

Role of ultrasound imaging in prostatic lesions and its correlation with biochemical and clinical findings

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Abstract

Background: In this cross-sectional study, we study the role of ultrasonography in evaluation of prostatic lesions and its correlation with biochemical and clinical parameters and findings.

Methodology: The present study entitled “Role of ultrasound imaging in prostatic lesions and its correlation with clinical & biochemical findings” was carried out for a period of two years. The study was conducted at Gandhi Medical College, & associated Hospitals (Hamidia Hospital) Bhopal, A total of 100 participants were enrolled in the study.

Results: As per the study, it was concluded that ultrasound was quite effective in assessing various causes of prostate enlargement. 82% cases were benign which mostly comprises of benign prostatic hyperplasia, with rest 18 % cases which were found to be malignant.

Benign cases predominantly demonstrated increased prostate volume, smooth margins, calcification, homogenous echotexture with median lobe indenting into bladder base. Malignant cases were identified on the basis of irregular margins, heterogenous echotexture, suspicious nodule showing raised intralesional vascularity and features of local infiltration. In our study, various ultrasound parameters such as increased prostate volume (>30cc), significant post void residual volume (>100cc), high grade of IPPV (>10mm), heterogenous echotexture and calcification were found to have increased severity of clinical symptoms and were found statistically significant (p=0.003). Whereas presence of intralesional/ parenchymal vascularity and smooth/ irregular margins were not found statistically significant in our study (p> 0.05).

PSA levels additionally complimented in evaluation of prostatic lesions. PSA in the range of 4-10ng/ml was found mainly in benign conditions, whereas >10ng/ml was observed in malignant prostatic lesion which showed highly significant association (P value < 0.001).

Conclusion: Ultrasound being a noninvasive procedure showed good results in diagnosing benign & malignant conditions therefore it should be the earliest investigation of choice in suspected patients with lower urinary tract symptoms.

Keywords: Ultrasonography, hyperplasia, echotexture, PSA.

Introduction

The prostate is a glandular part of the male reproductive system and is located just below the urinary bladder and anterior to rectum. Its physiological role is to produce a part of seminal fluid. As a man ages, the prostate gland tends to increase in size and result in genitourinary symptoms.¹

The diseases which are associated with the prostate are prostatitis, benign prostatic hyperplasia (BPH), and prostate carcinoma (PCa).² Although BPH is not life-threatening, its clinical manifestation such as Lower Urinary Tract Symptoms (LUTS) reduces the patient's quality of life.

Prostate cancer is primarily a disease of elderly men with more than three-quarters of the cases occurring in men above 65 years of age.³ In men Prostate carcinoma is the second most occurring cancer and the fifth leading cause of death globally. The worldwide burden of Prostate carcinoma is expected to grow to 1.7 million new cases and 4,99, 000 new deaths by 2030 which can be attributed to the growth and aging of the global population.

American Urological Association (AUA) recommends men of 50 years of age or above without any family

history of cancer and those at 40 years of age with family history must undergo a digital rectal examination (DRE) and PSA levels annually. Screenings for P. Ca include serum PSA and digital rectal examination (DRE); a biopsy is required to diagnose P.Ca.

The major limitation of using PSA, as a screening prostate cancer biomarker, is that majority of the men suffer from BPH and prostatitis as they become old, which increases their serum PSA levels. Therefore, PSA alone cannot be used as a biomarker for cancer detection. The elevated levels of PSA do not indicate cancer but the higher the PSA level, the more the chance of having cancer. With the advancement of imaging techniques, it is possible to provide better characterization of prostatic lesions and increase the detection of prostatic cancers.⁵

One such imaging technique is Trans rectal ultrasonography (TRUS) which is the most commonly used modality for imaging the prostate gland and is also the standard method recommended for measurement of Prostate Volume (PV). TRUS of the prostate has a diagnostic accuracy of 80%.⁶ TRUS can detect alterations in size, echotexture and vascularization of the prostate and Seminal Vesicle.⁷ On ultrasonography, prostate cancer is usually seen as a hypoechoic lesion (60–70% of the lesions), commonly in the peripheral zone, but can also be hyperechoic or isoechoic (30–40% of the lesions), whereas the typical sonographic feature of BPH is the enlargement of the inner gland (transition zone) which can exhibit diffuse enlargement or distinct hypoechoic, isoechoic, or hyperechoic nodules.⁷

Prostate Volume varies widely throughout a man's lifetime, and in the course of different prostatic diseases. Prostate volume estimates are routinely reported with pelvic imaging. PV is a predictor for the symptom's progression and the risk of complications such as urinary retention. PV may also be determinative in the decision

for BPH treatment. It is also required for calculating prostate-specific antigen (PSA) density when selecting active surveillance candidates.⁷

With this background, the present study is undertaken with the aim to assess Prostatic volume and serum PSA levels in Indian men with prostatic enlargement in different age groups.

Materials & methods

The present study entitled “Role of ultrasound imaging in prostatic lesions and its correlation with clinical & biochemical findings” was carried out for a period of two years.

Study design: prospective cross-sectional study.

Study area: Department of Radiodiagnosis, Gandhi Medical College, & associated Hospitals (Hamidia Hospital) Bhopal.

Study duration: August 2021 to November 2022

Sample population: 100 participants

Inclusion criteria

- All patients referred to Department of Radiodiagnosis, Gandhi Medical College, & associated Hospitals (Hamidia Hospital) Bhopal with suspicion of prostatic enlargement.
- All male cases age 50 years and above.
- Subjects consenting for the study.

Exclusion criteria

- Patients not consenting for the study.
- Normal ultrasound imaging with no clinical symptoms
- Proven prostate carcinoma.
- Previous prostate surgery
- Patients on treatment with 5-alpha reductase inhibitors (5-ARIs)
- Acute abdominal trauma

Study tool

- Ultrasound with colour flow imaging (USG): The patients were scanned under USG machine which can combine a real time B mode imaging system with color Doppler facilities together.
- Laboratory investigations- PSA values

Methodology

Permission to conduct the study was obtained from the ethical committee of Gandhi Medical college, Bhopal, Madhya Pradesh.

The study was conducted on patients referred to radiodiagnosis department, Gandhi Medical College, & associated Hospitals (Hamidia Hospital) Bhopal with suspicion of prostatic enlargement. After obtaining informed consent and explaining the purpose of study to the participants, data collection was done and information was recorded on a predesigned, pretested and semi-structured proforma. The questionnaire included information on brief history from the participant regarding his clinical history and laboratory investigations (with focus on PSA values).

Consent: Informed consent was obtained from the study participants after explaining them the nature and purpose of the study. They were assured that confidentiality would be strictly maintained. The option to withdraw from the study was always open for them.

Ultrasound examination

The ultrasound examination was carried on the USG machines available in our department using a low frequency (2.5-5 MHz) curvilinear transducer (TAS) and high frequency (5-8 MHz) intra cavitory transducer (TRUS). In the examination room, while performing transabdominal approach, the procedure is explained to the patient and they are asked to raise the clothing from above waist level, when the patient lies supine on the scanning table followed by placement of towels over the

lower clothing and warm gel is applied to abdomen. The prostate is examined in filled bladder state using a standard curvilinear transducer.

If patient gives consent for transrectal ultrasound, then bowel preparation is required. Before the exam, counselling the patient is mandatory. Then correct patient positioning is done by lying him in decubitus position with knees tucked up towards the chest. The transducer is covered with plastic sheath with gel on inside and outside as well. The transducer is introduced slowly and then prostate is visualized.

It was assessed under following parameters-

- Prostate volume
- Pre void & post void volume.
- Margins- Smooth / irregular
- Echotexture- Homogenous / heterogenous
- Intravesical prostatic protrusion – Grade 1 (0-5mm), Grade 2 (>5-10mm), Grade 3 (>10mm)
- Calcification
- Intralesional / normal parenchymal vascularity
- Focal/ diffuse enlargement of gland
- Other associated findings- (If any)

Imaging findings further classified into benign, infective or malignant etiology. The observations were recorded and analysis done.

Statistical analysis

Data was entered into MS excel 2007, analysis was done with the help of Epi info Version 7.2.2.2. Frequency and percentages were calculated. Quantitative variables were expressed as the mean and standard deviation. Categorical data was expressed as percentage. Microsoft office was used to prepare the graphs. Chi- square/ Fischer's exact test was applied for comparison. $P < 0.05$ was considered to be statistically significant.

Results

The present study entitled "Role of ultrasound imaging in prostatic lesions and its correlation with clinical & biochemical findings" was carried out for a period of two years. The study was conducted at Gandhi Medical College, & associated Hospitals (Hamidia Hospital) Bhopal. A total of 100 participant were enrolled in the study.

The observations have been mentioned under following headings:

Section A: USG findings

Section B: Biochemical findings

Section C: Clinical presentation

Section D: Association of USG with Clinical presentation

Section E: Association of USG with PSA levels

Table 1: Distribution of study participants on the basis of Prostate volume

Sn.	Prostate volume	Frequency	Percent
1	<30 cc	10	10
2	>30 cc	90	90
	Total	100	100

On USG it was observed that majority (90%) of the participants had prostate volume of >30 cc while only 10% had < 30 cc of the same.

Figure A 1: Distribution of study participants on the basis of prostate volume

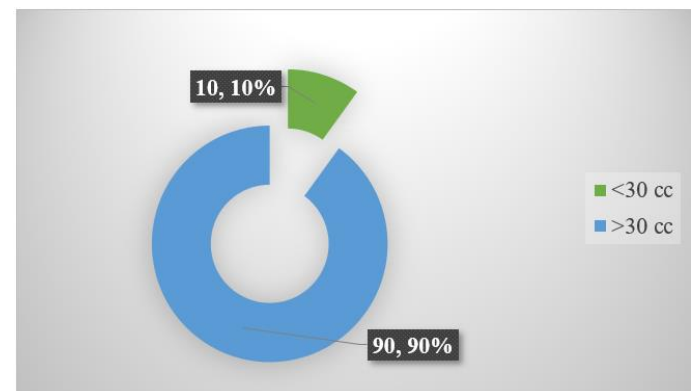


Table 2: Distribution of study participants on the basis of Post void volume

Sn.	Post void volume	Frequency	Percent
1	50 to 100 cc	41	41
2	> 100 cc	59	59
	Total	100	100

59% of participants reported post void volume of >100 cc on USG. Rest 41% reported 50-100 cc volume.

Figure A 2: Distribution of study participants on the basis of Post void volume

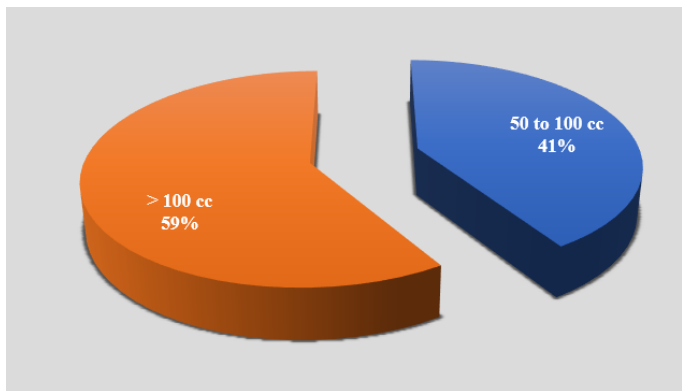


Table 3: Distribution of study participants on the margin of prostate.

Sn.	Margins	Frequency	Percent
1	Smooth	83	83
2	Irregular	17	17
	Total	100	100

On USG, 83% of participants had smooth margin of prostate while 17% had irregular margin of prostate.

Figure A 3: Distribution of study participants on the margin of prostate.

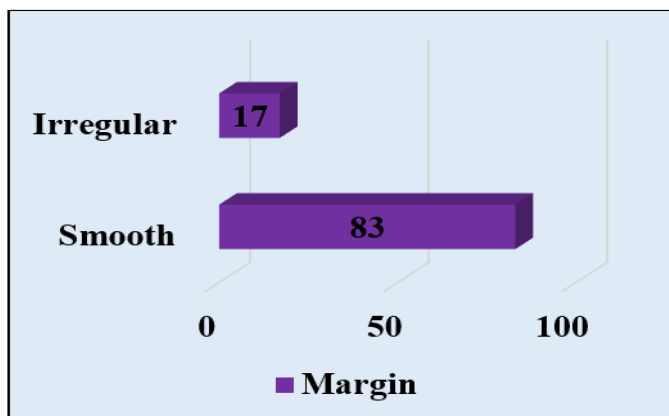


Table 4: Distribution of study participants on the basis of Echotexture

Sn.	Variable	Frequency	Percent
1	Homogenous	60	60
2	Heterogenous	40	40
	Total	100	100

60% of participants reported homogenous echotexture while 40% had heterogenous echotexture.

Figure A 4: Distribution of study participants on the basis of Echotexture

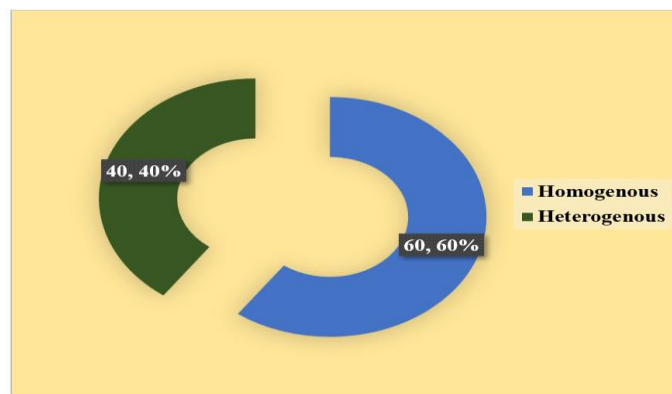


Table 5: Distribution of study participants on the basis of Intraventricular prostatic protrusion

Sn.	Intraventricular prostatic protrusion	Frequency	Percent
1	Grade 1 (≤ 5 mm)	25	25
2	Grade 2 (5.1 to 10 mm)	42	42
3	Grade 3 (>10mm)	33	33
	Total	100	100

Above table shows distribution of study participants on the basis of grade of intraventricular prostatic protrusion. 42% patients had grade 2 followed by grade 3 (33%) and grade 1 (25%).

Figure A 5: Distribution of study participants on the basis of Intravesicular prostatic protrusion

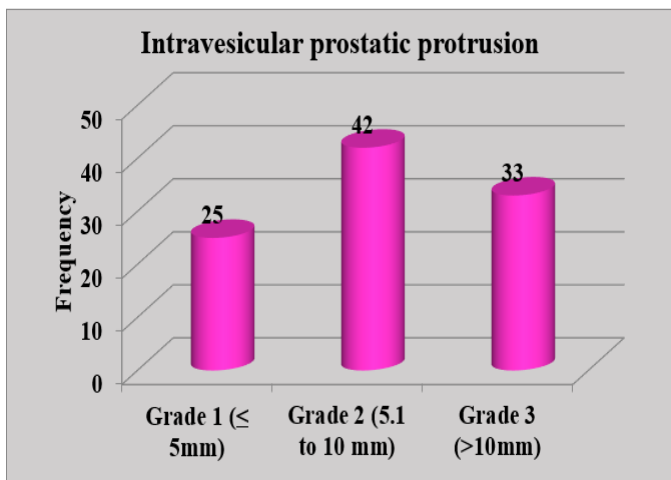


Table 6: Distribution of study participants on the basis of lesion type

Sl. No.	Lesion type	Frequency	Percent
1	Benign lesion	76	76
2	Benign and Infective lesion	4	4
3	Infective lesion	2	2
4	Malignant lesion	18	18
	Total	100	100

Distribution of study participants on the basis of lesion type have been depicted in above table. Majority (76%) of the participants reported benign lesion. This was followed by malignant lesion in 18% of the patients.

Figure A 6: Distribution of study participants on the basis of lesion type

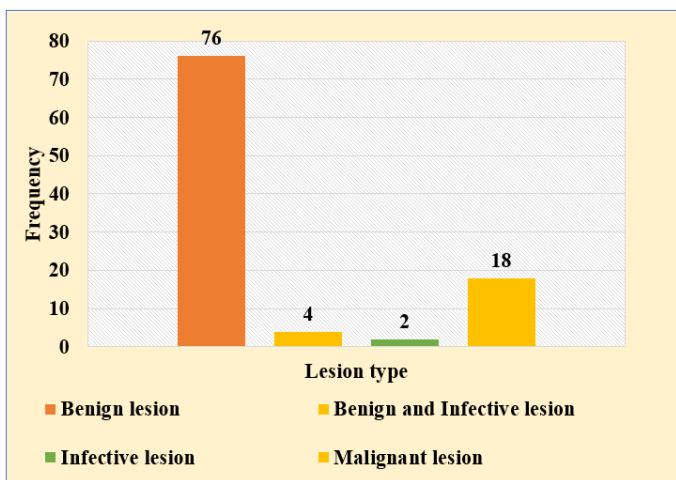
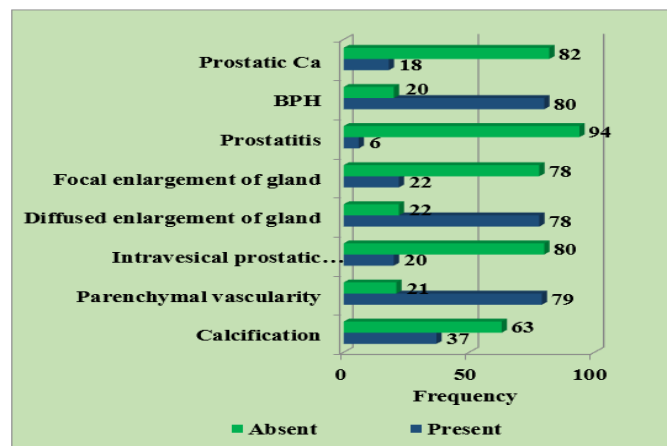


Table 7: Distribution of study participants on the basis of various USG observations

Sn.	Variable	Present		Absent		Total	
		No.	Percent	No.	Percent	No.	Percent
1	Calcification	37	37.0	63	63.0	100	100.0
2	Parenchymal vascularity	79	79.0	21	21.0	100	100.0
3	Intravesicular prostatic protrusion	20	20.0	80	80.0	100	100.0
4	Diffuse enlargement of gland	78	78.0	22	22.0	100	100.0
5	Focal enlargement of gland	22	22.0	78	78.0	100	100.0
6	Prostatitis	6	6.0	94	94.0	100	100.0
7	Benign prostatic hyperplasia (BPH)	80	80.0	20	20.0	100	100.0
8	Prostatic Carcinoma	18	18.0	82	82.0	100	100.0

On USG, calcification was observed in 37% of participants. 79% participants reported parenchymal vascularity while rest (21%) did not. Intravesicular prostatic protrusion was observed in 20% of study participants. In 78% of participants diffused enlargement of prostatic gland was observed and in 22% of participants focal enlargement of prostatic gland was observed. Prostatitis was observed in only 6% of participants. Benign prostatic hyperplasia was observed in majority (80%) of participants. Around 18% of participants reported prostatic carcinoma.

Figure A 7: Distribution of study participants on the basis of various USG observations



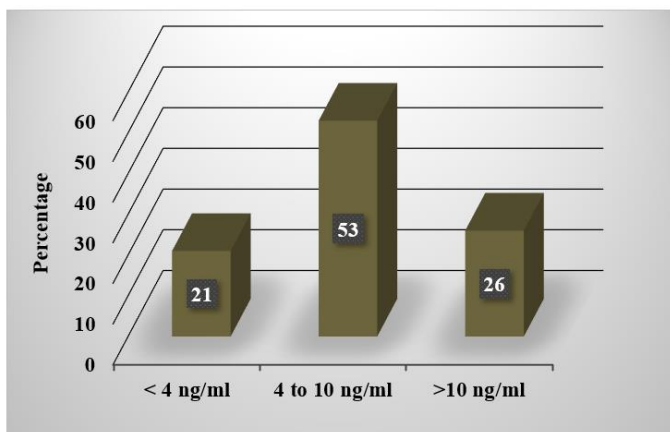
Section B: Biochemical findings

Table B1: Distribution of study participants on the basis of Serum PSA

Sn.	Variable	Frequency	Percent
1	< 4 ng/ml	21	21
2	4 to 10 ng/ml	53	53
3	>10 ng/ml	26	26
	Total	100	100

Distribution of study participants on the basis of Serum PSA have been displayed in table B1. 53% of the participants reported PSA level between 4 to 10 ng/ml, followed by > 10 mg/dl (26%) and <4 ng/ml (21%).

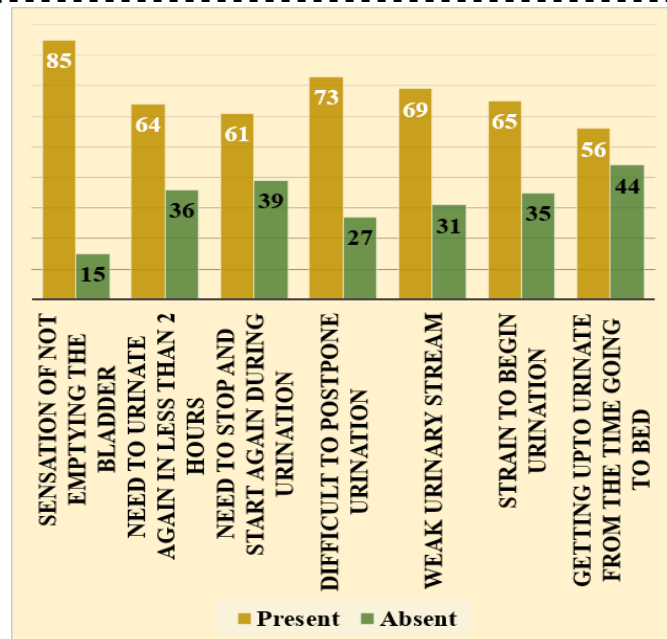
Figure B1: Distribution of study participants on the basis of Serum PSA



Section C: Clinical presentation

Figure C1: Distribution of study participants on the basis of clinical presentation

Figure C1: Distribution of study participants on the basis of clinical presentation



Section D: Association of USG with Clinical presentation

Figure D 1: Comparison of Prostate Volume with clinical presentations of patient

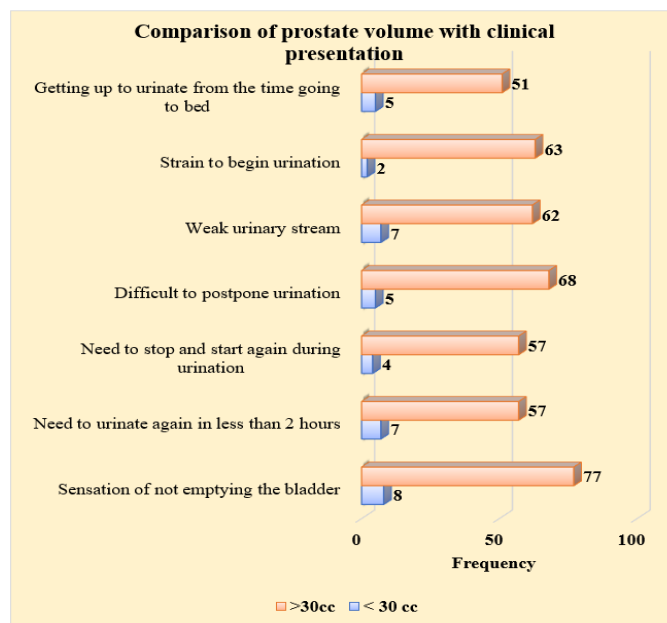


Figure D 2: Comparison of Post void Volume with clinical presentation of patient

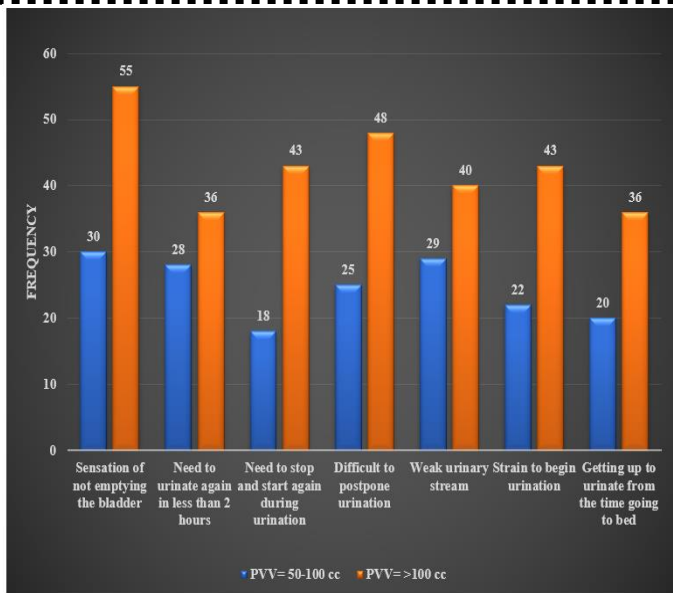


Figure D 3: Comparison of Intravesical prostatic protrusion with clinical presentation of patient

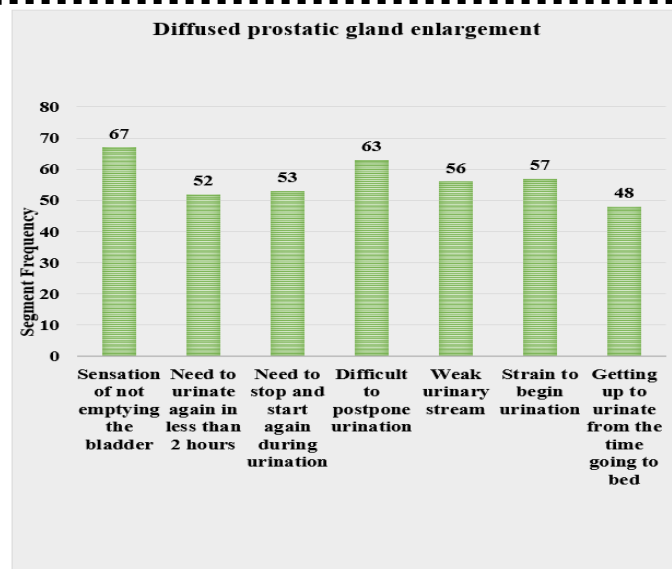


Figure D 5: Comparison of USG finding as Focal prostatic gland enlargement with clinical presentation of patient

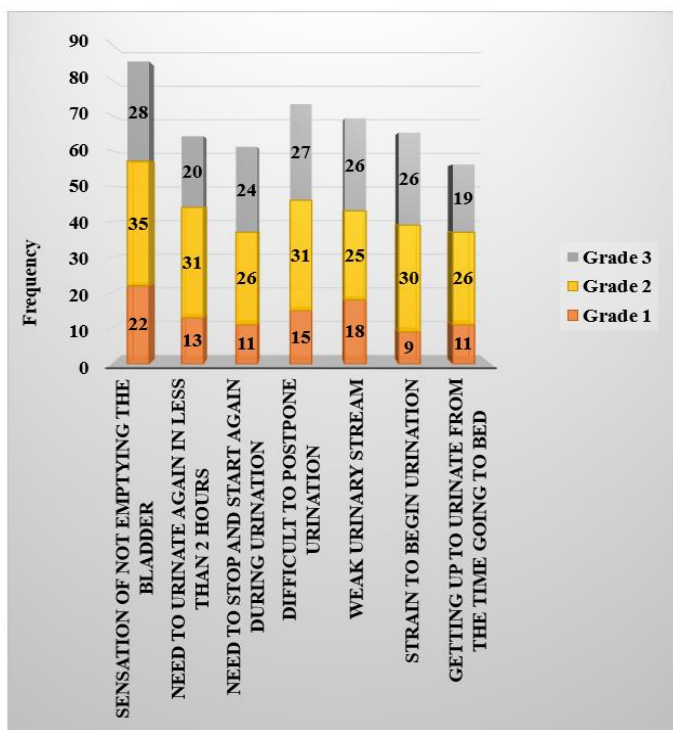


Figure D4: Comparison of diffuse enlargement of prostatic gland with clinical presentation of patient

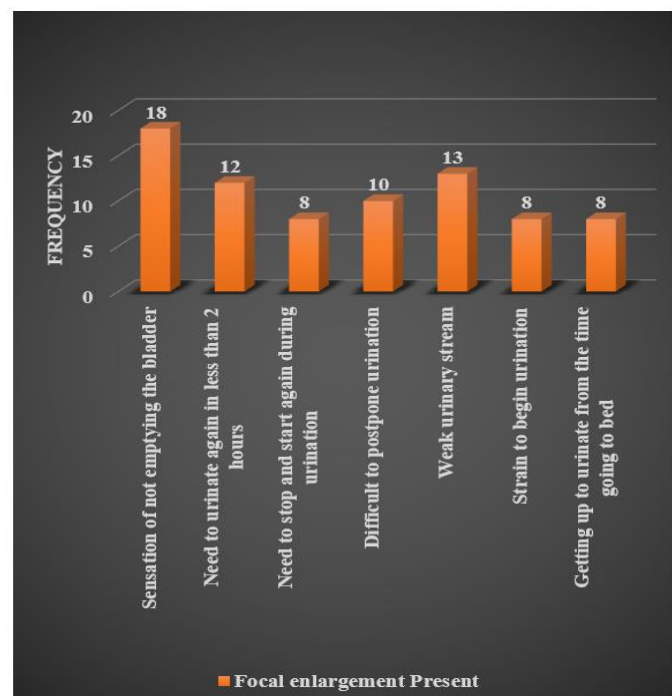


Figure D 6: Comparison of USG finding as lesion type with clinical presentation of patient

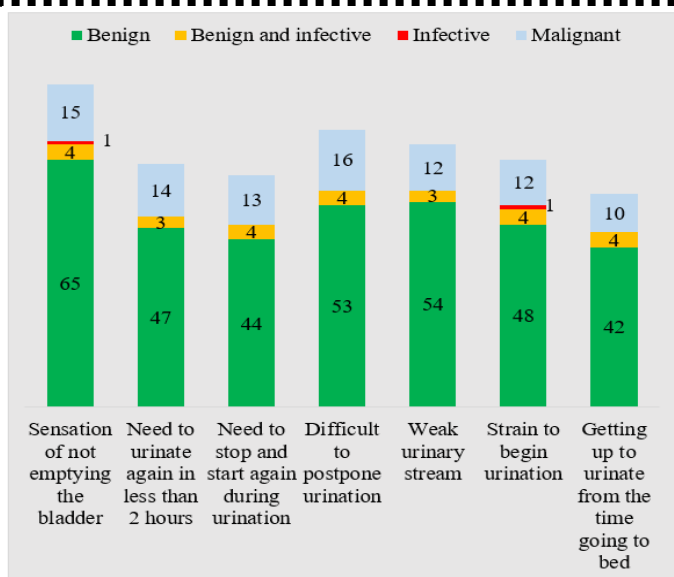
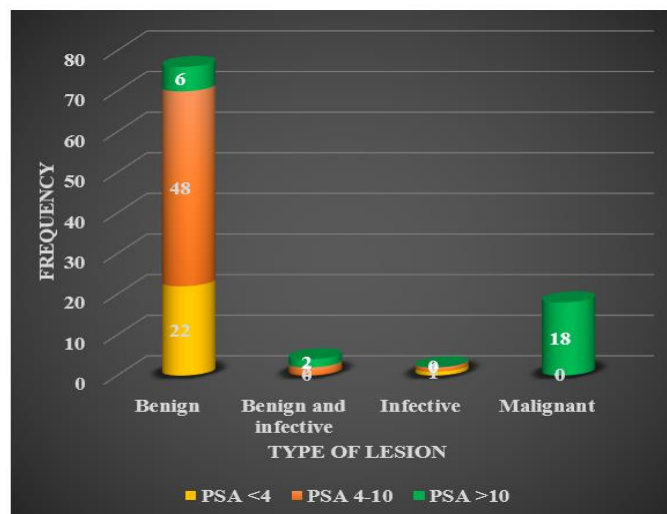


Figure E 2: Comparison of lesion type on USG with PSA levels of patient



Section E: Association of USG with PSA levels

Figure E1: Comparison of USG findings with the PSA levels of patient

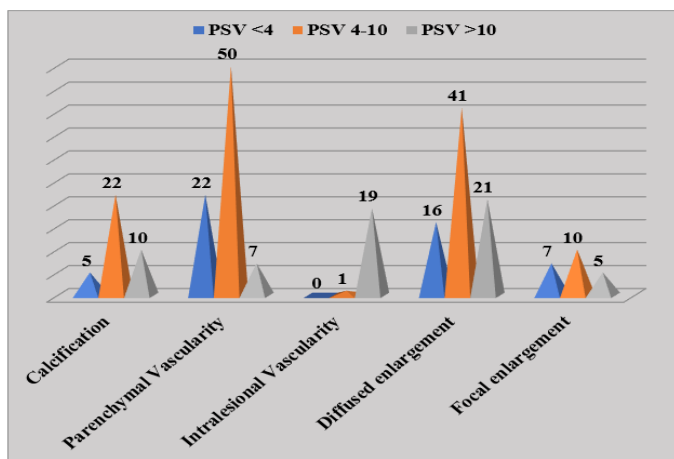
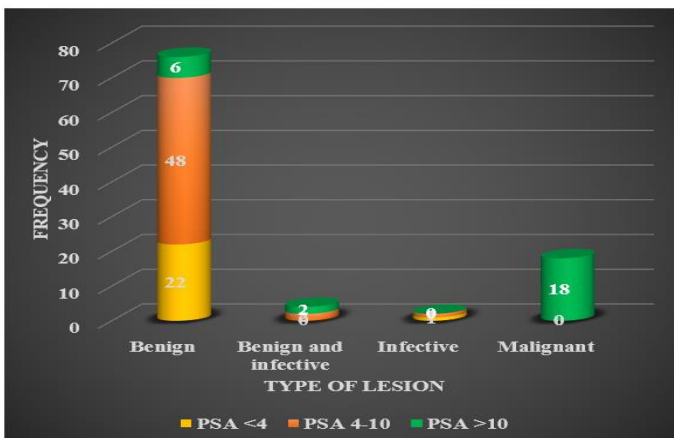


Figure E 2: Comparison of lesion type on USG with PSA levels of patient



Discussion

Results

We have done the prospective cross sectional cross study on 100 patients. We evaluated the role of USG examination in assessment of enlarged prostate gland i.e. benign prostatic hyperplasia and prostatic carcinoma along with its correlation with clinical and biochemical findings.

In the diagnosis of patients suspected with prostatic pathologies, timely diagnosis plays a significant role in planning the treatment of patient.

Prostate volume

We observed that majority (90%) of the participants had prostate volume of >30 cc while only 10% had < 30 cc of the same. Basawaraj N et al, [8] has reported that 30.4% of the patients with prostatic enlargement had <30 cc prostatic volume and 59.6% with > 30 cc of the same.

Post void volume

In our study, 59% of participants reported post void volume of >100 cc on USG with rest 41% reported 50-100 cc volume. Khattak et al., [9] studied the USG findings on 209 patients with prostatic enlargement and observed post void volume of 50-100 ml in 41.14%

followed by 100-200 ml (21.53%). On USG, 83% of participants had smooth margin of prostate while 17% had irregular margin. 60% of participants reported homogenous echotexture while 40% had heterogenous echotexture.

Intra vesicular prostatic protrusion

Out of 100 participants, 42% patients had grade 2 followed by grade 3 (33%) and grade 1 (25%) of intravesicular prostatic protrusion (IPPV). However, S J Chia et al, in 2003 [10] studied IPP in 125 subjects with prostatic enlargement and bladder outlet obstruction and reported 75.2% of the total with grade 3 IPP.

Other Parameters

We also noticed that majority (76%) of the participants reported benign lesion. This was followed by malignant lesion in 18% of the patients. On USG, calcification was observed in 37% of participants. 79% participants reported parenchymal vascularity. On USG, calcification was observed in 37% of participants. 79% participants reported parenchymal vascularity while rest (21%) did not. Intralesional prostatic protrusion was observed in 20%, diffused enlargement in 78% and focused enlargement of prostatic gland in 22% of participants. Prostatitis was observed in only 6%, benign prostatic hyperplasia in majority (80%) and prostatic carcinoma in round 18% of participants. We observed 53% of the total have serum PSA level between 4 to 10 ng/ml followed by 26% (> 10 ng/ml) and 21% (< 4 ng/ml).

We studied the clinical presentation of our participants and found sensation of not emptying the bladder was observed in 85% of patients. 64% patients observed requirement to urinate within 2 hours. 61% of patients needed to stop and start the process again during urination. 73% of patients had difficulty in postponing urination. 69% patients had weak urinary stream. 65% complained of difficulty/ strain to begin urination. 56%

of patients had to get up in the night to urinate. Sajida Nahid et al., [11] studied the clinical features of 50 patients with enlarged prostate. They also supported our finding with maximum of 90% of the patients with complaint of incomplete emptying. Apart from this, among them 84% presented with increased frequency, 80% with intermittency, 76% with urgency, 70% with weak stream, 66% with micturition with straining and 60% with history of nocturia.

Comparison of Clinical presentation with various USG parameters

On comparison of various clinical presentations with prostate volume, we observed that strain to begin urination was found statistically significant ($p=0.003$). This may be secondary to the bowel outlet obstruction due to enlarged prostate as also supported by Oelke et al., [12]. Marberger et al., [13] also reported that the risk of developing acute urinary retention was approximately 3-fold significantly higher in men with larger prostate volumes compared to that in men with smaller prostate volumes (4.2 vs. 1.6%, $p < 0.010$). This acute retention causes strain to begin urination.

We also noted that clinical presentations with post void volume, sensation of incomplete bladder emptying ($p=0.006$), need to stop and start again during urination ($p=0.003$), difficulty to postpone urination ($p=0.024$) and strain to begin urination (0.047) were found statistically significant. Also, on comparison of various clinical presentations with echotexture on USG, only difficulty to postpone urination ($p=0.027$) and weak urinary stream (0.042) were found statistically significant.

We reported on comparison of various clinical presentations with intravesicular prostatic protrusion (IPP), only strain to begin urination was found statistically significant ($p=0.003$). Zhang et al., [14] observed postvoiding residual urine volume (PVR), incidence of

acute urine residual (AUR), and bladder trabeculation appeared more often in the significant IPP group ($P < 0.05$). Positive correlation was found between IPP and prostate volume as well as PVR (Spearman's rho 0.401 and 0.342, respectively).

Comparison of USG findings with PSA levels

We have not observed any significant difference between PSA level and prostate volume in our study. However, Hochberg et al. [15] reported that mean PSA and prostate volume increased with each advancing cohort of age, and the correlation of PSA and prostate volume was determined to be statistically significant ($P < 0.001$) in each cohort with a correlation coefficient ranging from 0.33 to 0.41.

We also observed by various USG findings comparing with PSA levels of patients. Irregular prostatic margin ($p < 0.001$), heterogenous echotexture ($p < 0.001$) and intravesical prostatic protrusion ($p = 0.013$) were found to be significantly associated with PSA levels. Ding et al. [16] also supported our finding by demonstrating that the mean level of tPSA was raised along with the IPP grade. The mean tPSA level of IPP grade 1 patients was 4.07 ng/ml, and that of IPP grade 2 patients was 5.21 ng/ml. In IPP grade 3 patients, the mean tPSA level raised to 9.49 ng/ml.

In our study, PSA < 4 ng/ml and 4 to 10 ng/ml were observed mainly in benign lesions. PSA > 10 ng/ml was reported mainly in malignant lesions (18%) with significant association ($p < 0.001$). Vani et al. [17] reported similar findings that the range of PSA in nodular hyperplasia was 0.24–27 with an average PSA of 6.8 ng/ml. The range of PSA in carcinoma was 5–221, with an average of 107.0 ng/ml.

Our study aimed to evaluate various prostatic lesions via ultrasound in 50+ male patients with lower urinary tract symptoms. The present study is a prospective hospital

based study conducted in department of radiodiagnosis, GMC & HH Bhopal from August 2020 to July 2022, in Madhya Pradesh, India. All patients with suspected enlarged prostate were referred to our department matching inclusion criteria during study period were evaluated. The imaging findings of present study are described as under-

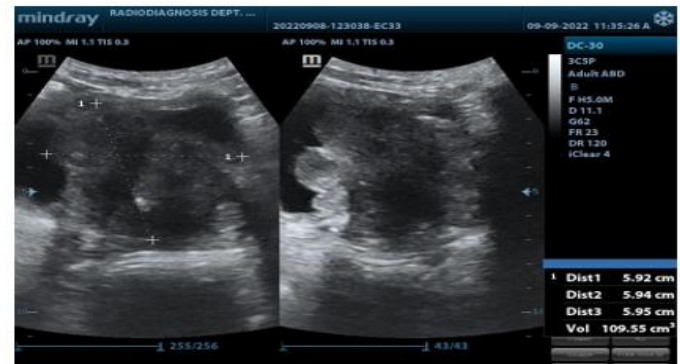


Fig. K: Transabdomen ultrasound of a 74 year old male patient presenting with lower urinary tract symptoms shows gross prostatomegaly (volume 109cc) with lobulated margins and heteroechoic echotexture. Median lobe of the prostate is seen indenting & protruding into bladder lumen. Multiple hyperechoic foci are seen diffusely scattered within prostatic parenchyma representing calcification suggesting benign prostatic hyperplasia.



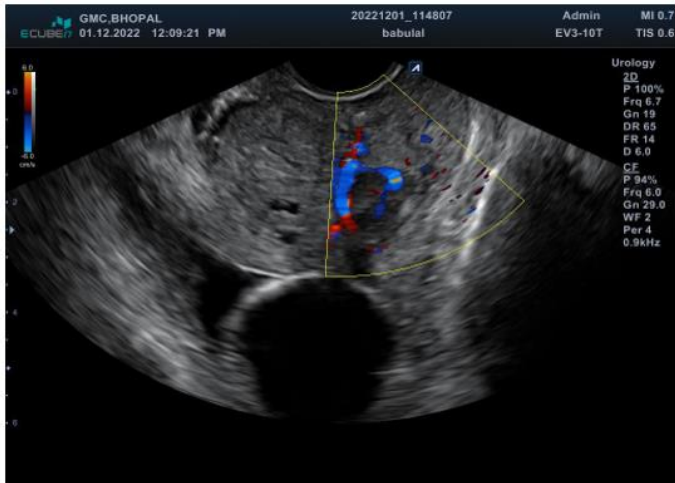


Fig. L1 & L2: Transrectal ultrasound of a 66 year old male patient presenting with dysuria & nocturia shows Mild prostatomegaly showing a focal well defined heteroechoic lesion with smooth margins noted in transition zone at base of prostate on left side showing intralesional vascularity on colour flow. Rest prostatic parenchyma appears normal in echotexture.

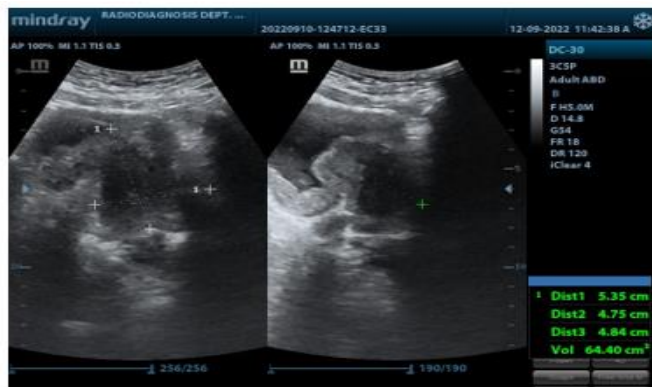


Fig. M: Transabdominal ultrasound of a 79 year old male patient presenting with dysuria & hematuria shows gross prostatomegaly (volume 61cc) with an ill defined hypoechoic lesion in base & mid zone seen infiltrating posterior wall of urinary bladder- likely neoplastic lesion of prostate. Thickening & irregularity of bladder wall is evident.



Fig N – Transabdominal ultrasound of a 62 year old male patient presenting with burning micturition shows a well defined hypoechoic lesion with mobile internal echoes noted involving left postero lateral aspect of prostate showing no vascularity on colour flow suggesting prostatic abscess..



Fig. O: Transabdominal ultrasound of a 65 year old male patient presenting with nocturia & incomplete sensation of micturition shows moderate prostatomegaly (volume 52cc) with lobulated margins and heterogeneous echotexture. Mild protrusion of prostate (Gr 1 IPPV) noted into bladder lumen. Few foci of hyperechogenicity are seen representing calcification suggesting benign prostatic hyperplasia.

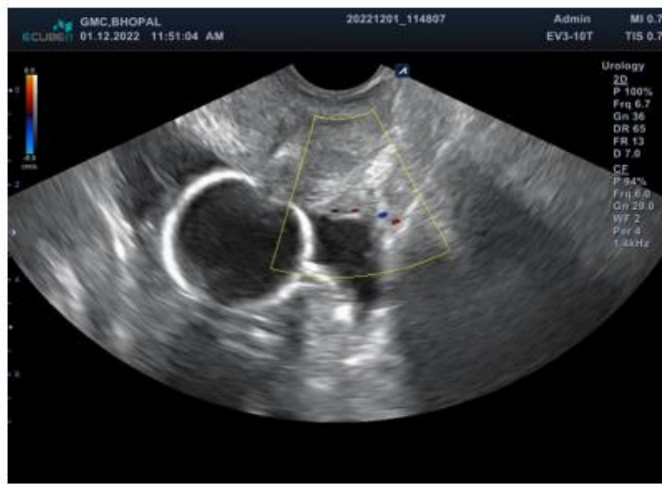


Fig. P: Transrectal ultrasound of a 58 year old male patient presenting with nocturia & strain while micturition shows mild prostatomegaly with smooth margins and homogenous echotexture. No abnormal nodular lesion seen likely benign prostatic hyperplasia.

Conclusions

This was a cross sectional prospective study done on 100 patients with symptoms of lower urinary tract syndrome and their evaluation by ultrasound examination.

As per our study, we concluded that ultrasound was quite effective in assessing various causes of prostate enlargement. 82% cases were benign which mostly comprises of benign prostatic hyperplasia, with rest 18 % cases which were found to be malignant. Benign cases predominantly demonstrated increased prostate volume, smooth margins, calcification, homogenous echotexture

with median lobe indenting into bladder base. Malignant cases were identified on the basis of irregular margins, heterogenous echotexture, suspicious nodule showing raised intralesional vascularity and features of local infiltration. They were further confirmed through histopathology examination.

In our study, various ultrasound parameters such as increased prostate volume (>30cc), significant post void residual volume (>100cc), high grade of IPPV (>10mm), heterogenous echotexture and calcification were found to have increased severity of clinical symptoms and were found statistically significant ($p=0.003$). Whereas presence of intralesional/ parenchymal vascularity and smooth/ irregular margins were not found statistically significant in our study ($p>0.05$).

PSA levels additionally complimented in evaluation of prostatic lesions. PSA in the range of 4-10ng/ml was found mainly in benign conditions, whereas >10ng/ml was observed in malignant prostatic lesion which showed highly significant association (P value < 0.001).

Therefore, Ultrasound being a noninvasive procedure showed good results in diagnosing benign & malignant conditions therefore it should be the earliest investigation of choice in suspected patients with lower urinary tract symptoms.

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