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Research Article

The Value of Abdomino-Pelvic (Trans-Abdominal) Ultra-Sound Scan in Evaluating Patients with Bladder Outlet Obstruction: A Retrospective Study

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Abstract: Bladder outlet obstruction is a recognized urological condition especially in aging males who may have prostate enlargements from benign or malignant lesions or when infra-vesical obstruction is due to urethral stricture in relatively younger subjects. Ultrasound scan is an integral tool in confirming suspected pathologies and also revealing incidental findings which could be life-threatening in some and of no effect in others. We retrospectively studied 156 patients who presented for follow up in the urology clinic with abdomino-pelvic ultrasound scan results. The mean age of the patients was 65.10(35-91) years. They were all males. Urinary bladder abnormalities consisted of increased bladder wall thickness (BWT) in 90(87.4%) patients, post void residual volume (PVRV) was abnormal in 31 (68.9%) patients and bladder stone was seen in 6 (3.8%) patients. The prostate gland was also evaluated with abnormal findings as follows: Prostate volume in 143(92.3%) patients, prostate outline was irregular in 50(32.1%) patients, the later finding showed a statistically significant association with the diagnosis of prostate cancer. Seminal vesicles were dilated bilaterally in 10(62.5%) out of 156 patients. The upper tract abnormalities were also noted and discussed. Abdomino-pelvic ultrasound scan just like trans-rectal ultrasound scan is very useful in assessing patients suspected of bladder outlet obstruction (BOO) with the added advantage of being able to visualize the upper tracts with the same probe. It is quite safe, quick, affordable and without risk of contrast allergy and radiation exposure.
Keywords: Value, Abdomino-pelvic ultrasound scan, Bladder Outlet Obstruction

INTRODUCTION

Bladder Outlet Obstruction remains a major urological problem among middle aged and elderly male population. Majority of them have prostate pathology as the cause. Bladder Outlet Obstruction (BOO) leads to lower urinary tract symptoms (LUTS) characterized by both obstructive and irritative symptoms. Complications from this disease process have been seen in the bladder, ureters and kidneys at varying proportions. Various laboratory and ancillary imaging studies can be used to evaluate the urinary tract in this setting of outlet obstruction. Renal function test can elaborately screen for the pattern of electrolyte, urea and creatinine as an index of renal status while imaging studies can allow structural evaluation of the entire urinary tract and any abnormality occasioned by an obstruction. There are currently a number of imaging modalities designed for this purpose which include ultrasound scan, computed tomography (CT) Scan, magnetic resonance imaging (MRI) and radioactive renal scans. Ultrasound scan by reason of being readily available, affordable, has been preferred in many centres. Ultrasonographic features of the urinary tract in outlet obstruction may suggest the specific pathology in the prostate and can also show evidence of complications in the bladder, ureters and kidneys. This can actually direct further investigative modalities and specific therapy. In evaluating the characteristics of the prostate, trans-rectal ultrasound (TRUS) is said to be superior to trans-abdominal route, however, the later is said to be equivalent to TRUS when prostate is visualized at a bladder volume>100mls[2]. It also offers the comfort of assessing the upper tracts with the same probe. Ultrasound scan can adequately measure prostate size/volume, echotecture and outline. Values of any pattern out of normal will direct further investigations. Bladder wall thickness, echotecture of its content and post void residual urine are very informative as well as the status of the ureters and kidneys in BOO.

This study is set to document the value of abdomino-pelvic ultrasound scan in evaluating the entire urinary tract in the setting of bladder outlet obstruction.

PATIENTS AND METHODS

A retrospective study of one hundred and fifty six (156) patients who presented in the clinic for follow up visits between February, 2016 to June, 2016. The study was restricted to all adult male patients seen with symptoms of bladder outlet obstruction. Exclusion criteria were those with known functional obstruction e.g neurogenic bladder from spinal cord injuries and

diabetic cystopathy. Information retrieved from their case notes included age, signs and symptoms, relevant investigation results including abdomino-pelvic ultrasound scan, renal function test, diagnostic modalities including a PSA, prostate biopsy, a retrograde urethrocystogram and a micturating cystourethrogram (where applicable). Data collected were analyzed using statistical package for social sciences (SPSS) Version 20.0 software and results used for the discussion.

RESULTS

One hundred and fifty six (156) male patients with a mean age of 65.10±10.324 years (35-91) were enrolled in the study. 37(23.7%) patients were diagnosed with cancer of the prostate (Cap), while 113 (72.4%) and 6 (3.9%) patients were respectively diagnosed with benign prostatic hyperplasia (BPH) and urethral stricture. Ultrasonographic characteristics of the variables were as follows: Mean bladder wall thickness (BWT) was 9.155mm±3.5860 (2.1-22.0); 13(12.6%) patients had normal values (<5.0mm) and 90(87.4%) patients had abnormal values (>5mm). Post void residual urine was within normal in 14(31.1%) patients (<50mls) and abnormal in 31(68.9%) patients (>50mls) with a mean of 207.522mls±280.4049 and a range and inter-quartile range of 1016.5 and 140.5mls respectively. Bladder stone was seen in 6(3.8%) patients. Prostate volume was within normal range (20-25cm^3) in 12(7.7%) patients and abnormal in 143 (92.3%) patients (>25cm^3) with a mean of 91.716cm^3±89.0505(14.9-780.6). Prostate outline was regular in 106(67.9%) and irregular in 50(32.1%). Prostate echotexture was hypoechoic in 25(16.1%) patients, hyperechoic in 43(27.8%) patients and mixed echo in 87(56.1%) patients. Seminal vesicles were dilated in 16(10.3%) patients out of which both were dilated in 10(62.5%) patients while the right and left were involved in 4(25.0%) and 2(12.5%) patients respectively. Hydroureter was present in 4(2.5%) patients of which 3(75%) patients had bilateral hydroureter and 1(25%) isolated left hydroureter. Hydronephrosis was seen in 26(16.7%) patients; bilateral in 17(65.4%) patients while isolated right and left involvements were noted in 5(19.2%) and 4(15.4%) patients respectively. Incidental renal cysts in 18(11.5%) with bilateral cysts in 5(27.8%)patients, 8(44.4%) patients and 5(27.8%) patients had cysts respectively in the right and left kidneys. One case of left renal stone was seen (0.06%). No renal tumour was encountered. Renal corticomedullary differentiation was preserved in both kidneys in 143(91.7%) patients and lost bilaterally in 10(6.4%) patients. Mean prostate volume for BPH was 86.267±65.7389. Mean post void residual volume was highest in BPH (241.403 mls ±325.9187) with a range and inter-quartile range of 1016.1 and 140.5mls respectively.

Table 1: Lower Urinary Tract Ultrasonographic Characteristics:

Urinary Bladder (n=155)

Frequency	**Normal**	**Abnormal**	**Mean**	**Range**	**Inter-quartile range**
Wall Thickness(n= 103)	13(12.6%)	90 (87.4%)	9.155±3.5860	2.1-22.0	=
PVR Volume(n=45)	14(31.1%)	31 (68.9%)	207.522±280.4047	1016.1	140.5
Bladder stone 6(3.8%)					
Prostate volume(n=155)	12(7.7%)	143 (92.3%)	91.716±89.0505	14.9-780.6	=
Prostate outline(n=156)	Regular 106 (67.9%)	Irregular 50 (32.1%)			
Prostate echotexture: (n=155)	Hypoechoic 25 (16.1%)	yperechoic 43 (27.8%)	Mixed-echo 87(56.1%)		

Seminal vesicle n=16(10.3%):

Sides	**Frequency**	**Valid Percent**	**Cumulative Percent**
Right dilated	4	25.0	25.0
Left dilated	2	12.5	37.5
Both dilated	10	62.5	100.0

Table 2: Upper tract ultrasound characteristics:

	Frequency	Valid Percent	Cumulative %
Hydroureter n = 16(2.5%)			
Left	1	25	25
Bilateral	3	75	100
Hydronephrosis n = 26(16.7%)			
Right	5	19.2	19.2
Left	4	15.4	34.6
Bilateral	17	65.4	100.0
Renal cysts n=18(11.5%)			
Right	8	44.4	44.4
Left	5	27.8	72.2
Bilateral	5	27.8	100.0
Renal stone n=1(0.064%)			
Left	1	100.0	100.0
Renal Tumour n=0(0.0%)			

Renal corticomedullary differentiation (n=156)

Side	**Preserved**	**Lost**
Left	146 (93.6%)	10(6.4%)
Right	145(91.7%)	13(8.3%)
Both	143(91.7%)	10(6.4%)

Table 3: Diagnosis/Lower urinary tract ultrasonographic characteristics:

(i) Post void residual volume (n=156)

Diagnosis	**Frequency n(%)**	**Mean**	**Range**	**Inter-quartile Range**
Cap	37(23.7)	141±117.5098	388.0	=
BPH	113(72.4)	241.403±325.9187	1016.1	145.0
Urethral Stricture	6(3.9)	81.500±23.3345	33.0	=

(ii) Prostate volume n(155)

Diagnosis	**Frequency n(%)**	**Mean**	**Range**	**Inter-quartile Range**
Cap	37(23.9)	119.185±137.6991	756.6	76.5
BPH	112(71.8)	86.267±65.7389	481.0	55.8
Urethral Stricture	6(4.3)	24.167±8.2856	24.1	11.4

(iii) Prostate outline (n=156)

Diagnosis	**Regular n(%)**	**Irregular n(%)**	**Total n(%)**	**Statistical Values** DF= 2
Cap	11(29.7)	26(70.3)	37(100.0)	P value= 0.000*
BPH	89(78.8)	24(21.2)	133(100.0)	
Urethral Stricture	6(100.0)	0(0.0)	6(100.0)	

***There is a statistically significant association between the diagnosis of Cap and irregular prostate outline (Pvalue=0.000).**

(iv) Prostate echotexture (n=156)

Diagnosis	**Hypoechoic n(%)**	**Hyperecloic n(%)**	**Mixed n(%)**	**Total n(%)**
Cap	25(67.6)	12(32.4)	0(0.0)	37(100.0)
BPH	0(0.0)	31(27.4)	82(72.6)	113(100.0)
Urethral Stricture	0(0.0)	0(0.0)	6(100.0)	6(100.0)

(v) Seminal vesicle (n=16)

Diagnosis	Right dilated n(%)	Left dilated n(%)	Both dilated n(%)	Total n(%)
Cap	1(25.0)	1(25.0)	2(50.0)	4(100.0)
BPH	3(30.0)	1(10.0)	6(60.0)	10(100.0)
Urethral Stricture	0(0.0)	0(0.0)	2(100.0)	2(100.0)

Table 4: Diagnosis and upper urinary tract ultrasonographic characteristics:

(i) Hydroureter (n=4)

Diagnosis	Right n(%)	Left n(%)	Bilateral n(%)	Total n(%)
Cap	0(0.0)	0(0.0)	1(100.0)	1(100.0)
BPH	0(0.0)	1(50.0)	1(50.0)	2(100.0)
Urethral Stricture	0(0.0)	0(0.0)	1(100.0)	1(100.0)

(ii) Hydronephrosis (n=26)

Diagnosis	Right n(%)	Left n(%)	Bilateral n(%)	Total n(%)
Cap	0(0.0)	1(16.7)	5(83.3)	6(100.0)
BPH	5(26.3)	3(15.8)	11(57.9)	19(100.0)
Urethral Stricture	0(0.0)	0(0.0)	1(100.0)	1(100.0)

(iii) Renal cysts (n=18)

Diagnosis	Right n(%)	Left n(%)	Bilateral n(%)	Total n(%)
Cap	4(80.0)	0(0.0)	1(20.0)	5(100.0)
BPH	4(33.3)	4(33.3)	4(33.3)	12(100.0)
Urethral Stricture	0(0.0)	1(100.0)	0(0.0)	1(100.0)

(iv) Renal stone (n=1)

Diagnosis	Right n(%)	Left n(%)	Bilateral n(%)	Total n(%)
BPH	0(0.0)	1(100.0)	0(0.0)	1(100.0)

(v) Renal tumour: nil

(vi) Renal corticomedullary differentiation (n=156):

Diagnosis	Both preserved n(%)	Both lost n(%)	Total n(%)
Cap	34(94.4)	2(5.6)	36(100.0)
BPH	104(93.7)	7(6.3)	111(100.0)
Urethral Stricture	5(83.3)	1(6.7)	6(100.0)

DISCUSSION

Bladder outlet obstruction refers to blockage of urine flow from the bladder to the urethra [3]. It is a common condition in elderly males due mostly to prostatic diseases [4]. The patients present with lower urinary tract symptoms (LUTS). In the long term, complications in the bladder, ureters and the kidneys may occur. Ultrasound scan remains one of the ancillary imaging tools for evaluation of such patients being safe, quick, affordable and with no risk of contrast allergy and radiation exposure.

Increases in bladder wall thickness (BWT) occurs in the setting of BOO due to increase in size of its constituent tissues such as the mucosa, submucosa, detrusor and serosa/adventitia. There is a significant change in the extracellular matrix structure of the obstructed bladder with increases in the ratio of type 3 to type 1 collagen resulting in decreased bladder compliance which will ultimately affect the response of the bladder to filling and contraction [5]. BWT measurement by ultrasound can be conveniently used to evaluate patients with lower urinary tract obstruction given its non invasiveness as compared to urodynamic tests. Moreover, Oelke *et al*[6] found out that BWT was more useful compared to uroflometry, post void residual urine and prostate volume in the evaluation of patients with LUTS. Again, although pressure flow studies (PFS) is the gold standard technique for the differentiation of BOO and detrusor hypo-contractility, BWT can predict BOO as well as PFS. Except for detecting hypo-contractility in BOO patients, PFS is optional [7] in the evaluation of patients with LUTS aside from its invasiveness and cost. Klinger *et al* [8] recorded urinary retention and gross haematuria during and after urodynamic investigations in 19% of his patients indicating its invasiveness. Manieri *et al* [9] also found a strong association between urodynamic pressure measurements and bladder wall thickness. Another study [10] also reported that BWT parameters was higher in patients who had Qmax of <10mls which is consistent with an obstructed bladder.

Measurements of BWT is however affected by the volume of the bladder during the procedure and it is general knowledge that BWT decreases steadily up to 50% of capacity and thereafter remains constant till full capacity (100% full). In our study, the procedure commenced at full bladder capacity which is thought to exceed 250mls and ultimately excludes patients with detrusor instability who have a bladder capacity less than 250mls. At present, there is no concensus as to the cut-off value of BWT that is directly used as a diagnostic point for BOO patients. Several studies have used values $\geq$5mm as cut-off for BOO patients [9,11]. According to Kim *et al* [12], BWT >5mm was associated with higher post void residual volume and acute urinary retention. A different author and colleagues reported that BWT $\geq$2mm was 95.5% diagnostic of lower urinary tract obstruction [13]. At the same time Elsaied *et al*[14] postulated that patients were classified as obstructed when the detrusor wall thickness (DWT) was $\geq$2mm and non-obstructed with $\leq$2mm. These 2 studies use same cut-off value for both BWT and DWT yet BWT is thicker than DWT by reason of its component tissues. Considering the implication of this in interpreting our results, we choosed >5mm as the cut-off value denoting abnormal BWT. Also, according to some researchers, BWT of 5mm appears to be the best cut-off points for diagnosing BOO with a high sensitivity and specificity [9].

In our study, the mean BWT was 9.155mm$\pm$3.5860. This was higher than 5.25mm$\pm$1.76 reported by Ayhan *et al*[15], who also detected lower urinary tract obstruction in 87.5% of patients with LUTS and BWT>5mm. Our report of 90(87.4%) patients with BWT>5mm and LUTS was consistent with their study. The wide disparity in the mean BWT may be due to patients selection and most importantly on the operator dependency of ultrasound scan and type of machine used as well as the population of patient studied and duration of obstruction. Yilmaz *et al*[16] also saw a link between BWT and duration of lower urinary tract obstruction in patients with LUTS.

Interpreting results of BWT should however be done with caution as there are few factors that can influence it. Infection in the bladder and tumours should be ruled out by doing a urine (mid stream urine) culture and a cystoscopy to visualize the interior of the bladder. Secondly, ultrasound feature of the mucosa/submucosa together with the outer adventitia is said to be hyperechogenic relative to the detrusor layer which is hypoechogenic. The peri-vesical tissues also have the same echopattern as the adventitia which may be erroneously measured as part of BWT. On the whole, with the high sensitivity and specificity recorded by many authors, BWT as a surrogate of BOO in patients with LUTS is highly justified.

Post void residual urine is the volume of urine remaining in the bladder immediately after completion of voiding. It was measured in 45(29%) patients, the rest were on catheter drainage which precluded such measurement. It was abnormal in 31(68.9%) patients being considered so when measurements exceeded 50mls. Significant post void residual volume is a frequent manifestation of BOO and a serial measurement may indicate clinical progression of the underlying cause of obstruction[17]. In a study by Gilpin *et al*[18], post void residual volume correlated well with BWT and uroflometry in patients with infra-vesical obstruction. The mean ultrasound estimated post void residual volume (PVRV) in our study was 207.522mls$\pm$280.40 which was lower than that reported by Adewumi *et al*[19] by both ultrasound and catheterization. Traditionally, bladder catheterization was used to estimate PVRV and it is regarded as the gold standard and accurate means of measurement [20]. However, its use may be complicated by urethral trauma and infection [21] in contrast to ultrasound which carries no such morbidity beings non-invasive and quite safe. With these special characteristics of ultrasonography, a lot of authors recommend it as an alternative to catheterization [22] and has been preferred by patients. However, interpretation of PVRV should be done with caution. Eriz *et al*[23] advocated

that PVRV measurement should be done when pre-micturition bladder volume is less than 540mls (at moderate sense of micturition). This is because voiding at full bladder capacity will stress and temporarily decompensate the bladder causing unreliable post void residual urine measurements [24]. This was demonstrated in healthy volunteers without LUTS who voided at mean pre-micturition volume < 540mls with no evidence of pathological PVRV (>50mls) and same patients who voided at mean pre-micturition volume of 639mls in which 60% of them recorded pathological volume[24]. Although PVR urine volume is an important factor in diagnosing voiding dysfunction and also directing further line of management of patients with this condition, it is not without limitations. In our study, being retrospective, we were limited by lack of information regarding the pre-micturition volume of the bladder which may have affected the result in any where, however, it has primed our minds for a future prospective research in this direction, albeit very helpful study in knowledge integration.

Bladder stone was seen in 6 (3.8%) patients. It is not a rare condition in long-standing BOO due to stasis and crystallization of substances in urine. Bladder stone in the setting of BPH may influence the choice of treatment being an absolute indication for open prostatectomy (trans-vesical) to extract it at same surgery.

Ultrasonography estimation of the prostate size/volume is the preferred method being more accurate than digital rectal examination (DRE). The latter is also fraught with inter-examiner variability and underestimates the prostate size [25]. Normal adult has a prostate gland that measures between 20-25g [26] (20-25cm^3). The normal echotexture is a homogenous ovoid structure with mixed low-level echoes on ultrasound [27]. Prostate enlargement has been known as a common cause of BOO in middle and aged males. In our study, the mean prostate volume was 91.716cm^3±89.05 and was abnormal in 143(92.3%) patients. This was higher than 56.2cm^3 reported by Ahmed *et al* [28]. In the later study, they used TRUS which is said to be superior to trans-abdominal ultrasound in assessing the prostate and its features [29]. In another study [30] using trans-abdominal route, a mean prostate volume was 214.0±8.40cm^3, a value far higher than what we reported. The reason for this wide differences might be difficult to explain but a strong factor could be differences in the experience of the operator. Prostate volume in symptomatic BPH does not correlate with symptom severity but may determine the choice of treatment. Volumes greater 60cm^3 (60mls) where surgery is indicated are usually treated by open prostatectomy although experienced urologists can still resect this volume. In our study, mean prostate volume for BPH was 86.267cm3±65.7, this value and in various other studies in blacks are relatively larger than those of the white and Asian populations [30] and so open prostatectomy still remain a relevant treatment modality. The nature of prostate outline and echotecture can also direct further evaluation and offer a choice of treatment modality. About one-third of the patients had irregular prostate outline and about half of that number had hypoechoic nodules in the peripheral zone. These features are typically seen in prostate cancer. This information will warrant prostate biopsy and further management in line with cancerous prostate. There was a significant statistical relationship between a diagnosis of Cap and irregular outline of the prostate (Table 3, Pvalue = 0.000)

Seminal vesicles were dilated in 16(10.3%) patients and bilateral involvements in about two-third of this number. This is however a non-specific condition which could be congenital or acquired secondary to inflammatory aetiologies, ejaculatory duct obstruction, cancer cell infiltration from the prostate, bladder and rectum. Tumour involvement of the seminal vesicle is commonly seen with prostate cancer [31] while primary neoplasms of the seminal vesicle which arise from the epithelial or mesenchymal elements are very rare [32].The presence of dilated seminal vesicle on ultrasound will attract concerns as to the state of other related structures and a focused evaluation with magnetic resonance imaging (MRI) to rule out tumours especially of prostatic origin and will also direct further management.

Upper tract abnormalities can also be confirmed on suspicion from symptoms or discovered incidentally. Hydronephrosis was detected in 26(16.7%) patients and about two-third of them were bilateral. This is worthwhile in directing further line of management before renal damage occurs. Patients with LUTS or acute urinary retention with evidence of hydronephrosis should not be offered a trial of voiding because hydronephrosis occurs long before the renal biochemical parameters become apparent [33]. It occurs due to obstruction at any point along the urinary tract which interferes with normal antegrade urine flow. Hydronephrosis on ultrasound scan was seen in 95% of patients with obstruction [34] increasing to 100% sensitivity in moderate to severe hydronephrosis [35]. However obstruction without hydronephrosis can occur due to pathologies that prevent dilatation of the collecting system e.g. in retroperitoneal fibrosis and tumours, in volume depletion and acute obstruction where the event is too early for dilatation to take place [36]. On the other hand, hydronephrosis can occur without any obstruction as in pregnancy, vesico-ureteric reflux, full bladder, urinary tract infection, brisk diuresis as in nephrogenic diabetes insipidus and after relief of obstruction [37]. With this in mind, the presence of hydronephrosis should be confirmed with clinical suspicion of obstruction together with imaging studies such as diuretic renography, doppler imaging for

ureteral jets and treatment directed on the underlying pathology.

Incidental renal cyst was seen in 18(11.5%) patients with no suspicious features. No renal tumour was encountered. Incidentally, ultrasonography can accurately differentiate between a renal cyst and a tumour. One case of left renal stone with a strong posterior acoustic shadow was seen in a BPH patient. This also strongly supported a distal obstruction and an indication for prostatectomy. Renal corticomedullary differentiation was lost in both kidneys in 10(6.4%) patients. This indicates long standing urinary tract obstruction and a reflection of the degree of renal insufficiency. Loss of corticomedullary differentiation has been observed in renal insufficiency secondary to a variety of aetiologies including obstructive hydronephrosis [38].

CONCLUSION

Abdominopelvic ultrasound scan is an indispensable tool in the evaluation of patients with bladder outlet obstruction. Being non-invasive, cheap, readily available and sometimes portable, its use is widely accepted. With the use of this instrument, incidental findings in the urinary tract which may be life threatening can be discovered early and curative treatment offered to the patient. It can also confirm suspicious lesions all in an attempt to offer a focused management plan for the patients.

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