ms9.0000000000002062>
17. Tubaro A, Miano L. (2002) Managing the consequences of obstruction. European Urology supplements. 2002; 1: 21-27. doi: [https://doi.org/10.1016/S1569-9056(02)00120-3](https://doi.org/10.1016/S1569-9056%2802%2900120-3)
18. Matthews PN, Quayle JB, Joseph AE, Williams JE, Wilkinson KW, Riddle PR. (1982) The use of Ultrasound in the investigation of Prostatism. Br J Urol. 1982; 54: 536-538. [HTTPS://DOI.ORG/101111/J.1464-410x.1982.tb13584x](https://DOI.ORG/101111/J.1464-410x.1982.tb13584x) PMID: 6184109
19. Blatt AH, Jehan T, Chan L. (2008) Ultrasound measurement of bladder wall thickness in assessment of voiding dysfunction. J Urol. 2008; 179: 2275-8; discussion 2278-9. <https://doi.org/101016/j.juro.2008.01.118> PMID: 184223703.
20. Ozdedeli S, Akkoc Y, Demirel Y, Atamaz F, Durmaz B. Bladder wall thickness and ultrasound estimated bladder weight in healthy adults with a portable ultrasound device. [www.ics.org/Abstracts/publish/45/000347.pdf.](http://www.ics.org/Abstracts/publish/45/000347.pdf.%20%20)
21. Sabri MK, Mahmoud MA, Bahaa E, Hamdy A, Mustafa EA. (2012) The role of ultrasound estimated bladder wall thickness in the prediction of detrusor overactivity in patients with irritative lower urinary tract symptoms. UroToday Int. J. 2012; 5: 48. <http://dx.doi.org/10.3834/uij.1994-5784.2012.10.07>
22. Anwar M, Saifullah M, Malik MTB, Munir MI, Akmal M, Subhani GM, Javed SH. (2020) Correlation between bladder wall thickness and IPSS in patients having benign prostatic hyperplasia. Professional Med J 2020; 27(12):2553-2557. <https://doi.org/10.29309/TPMI/2020.27.12.5021>
23. Oelke M, Hofner K, Wiese B, Grunewald V, Jonas U. (2002) Increase in detrusor wall thickness indicates bladder outlet obstruction (BOO) in men. World J. Urol. 2002; 19: 443-452. <https://doi.org/10.1007/s00345-001-0238-z> PMID: 12022713.
24. Kessler TM, Gerber R, Burkhard FC, Studer UE, Danuser H. (2006) Ultrasound assessment of detrusor thickness in men- can it predict bladder outlet obstruction and replace pressure flow study? J. Urol 2006: 175: 2170 - 3. https[://doi.org/10.1016/S0022-5347(06)00316-8](https://DOI.ORG/10.1016/S0022-5347%2806%2900316-8)
25. Peedikayil AV, Shyamkumar NK, Kekre N. (2004) Diagnosing bladder outlet obstruction can we do away with pressure flow studies? Indian J. Urol. 2004; 20: 36 - 41. <https://journals.iww.com>
26. Prakash JVS, Arun A, Balaji AR, Vetrichandar S, Arasi KV, et al. (2019) Detrusor Wall Thickness an Adjunct or Alternative in the Diagnosis of Bladder Outlet Obstruction in Men - Prospective Controlled Study. J Urol Ren Dis 04; 1171. <https://doi.org/10.29011/2575-7903.001171>
27. Anilkumar BU, Shyam S. (2020) Correlation of international prostate symptom score and uroflowmetry in evaluation of benign prostatic hyperplasia. Int Surg J. 2020; 7(10):3381-88. <https://doi.org/10.18203/2349-2902.isj20204141>
28. Amu OC, Udeh EI, Ugochukwu AI, Dakum NK, Ramyil VM. (2013) The value of international prostate symptom scoring system in the management of BPH in Jos, Nigeria. Niger J Clin Pract. 2013; 16(3): 273–8. <https://doi.org/10.4103/1119-3077.113446> PMIB: 23771445.
29. Bassey I-AE, Isiwele EM, Eyam SE, Ushie DE, Ani NE. (2018) Correlation of International Prostate Symptom Score with Prostate Volume and Quality of Life in a Screened Population of University Workers. Int J Contemp Med Res. 2018:5: 15-17.
30. Ulebe AO. (2021)Correlation of detrusor wall thickness with International prostate symptom score: A cross-sectional study of Nigerian men with prostate-related diseases. J Clin diag resear. 2021 15: 8-12. <https://doi.org/10.7860/JCDR/2021/45176.15419>
31. Jindal T, Sinha RK, Mukherjee S, Mandal SN, Karmakar D. (2014)Misinterpretation of the international prostate symptom score questionnaire by Indian patients. Indian J Urol. 2014; 30(3):252–5. [https://doi.org/10.4103/0970=1591.134246](https://doi.org/10.4103/0970%3D1591.134246)