*DISSERTATION ON*

# ROLE OF TRANSRECTAL SONOGRAPHY WITH COLOUR DOPPLER AND MRI IN EVALUATION OF PROSTATIC LESIONS WITH TRUS GUIDED BIOPSY CORRELATION

***Submitted in partial fulfilment of requirements for***

**M.D. DEGREE BRANCH VIII (RADIODIAGNOSIS)**

***of***

***The Tamil Nadu Dr. M.G.R. Medical University***

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# CERTIFICATE

*This is to certify that this dissertation entitled* "**ROLE OF TRANSRECTAL SONOGRAPHY WITH COLOUR DOPPLER AND MRI IN EVALUATION OF PROSTATIC LESIONS WITH TRUS GUIDED BIOPSY CORRELATION**" *submitted by* ***Dr. TIXON THOMAS***, *appearing for Part II M.D. Branch VIII - Radiodiagnosis degree examination in February-March 2006 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfilment of regulations of The Tamil Nadu Dr. M.G.R. Medical University, Chennai. I forward this to The Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India.*

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# DECLARATION

I Solemnly declare that the dissertation titled, "ROLE OF TRANSRECTAL SONOGRAPHY WITH COLOUR DOPPLER AND MRI IN EVALUATION OF PROSTATIC LESIONS WITH TRUS GUIDED BIOPSY CORRELATION" is done by me at Madras Medical college and Hospital, during 2004-2005 under the guidance and supervision of **Prof. T.S. Swaminathan.**

This dissertation is submitted to **THE TAMIL NADU. Dr. M.G.R. MEDICAL UNIVERSITY** towards the partial fulfilment of requirements for the award of **M.D.DEGREE [BRANCH VIII] RADIODIAGNOSIS**

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# CONTENTS

# INTRODUCTION

The prostate is a small organ situated deep in male pelvis and is the organ most prone to pathological change. Indeed, all men who live past the age of 50 will develop histological change within the prostate, most common process being BPH. Many older men also develop prostate cancer the second most common carcinoma in men.

For a long time using conventional imaging techniques we were unable to directly visualize the prostate. However we assessed the prostatic enlargement by its effect over adjacent structures like prostatic urethra, bladder base and distal ureters by doing voiding cystourethrogram, cystogram and intravenous urogram. But we were not able to characterize various prostatic lesions.

Nowadays with the advent of sectional imaging techniques like ultrasound, computerised tomography and magnetic resonance imaging, we are able to directly visualize the prostate. Since ultrasound is free from radiation hazards and because of its easy availability, it is a valuable technique for detecting prostatic diseases.

With the advent of Transrectal sonography we are able to get a detailed view of prostate. As we are using high resolution transducers with high frequency ranges and sharply focused near fields, we are able to appreciate zonal anatomy of prostate, the lesion distribution and to characterize various prostatic lesions.

Colour Doppler techniques help us to know the vascular nature of various lesions and thus help to differentiate and localise the lesions.

Magnetic resonance imaging helps us to get multiplanar views of the prostate along with adjacent structures in the pelvis. Also it is able to clearly delineate the zonal anatomy especially with Endorectal coil.

With Transrectal sonography we are able to localise the lesions accurately and under its guidance, biopsies are taken.

# AIMS AND OBJECTIVES

- To categorize prostatic diseases as benign and malignant depending on their sonographic appearances.
- To assess the role of colour Doppler in localizing and differentiating prostatic lesions.
- To evaluate various prostatic lesions depending on their MR signal characteristics.
- To do TRUS guided biopsy of suspicious lesions and to confirm by histopathology.

# HISTORY AND REVIEW OF LITERATURE

**Wild and Reid** first proposed a screw type trans-rectal scanner in the early days. The principle was identical to that of modern transrectal ultrasonography although the investigators obtained only a square picture, presumably thought to represent a part of the rectum. In the following decades, trials with transrectal scanner of the A – mode type were reported, but this mode of presentation was not successful because of the difficulties in interpretation.

**Watanabe**[1] and associates turned the concept to more practical use, with modern electronic techniques and established the basic standard for imaging of the prostate. Their original scanner used a single oscillating disk and had both radial and linear scanning functions. **King** and associates introduced the method in the United States in 1973 and were followed by **Resnick** and co-workers. **Hallemans and Squassabia et al** reported European results with transrectal sonography at the same time.

In 1980 **Harado et al** applied grey scale imaging to transrectal ultrasound**. Itakura et al** developed a pistol type hand held transrectal scanner. Recent advancement of electronic real time ultrasound has made it possible to set many small oscillating discs in a thin probe for transrectal use**. Sekine et al** reported the first trial with this probe in 1982**. Riffkin and**

**Lee et al** soon reported its use in United States. Now a days scanner with dual transducers called biplanar transducers are available.

**Saitoh et al** in 1981 developed a special unit for interventional ultrasound consisting of a transrectal electronic linear scanner and an attachment for needle guidance for the puncture of prostate and seminal vesicle.

**Holm and Gammelgaard et al** in the same year developed a system for precise needle placement used along with trans-axial ultrasound monitoring.

**Watanabe et al**[1] proposed diagnostic criteria for various prostatic lesions by transrectal sonography which were later approved as the official criteria of the Japan Society of Ultrasonics in medicine and Japanese Urological Association.

In 1985 **Lee et al**[22] established the hypoechoic lesion as a sign of cancer focus and this finding had a great impact on the advancement of early cancer detection by transrectal ultrasonography.

**Ohe et al** proposed a factor called presumed circle area ratio (PCAR) that relates to the degree of roundness of prostate in axial section which has close relation with benign hyperplasia.

**Griffifths et al** addressed the ultrasound features of chronic prostatitis.

In 1981 **Holm and Gammelgaard et al** first described transperineal biopsy by transverse ultrasound guidance. In 1983 **Fornage and Riflдn et al**. described a technique using longitudinal ultrasound guidance for transperineal biopsy of prostate. Combination of transverse and longitudinal imaging for guiding transperineal biopsy was described by **Lee et al** in 1987. In 1986 the development of biplanar transducers made biopsy via transrectal route possible.

MRI of the prostate has evolved along with developments in Radio frequency coils and in MR pulse sequences. Initially only body coil MR with conventional spino-echo pulse sequences were used.

Endorectal surface coil was first developed in 1988. The use of endorectal surface coil increases signal-to-noise ratio at the expense of small field of view. To compensate this recently, Integrated Endorectal External Phased array coil is used which allows more homogenous signal over a larger field of view.

With the advent of colour Doppler techniques, it was also used in prostatic lesion where it helps to reinforce the suspicious lesions with its hypervascularity and helps to guide for biopsy.

## NORMAL ANATOMY AND REVIEW OF PATHOLOGY

The prostate gland is a flattened, conical structure oriented in a coronal plane. Its apex points downwards and is located just above deep

fascia of the urogenital diaphragm. Its anterior surface is directed towards the symphysis from which it is separated by adipose tissue and periprostatic veins. The anterior fibromuscular band separates the prostate proper from the preprostatic space, and the posterior surface is separated from the rectum by a double layer of Denonviller's fascia. The length of the normal prostate is 2.5 to 3.0 cm; the transverse diameter at the base is 4.0 to 4.5 cm; and the thickness is 2.0 to 2.5 cm. The dimensions often increase with age, and the normal weight of 20 to 25gms; may be surpassed several times. The prostate is surrounded by a capsule, approximately 10mm in diameter consisting of fibromuscular strands from which the puboprostatic ligament extends.

***Mc Neal*** in 1968 introduced a zonal concept of prostate anatomy, defining 3 glandular zones - *Transition, Central,* and *Peripheral* — which are covered anteriorly by fibromuscular stroma. The urethra and ejaculatory ducts form the framework for the glandular zones. Each zone has a unique spectrum of clinical disease because of its internal anatomic features.

**CENTRAL ZONE:**

The central zone is triangular and constitutes the major mass of glandular tissue at the base of the prostate. Its apex is at the verumontanum. Approximately 25% of prostatic glandular tissue originates from this zone. Ducts in the central zone radiate from the base of the gland and terminate in the urethra at the proximal aspect of the verumontanum.

Ducts of the vas deferens and seminal vesicles form the ejaculatory ducts which pass through the central zone and empty in to the urethra at the verumontanum. Disease processes rarely affect the central zone, and it is the site of origin of only 5 to 10% of prostate cancers.

The site where the seminal vesicle and the ejaculatory ducts enter the central zone is devoid of prostate capsule. The seminal vesicles join the vas deferens at the base of the prostate to form the ejaculatory ducts. The extra prostatic space invaginates around the ejaculatory ducts and continues to the verumontanum as the invaginated extra prostatic space. Thus a path in the centre of the gland connects the extraprostatic space at the base with the apical portion of the gland at the verumontanum. On sagittal projection, this is seen as a hypoechoic beak like configuration formed by the entrance of the seminal vesicle and vasdeferens into the central zone. This beak continues as a hypoechoic band formed by the smooth muscle surrounding the ejaculatory ducts and extends to the verumontanum.

Hypoechoic tumour invading the central zone has ready access to the invaginated extraprostatic space. Obliteration or displacement of the beak of seminal vesicles may indicate extracapsular extension of tumour. If invasion of the invaginated extra prostatic space is the earliest finding of seminal vesicle involvement, the ultrasound criteria are then,

1. A hypoechoic halo or ring like mass about the ejaculatory duct on the axial section.

2. Obliteration or displacement of beak of seminal vesicle by hypoechoic cancer seen on sagittal scan.

3. Hypoechoic cancer extending into the seminal vesicle

4. An extra prostatic hypoechoic mass at the entrance of the seminal vesicle obliterating the seminal vesicle — prostate angle.

**PERIPHERAL ZONE**

The peripheral zone contains approximately 70% of the glandular tissue in the normal prostate. Its glands are uniform in size and smaller than that of central zone. The peripheral zone occupies the posterior, lateral and apical regions of the prostate and extends anteriorly for a variable distance. The ducts enter the urethra at a point distal to the verumontanum. The zone is homogenous in echo texture and is defined as isoechoic.

Approximately 70% of prostate cancers originate in the peripheral zone. The majority of these cancers are located close to, or in direct contact with the prostate capsule. Cancer spreads along the subcapsular space or the interstitial space between the prostatic acini and the ducts of the peripheral zone. The inward spread of cancer is resisted by the surgical

capsule, a muscular interface between the peripheral and transition zone. Cancer of the peripheral zone readily invades the central zone, giving them access to the invaginated extraprostatic space.

The prostatic capsule is thin or absent at the apex of the gland. *The region distal to the apex, bounded by the peripheral zone proximally, rectourethralis muscle distally, the membranous urethra anteriorly, and the rectal wall posteriorly is designated as the* ***Trapezoid area***. Tumour may readily spread from the peripheral zone into the trapezoid area, which may be considered as a region of anatomic weakness.

**TRANSITION ZONE:**

The transition zone approximately forms 5% of the prostatic glandular tissue. In aging prostate this zone can show marked glandular hyperplasia and eventually may constitute the majority of the prostatic glandular volume.

The transition zone is located on both sides of the proximal urethra. The ducts run parallel to and end in the proximal urethra at the level of the verumontanum. Prostatic calculi within the glands of the proximal urethra and verumontanum produce an Eiffel Tower - shaped hyperechoic configuration that defines the distal limits of the transition and central zones. The surgical capsule separates the transition zone from the peripheral and central zones.

The understanding of the gross and microscopic anatomy of the prostate has changed during the past few decades. The classic understanding of prostate anatomy was the division of the gland into five lobes, termed **Lowsley's** lobar concept of anatomy. This method has been used to identify the prostatic disease for close to 100 years. However, Lowsley's concept of anatomy did not consider the different histological components of the prostate but was based purely on anatomic position as defined in the embryonic and foetal gland. In this description, the prostate was divided into five major lobes. The first, the anterior lobe is in the anterior portion of the prostate. It is situated from the anterior margin of the gland to the level of the prostatic urethra posteriorly. The middle or median lobe is a smaller area between the proximal prostatic urethra and the ejaculatory ducts. This lobe extended from the base to the level of the verumontanum in the midportion of the prostate The posterior lobe encompassed the posterior portion of the prostate and was situated posterior to the ejaculatory ducts and the prostatic urethra The posterior lobe extended to the posterior margins of the gland The fourth and fifth lobes were the two large lateral lobes that extended from the lateral margin of the prostate bilaterally towards the middle part of the gland. None of the lobes had clearly defined medial margins.

The comparison of the **Lowsley lobar** and **McNeal zonal** concepts of the anatomy is both possible and important because of the need to compare clinical findings and the terminology with imaging studies. *The*

*anterior lobe correlates with the anterior fibromuscular stroma. The median lobe and central zone are similar. The sum of the posterior and two lateral lobes correlates to the large peripheral zone.*

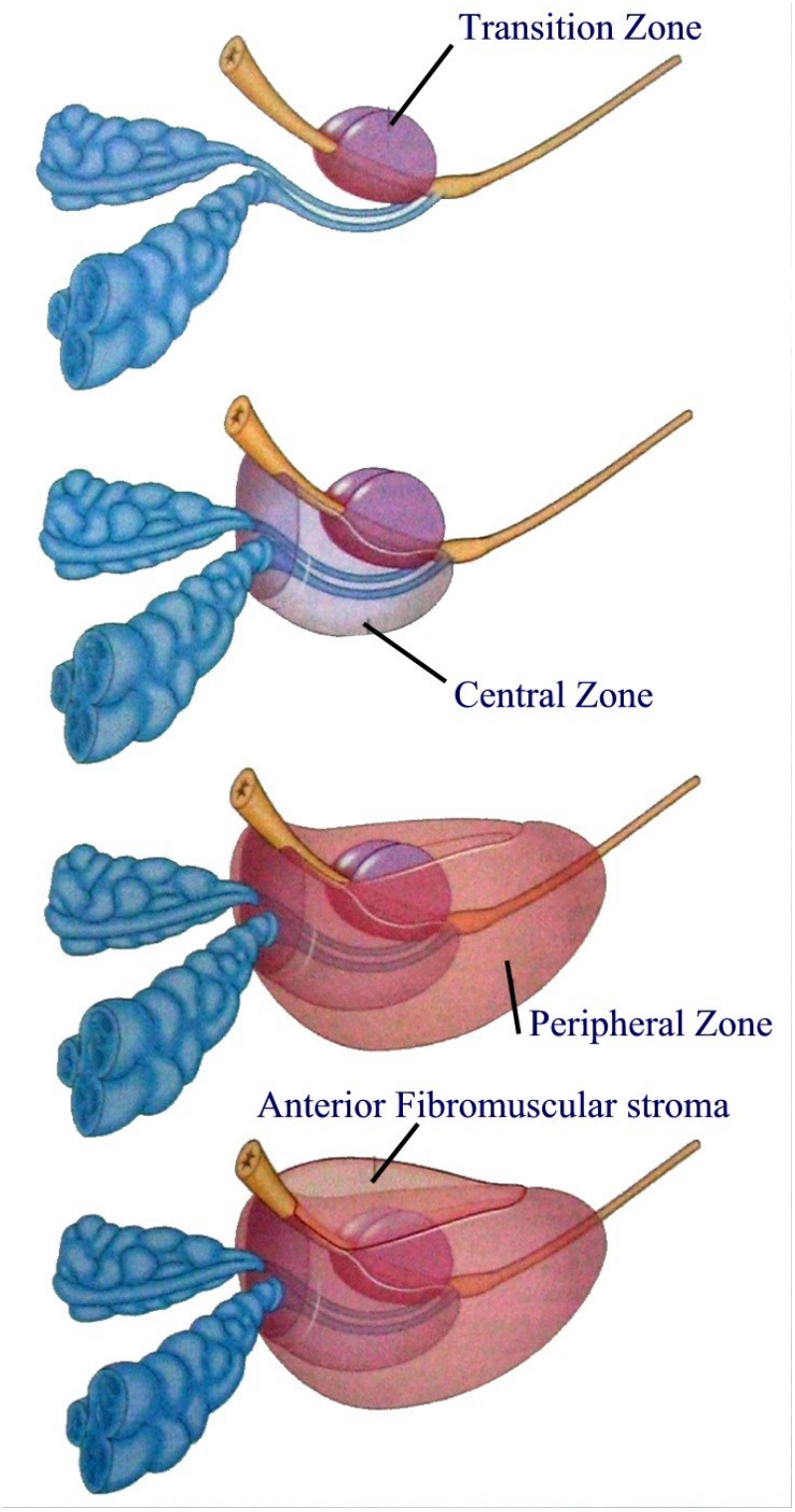
Initially, McNeal's concept of zonal anatomy had little utility in the clinical sphere or in diagnostic imaging. However with the development of cross- sectional imaging studies, endorectal sonography and MR imaging, the zonal concepts of anatomy became a useful technique to apply to imaging because the different areas can be defined. Both sonography and MR imaging can differentiate the normal central gland from a peripheral gland. In the hyperplastic prostate they differentiate benign hyperplastic areas from normal tissues.

The zonal concept of anatomy is also useful because it incorporated a clearer understanding of the development of disease. The origin of prostatic disease within the gland was poorly understood under Lowsley's concepts of lobar anatomy. It was previously thought that cancers only arise in the posterior lobe and the benign prostatic hyperplasia develops predominantly in the lateral and to a lesser degree in the median lobes. These concepts were based on the clinical presentation of disease, not on actual position of the tumours and were inaccurate. The concept of zonal anatomy has clarified much of this misunderstanding.

It is now understood that prostate cancer develops in the acinar tissue, predominantly the peripheral prostate. The peripheral zone is three

times larger in volume than the central zone. Prostate cancer develops seven times more often in the peripheral zone. Approximately 70% of all cancers develop in the peripheral zone 20% from transition zone and 10% from the central zone. In contrast benign prostatic hyperplasia develops exclusively from transition zone. Prostatitis develops predominantly from the peripheral zone.

## McNEAL'S ZONAL ANATOMY OF PROSTATE



## SONOGRAPHIC FEATURES OF NORMAL PROSTATE

On TRUS obtained in the transverse plane of Imaging the prostate is visualized as a symmetrical crescent-shaped ovoid structure with triangular posterolateral margins. Zonal anatomy is routinely seen. The peripheral zone is imaged with homogenous medium echogenicity. The transition zone is imaged with lower echogenicity and often has an inhomogenous echo pattern. Dense echogenic foci at the margin between the peripheral and transition zone can be seen and these represent corpora amylacea. Anteriorly echogenic rim represents the anterior fibromuscular band. The capsule is not directly visualized, but lies at the junction of the peripheral zone and the periprostatic fat. The seminal vesicles may be seen in a bow-tie configuration on a transaxial view.

TRUS in the sagittal projection is useful for evaluating the craniocaudal margins of the prostate & volumetric measurements of the prostate. Using a combination of sagittal and transverse plane allows the calculation of prostatic size using the ellipsoid formula

$V = ½ (L \times AP \times W)$

L - Length

AP - Antero posterior diameter

W - Width

***Normal MRI Anatomy:***

On MRI the ability to demonstrate the zonal anatomy of the prostate gland and the distinction between the gland and periprostatic tissues varies with the imaging planes and sequences used. On $T_2$ - WI, the zonal anatomy is well delineated. With the prostatic urethra serving as the key reference point on $T_2$WI, the PZ demonstrates higher signal intensity than either the central or the transition zones.

The central and transition zones have similar lower signal intensity and can be differentiated from each other by knowledge of their anatomical location. In young subjects, the transition zone has uniformly low signal intensity but it becomes heterogenous with the development of BPH. The surgical pseudocapsule can be seen in older subjects at the interface between the transition and peripheral zones. The anterior fibromuscular band covering the anterolateral surface of the prostate gland demonstrates a low signal intensity allowing distinction between the prostate and the anterior periprostatic space composed of vascular areolar tissue.

On axial $T_2$-WI the shape of the peripheral zone changes from base to apex. The apical urethra is surrounded by muscular fibres giving low-intensity signals.

The NVB are seen as punctuate signal voids, posterolateral to the capsule at the 5 and 7 O' clock position. The levator Ani muscles give lower signal intensity than the peripheral zone, regardless of which spin-echo TR

or TE is used, though the contrast between the peripheral zone and the levator Ani muscles is enhanced on $T_2$-WI. Unlike CT, MR in all three planes enables the prostate to be differentiated from surrounding levator, bladder neck & lower rectum. In the assessment prostate size using Ellipsoid formula, MR is more accurate than USG or CT.

Colour Doppler evaluation of the prostate has shown that most cancers are hyper vascular. The cancers there are hypoechoic in grey scale are hyper vascular when evaluated with the colour Doppler technique spectral analysis has demonstrated that the vessels within the prostate have a resistive index between 0.50 and 0.80 and velocities between 9 and 30cm/s. These valves are not changed within a cancer as prostatitis. The infiltrating cancers are 180 vascular as cell as being isoechoic. Both A/C and C/C prostatitis and occasionally atrophy demonstrate increased flow. The use of the power Doppler technique has not offered any additional information when compared to conventional colour Doppler sonography.

**BENIGN PROSTATIC HYPERPLASLA**

Benign prostatic hypertrophy is an age related disorder found in majority of men by the sixth decade. It mainly involves periurethral transition zone. As the transition zone enlarges it causes compression and distortion of prostatic urethra and outward displacement of the normal prostatic tissue which becomes compressed as a narrow layer forming a false capsule.

Histologically several cell types are concerned with the development of BPH including glandular epithelial cells, fibroblasts, myoepithelial cells and smooth muscle fibres. The aetiology of BPH is uncertain. But the prostate develops and become hyperplastic only in men with normal androgen production. The principle prostatic androgen is Dihydro-testosterone, an alpha reduced metabolite of testosterone. Serum levels of 17-oestrodiol increases with age and increase the oestradiol /testosterone ratio which may be relevant to the development of BPH Prostate stroma contains high level of oestrogen receptors and 17-oestrodiol enhances the androgen receptor content of the prostate.

Prostatic obstruction increases the resistance to the flow of urine and the detrusor muscle responds by hypertrophy. The bladder wall becomes thickened and trabeculation occurs with intervening sacculation and diverticula formation. The bladder capacity increases and back pressure may be transmitted to the upper tract causing obstructive uropathy. Urinary stasis due to residual urine predisposes to infection and bladder stone formation. The chronically distended bladder may decompensate and chronic retention and overflow incontinence ensues.

Clinically patient may present with obstructive symptoms like hesitancy, poor stream and acute retention of urine or irritating symptoms like urgency, urge incontinence, precipitancy and nocturia.

Sonographically prostate will assume a more rounded configuration due to increased AP dimension. Transition zone will be hypertrophied causing compression of rest of the glandular tissue causing good demarcation of surgical capsule. There may be calcareous deposition along the surgical capsule or along the transition zone glandular ducts which gives a specific configuration called EIFFEL TOWER appearance. The gland may be either homogenous or inhomogenous in echo texture depending on whether it is fibromuscular stromal proliferation or mixed fibrous and glandular element proliferation. Pure adenomatous hyperplasia will be seen as hyperechoic nodules.

As benign prostatic hyperplasia develops from the transition zone the rest of the glandular zone is compressed. This results in marked sonographic difference between central and peripheral portion of the prostate. BPH is generally defined as well demarcated, well differentiated enlargement of the central gland (transition zone). A single relatively well demarcated focus may be identified or multiple benign hyperplastic nodules may be noted. The area separating the hyperplastic tissue from the compressed peripheral zone is the ‘surgical capsule’. This region the surgical capsule may be demarcated by a well defined change in echogenicity, a hypoechoic rim or calcifications.

BPH can be demonstrated by MR, though it cannot be differentiated from prostatic carcinoma. Its appearance varies depending on the type of hypertrophy and the imaging protocol used. In nodular hyperplasia enlarged

prostate gland with homogenous signal intensity with nodules of diminished intensity on $T_1$ - WI and varying intensity on $T_2$-WI is seen.

A surgical pseudocapsule imaged with low signal intensity can be seen at the margin between Adenoma and the PZ. Diffuse hyperplasia ranges in appearance from or homogenous or inhomogenous, medium to high signal intensities on $T_2$-WI. The ability of MRI to provide multiplanar imaging allows accurate volumetric measurement of the hypertrophied gland and displays the intravesical portion of the hyperplastic nodule and demonstrates the effect of hypertrophy on the bladder neck.

**PROSTATIC CANCER**

Cancer prostate is the second most common cause of cancer death in men in the United Kingdom and USA. The incidence is more than 30% in men aged over 50 years and as high as 80% at the age of 80 years. At initial diagnosis approximately 75% will have either locally invasive disease or distant metastasis, 5 year survival rate is 15%.

There are no known causal etiological factors. There is a genetic predisposition as the risk is two to three times greater in first degree relatives of prostate cancer patients.

Approximately 70% of prostate carcinomas arise in the peripheral zone, 25°% in the transition zone and the remainder in the central zone. Prostate cancer spreads locally by direct invasion through the capsule, to

the seminal vesicles through the invaginated part of extraprostatic tissue. Lymphatic spread to obturator and internal iliac nodes and then to common iliac and para aortic nodes. Bones are usually involved through blood spread (BATSONS VENOUS PLEXES) and the bones affected are lumbo-sacral spine and pelvis.

Prostate Specific Antigen is an enzyme specific for prostatic tissue. It ha largely replaced acid phosphatase as marker of prostate cancer. The normal reference range is 0-4 ng / ml. A value greater than 10ng/ml is suspicious of cancer while a value above 40 ng / ml suggests extra capsular disease, and value of 100 ng / ml suggests distant metastasis.

Prostatic cancer classically presents in the peripheral zone as a relative poorly marginated hypoechoic area. These lesions are often obvious on the sonograpic examination because of the considerable differences in echogenicity between tumour & normal appearing glandular tissue. However, not all large lesions have this typical sonographic appearance. Studies have shown that up to 40% of tumours lesser than 5mm in size when evaluated by radical prostatectomy specimens, cannot be identified by endorectal sonogram. These are not seen directly because they are of the same echogenicity as the remainder of the prostate, but some may still be identified by their secondary characteristics like capsular bulge or erosion. Capsular bulge is not a specific sign of tumour infiltration, although irregularity of the pericapsular fat is highly suggestive of tumour infiltration. Lesions with mixed echogenic appearances with subtle

scattered areas of decreased echogenicity also may be identified The reasons for these differences in echogenic appearances of prostate cancer are

1. Gleason grade of the tumour (an index of cellular differentiation)

2. Fibrotic change

3. Intermixing of benign prostatic tissue with cancer,

4. Increased number of interfaces,

5. Tumour size and

6. Undefined causes.

Tumour spreading through invaginated part of extra prostatic tissue will obscure the normal beaking of seminal vesicle at its entrance to the prostate as ejaculatory duct.

The most common presentation of prostatic carcinoma in MR is the e/o hypointense signal lesion in the peripheral zone, regardless of the field strength .However, the signal intensity changes are non specific and various benign and malignant condition can mimic each other. Differential considerations for low signal intensity within the PZ on $T_2$ WI include *Tumour, post biopsy haemorrhage, post radiation and hormone therapy, scar / positional inflammatory changes, and dystrophic changes*.

The major role of MRI in prostate carcinoma is in the local staging of the disease each parameter of tumour extension of capsular, seminal vesicular and bladder involvement can be assessed separately. Extracapsular entension of tumour usually begins posterolaterally adjacent to the NVB (at the 5&7 'O' clock positions) where the nerve branches perforate the capsule. The criteria used for the detection of extra capsular extension of tumour on T2-WI include

1. Broad (>12mm) tumour contact.
2. Smooth capsular bulge.
3. Irregular capsular bulge.
4. Obliteration of the rectoprostatic angle.
5. Asymmetry or direct involvement of the NVB.
6. Angulation or step- off appearance.
7. Focal capsular retraction and thickening.

According to **YU et al**[28] obliteration of the rectoprostatic angle and asymmetry of the NVB were most indicative of extracapsular extension. Criteria used for the defection of seminal vesicular invasion include.

1. Direct tumour extension into & around the seminal vesicles.

2. Tumour extension along the ejaculatory ducts, resulting in seminal vesicles of low signal intensity on $T_2$ WI & Non Visualization of ejaculatory duct.

The detection of prostate cancer and the accuracy in staging is improved when MRI is used in conjunction with 3D- MRSI. Higher choline and lower citrate levels are seen in prostatic tissue containing cancer than in normal prostatic tissue.

# PROSTATE CANCER STAGING

| WJ | TNM | DEFINITIONS | AJC | OSC |
|---|---|---|---|---|
| A | T0 | Non palpable tumour; incidental finding in operative specimen | T1 | TA |
| A1 | Toa | <3hpf<br><5% of specimen | T1a<br>T1b | TA1<br>TA2 |
| B | T1 | Palpable tumour confined to the gland | T2 | TB |
| B1 | T1a | Confined to one lobe <2cm | T2a | TB1 |
| B2 | T1b | Confined to one lobe> 2 cm | T2b | TB2 |
| B3 | T2 | Both lobes involved. Contour deformity of the gland No seminal vesicle involvement. | T3a | TC1 |
| C1 | T3 | Both lobes involved contour deformity and seminal vesicle involvement. | T3b | TC2 |
| C2 | T4 | Contour deformity, seminal vesicle involvement and invasion of adjacent pelvic organs | T4 | TC2 |
| D | N1-3 | Secondary involvement of regional lymph node only | N+ | M1<br>N1-2 |
| D1 | N4 | Metastasis to juxtaregional nodes | | N3 |
| D2 | M1 | Distant metastasis | M1 | M2 |

WJ- Whitmore -Jewett

TNM- Tumour, Node, Metastasis.

OSCC - Organ Site Programe of National Cancer Institute.

AJC- American joint committee

## CLINICAL STAGING SYSTEM FOR PROSTATE CANCER

A1 Non-palpable, incidentally found cancer in <5% of prostatic specimen.(TURP)

A2 Tumour cells found in >5% of prostatic specimen.

B1 Palpable nodule <1.5cm confined to one lobe.

B2 Both lobes involved.

C1 Extension into lateral sulci or seminal vesicles <6cm in maximum diameter.

C2 >6cm or fixed to pelvic side walls or invading adjacent organs

## *STRUCTURES OTHER THAN MALIGNANCY THAT PRODUCE HYPOECHOIC AREAS IN THE PROSTATE*

### A) ANATOMIC STRUCTURES

Urethra and periurethral fibromuscular tissue.

Ejaculatory duct complex.

Prostate capsule.

Seminal vesicles ampulla of vas deferens.

Periprostatic veins.

Neurovascular bundle.

**B) BENIGN DISEASES**

Hyperplasia

Granulomatous and nonspecific prostatitis.

Cysts.

Haematoma

**C) ARTIFACTS**

Inappropriate use of focal range of transducers.

Acoustic shadowing.

Edge effect.

Reverberation artefact.

Edge effect is seen when the angle of incidence of the sound waves on a tissue plane leads to rarefaction rather than reflection. The sound wave is deflected, and the returned echoes are interpreted as being from a more lateral position .As a result a fan shaped anechoic area is seen. An edge effect is most commonly seen on transverse scanning of the base of prostate at the lateral margins of the transition zone. The result is a hypoechoic area in the anterior horn of the peripheral zone. A similar effect is often seen at the extreme edge of the prostate in the sagittal plane giving a ragged appearance to the lateral boundary.

Reverberations may be seen as bright white lines at regular intervals from the transducer. They are caused by sound waves reflecting from an

echodense surface and then bouncing between the transducer and the reflecting surface. The most common sites of reverberation echoes are at the surface of balloon surrounding the transducer in the rectum and faecal material within the rectal wall. An apparent decrease in echo density between the reverberations may make the prostate seem relatively hypoechoic.

**PROSTATITIS**

Prostatitis when due to haematogenous spread of infection involves the peripheral gland. When due to post-surgical instrumentation the central gland may be affected. Actually there are no specific features on sonography unless an abscess develops, in which case an anechoic to hypoechoic area with a thin or thick wall may be seen. The sonographic findings arc not diagnostic but in conjunction with clinical findings are highly suggestive of diagnosis.

On MR, Both A/c & C/c prostatitis may show multiple small areas increased signal intensity scattered throughout the prostate on SE-$T_2$W images. Conversely c/c prostatitis / scarring may cause decreased signal intensity change on $T_2$ WI image and therefore mimic tumour. When a prostatic abscess develops, discrete rounded foci are seen. These are hypointense on $T_1$-WI and hyperintense on $T_2$W - Images.

## PROSTATIC CYSTS

### *Prostatic utricle cyst*

Prostatic utricle cysts develop from utricle which is a normal structure seen as a dimple on the surface of the verumontanum. In 10% of individual utricle becomes larger and forms a slit like aperture lying between the ejaculatory ducts and extending in cephalad direction for a variable distance. The seminal vesicle and vas deferens do not communicate with dilated utricle. However a tense utricular cyst may obstruct the nearby ejaculatory ducts.

#### *Mullerian Duct Remnant Cyst*

They are derived from remnants of paranephric ducts. They are situated more caudally than the normal utricle. Both utricle cyst and mullerian duct remnant cyst are midline cysts.

#### *Ejaculatory Duct Cyst*

Cystic dilatation of the ejaculatory duct may occur either primarily or as a result of obstruction.

#### *Degenerative Cyst of Prostate*

Degenerative cyst within the transition zone and are well known to the urologist performing transurethral resection of prostate when such cyst

are often resected and jelly like material is released. They are smaller in size.

***Sonographic Features***

A small cystic structure identified in the midline near verumontanum is most likely to be utricle cyst. Mullerian duct cyst tends to be found towards the top of the prostate in midline. Cysts that are seen in the line of ejaculatory duct are ejaculatory duct cysts. They are often associated with azoospermia.

The seminal vesicles are seen as flat paired structures lying behind the bladder. The outline is usually smooth, although the saccular nature of the gland can sometimes be appreciated. The centre of the gland is echopenic with areas of increased echo density corresponding to the folds of the excretory epithelium. If the seminal vesicle is distended, the wall can be seen to be composed of two thin layers. Caudally the vesicle spreads laterally and can be seen ramifying in the perivesicular fat.

The vasdeferens on either side can usually be identified behind the bladder as it runs inward and posteriorly to become the ampulla. The cranial ampullary part of the vas may be seen as a separate structure, but in its more distal part, near to the prostate, it cannot be distinguished from the seminal vesicles. In the sagittal plane, the body of the seminal vesicles are easily appreciated. The junction of the seminal vesicle with the ejaculatory duct usually lies within the prostate. Ultrasonography of the

intraprostatic portion of the seminal vesicle produces the ‘Beak sign’. The ejaculatory duct complex from each side lies in a common muscular envelope, which is clearly seen by sonography. The actual lumen of the ejaculatory ducts is not normally visible. The path of the ejaculatory duct can be traced to an area of slightly increased echo density, which corresponds to the verumontanum. Small echo densities are often identified at the junction of the ejaculatory ducts and the urethra and provide a useful landmark.

## SEMINAL VESICLE CYSTS

Seminal vesicle cysts are almost associated with either an ectopic ureter draining into seminal vesicle from a dysplastic kidney or unilateral agenesis. The diagnosis is usually made at the time of increasing sexual activity when accumulation of material within the cysts leads to infection or obstruction of the ejaculatory ducts and consequent infertility. Cysts can be easily identified by trans-rectal sonography as an echo free area. Configuration of contralateral seminal vesicle can be studied.

Owing to its excellent display of anatomy multiplanar MRI is useful in demonstrating the size and location of prostatic cysts. The signals intensity of the cyst depends on their fluid content. Serous fluid similar to urine will have a low signal intensity on SE T -1 WI and an increased signal intensity on either $T_1$ or $T_2$ - W Image.

# MATERIALS AND METHODS

A prospective study of 50 patients between the age group 41-78 years admitted in Urology Department, Govt. General Hospital, Chennai between July 2004 - August 2005, with prostatic complaints like hesitancy, poor stream, A/c retention of urine, urgency, urge incontinence and nocturia was done. All 50 patients were subjected to Transrectal sonography (TRUS), MRI and TRUS guided biopsy. TRUS was performed using ALOKA -3500 equipped with 7.5 MHz Transrectal probe , MRI was done using SIEMENS 1.5T superconducting magnetom, using CP spine array coil, colour Doppler was also used in evaluating the lesions.

***Technique of TRUS:***

Prior to TRUS we did Trans abdominal usg for every patient to assess the prostatic size.

1. All our patients are given a thorough cleansing enema.
2. They were put in left lateral decubitus position.
3. Thorough inspection of the anal verge was done to rule out any painful fissures.

4. Digital rectal examination of the prostate was done for all our patients before transrectal sonography which will help us to know where exactly to concentrate while doing sonography.

5. Good lubrication in the form of xylocaine jelly 2% applied.

6. By asking the patient to take deep breath the trans-rectal probe was gently inserted into the rectum.

7. The probe we used was 7.5 MHz. Biplanar trans-rectal probe which was having end firing and side firing crystals.

8. The probe was inserted till we reached the seminal vesicles and we examined the prostate in various axial sections from base to apex by slowly withdrawing the probe using side fire crystal, then we switched over to end firing crystal we took midline sagittal section and then by rotating the probe towards right and left we took right and left paramedian sections.

***MRI Technique used:***

Patient was placed in supine position in the MR gantry.

A scout sagittal section was obtained through the prostate for planning of coronal and axial views.

Sections were taken extending from base to the apex of the prostate including the seminal vesicles.

The sequences used were,

a) T2 weighted sequence.

TR: 4000 ms TE - 101 ms

Averages: 2 No of slices: 12-15

Slice thickness: 5mm FOV - 200 mm

Axial, Sagittal, Coronal oblique.

b) Short Tau inversion recovery sequence (STIR)

TR: 2300 ms TE - 20 ms TI: 150 ms

Averages: 2 No of slices: 12-15

Slice thickness: 3mm FOV - 200 mm

Axial, Sagittal, Coronal oblique.

c) Optional Sequences

a) T1 weighted sequence

***Inclusion Criteria:***

All the patients in the study were referred from Urology Department with symptoms of prostatic enlargement like frequency, urgency, urge incontinence and hesitancy. Broadly the patients included fall into the following criteria.

i. Diffusely enlarged prostate as per DRE

ii. Patients with hard prostatic nodule.

iii. Patients having tender enlarged prostate.

iv. To evaluate those patient with osteoblastic bone secondaries.

***Exclusion Criteria:***

Patients not willing to undergo TRUS &MR Examination

Patients with MR incompatible devices/implants

Those patients who are unable to lie down in supine/lateral position.

Patients with claustrophobia.

Those patients who are not operated or non availability of HPE report

***Biopsy criteria:***

Patients showing features of BPH were subjected for Trans- urethral resection of prostate and specimen sent for HPE.

Patients showing inhomogenous echotexture of prostate and nodular lesion irrespective of their zonal distribution were subjected for usg guided biopsy of prostate through transrectal route.

***TRUS guided Biopsy Technique***

We used the same convex transrectal probe with biopsy gun holder attached to it which was wrapped in a sheath .To ensure good acoustic contact USG gel was put inside the sheath. Bard's 18 gauge automatic spring loaded biopsy gun was used for taking biopsy.

Pre biopsy instruction were followed in all patient which included

Clotting parameters, Bowel cleaning enema.

Withdrawal of anticoagulants for 1 week if the patient is on anticoagulant therapy.

Antibiotic prophylaxis: (1).Tab Taxim 0-250mg tds 5 days - 2 days prior. (2) .Tab. Metrogyl 400mg 1 hour before.

After putting the patient in left lateral position, Digital rectal examination was done, to confirm the prostatic enlargement and to localize the nodular lesions. Then rectal probe with biopsy gun holder was slowly introduced. Scan was done in both planes from base to apex and from side to side also necessary images were recorded. Echotexture, nodules, calcification were noted. Evaluation of capsule, SV & ED was done. Colour Doppler was used to know vascularity of the lesion and biopsy was taken in a systematic way from 6 sites (2 each from base, mid gland & apex) and also from suspicious lesions.

After observing for any post-procedural complications, rectal probe was taken out, post procedure analgesic and antibiotics were also given.

# REPRESENTATIVE CASES

NORMAL PROSTATE

Fig 1: TRUS -AXIAL

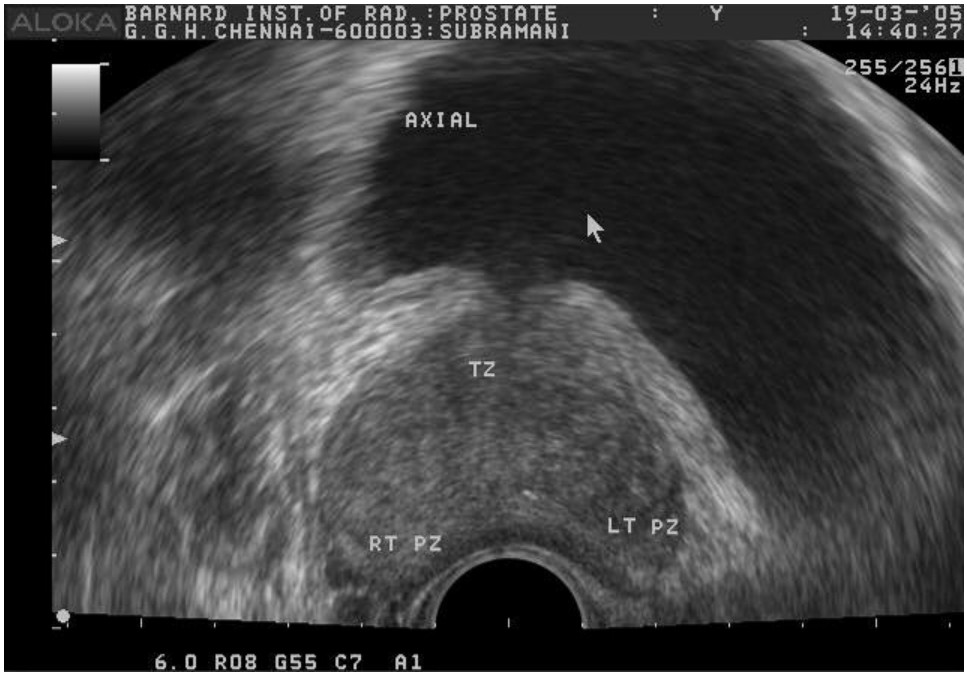
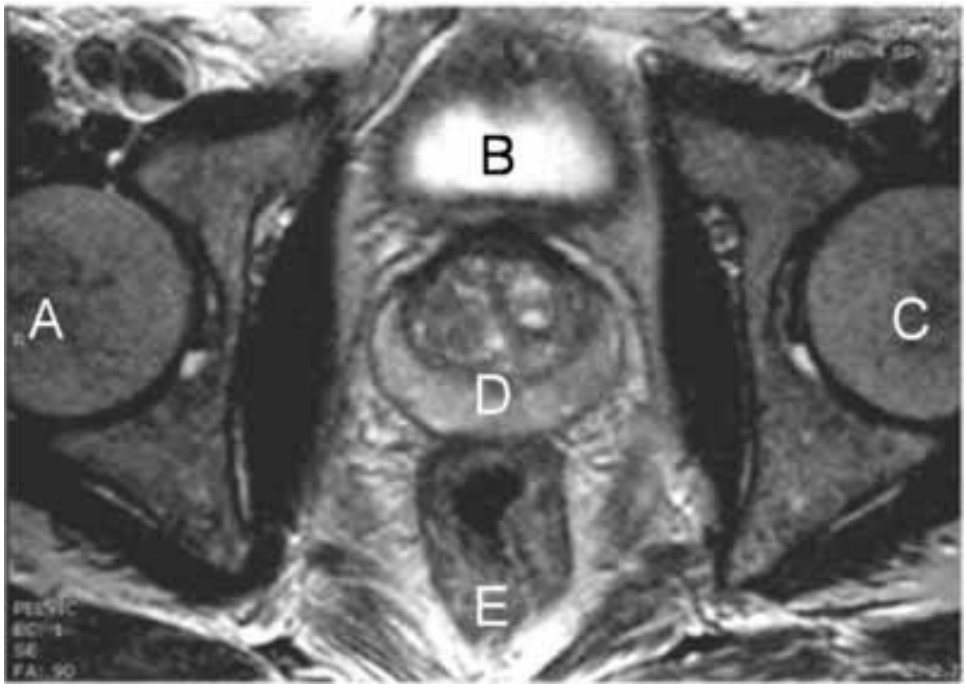


Fig 2: T-2 AXIAL




B - Bladder
E - Rectum
D - Prostate

'ATIC HYPERPLASIA [BPH]

Fig 3: TRUS -AXIAL

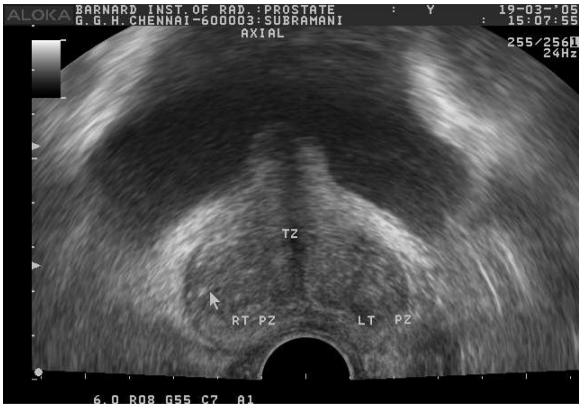



Fig 4: STIR- AXIAL

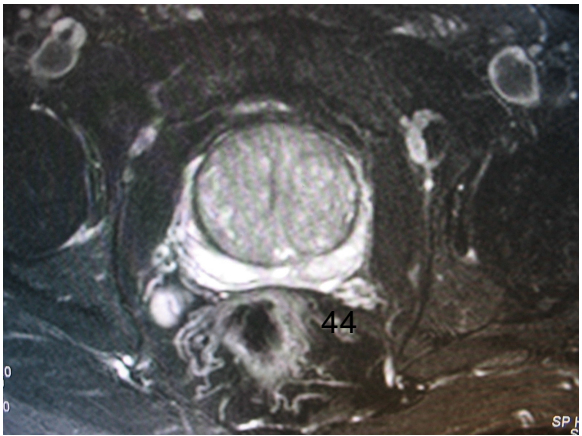
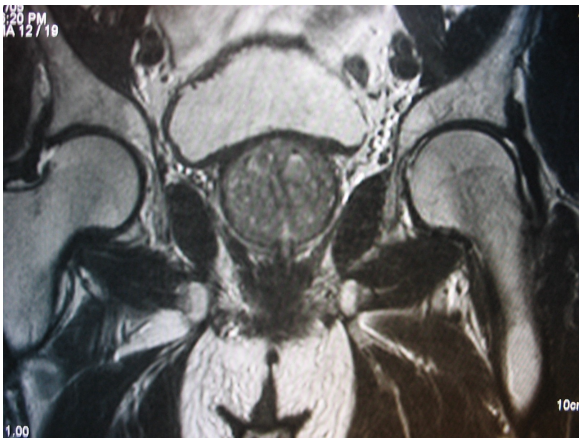


Fig 5: T-2  CORONAL



CARCINOMA PROSTATE

Fig 6: TRUS – AXIAL

Fig 7: TRUS- SAGITTAL


CARCINOMA PROSTATE

Fig 8: STIR - AXIAL

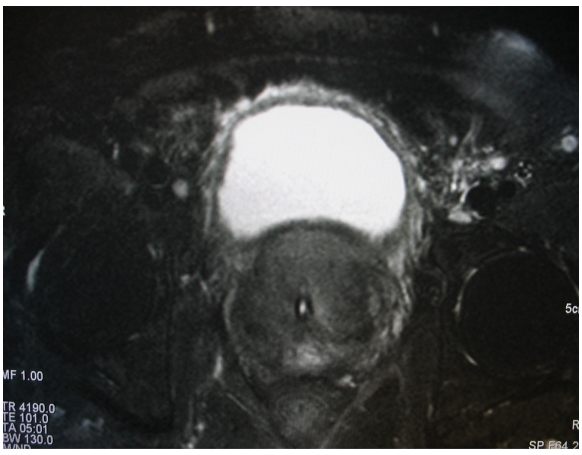


Fig 9: T-2 CORONAL

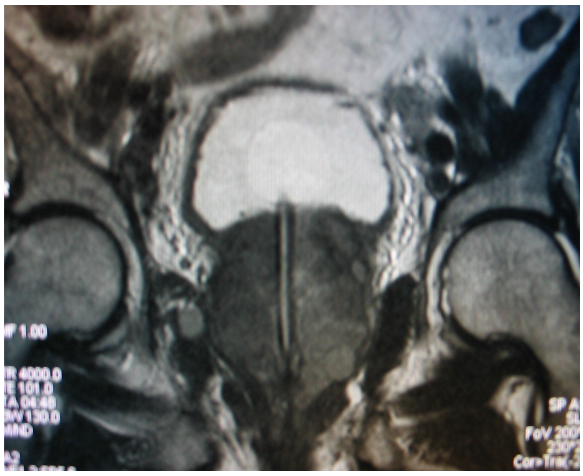
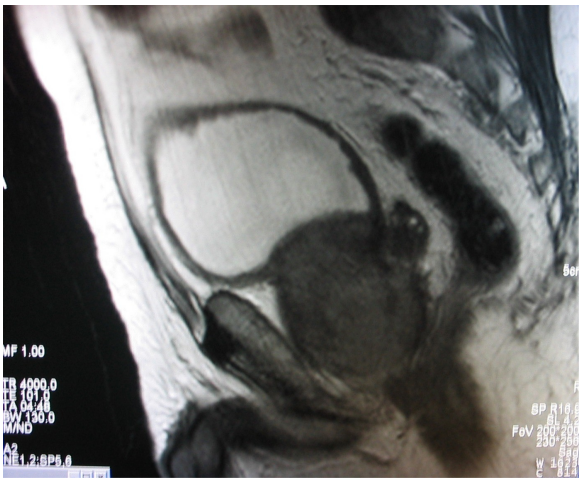


Fig 10: T-2 SAGITTAL



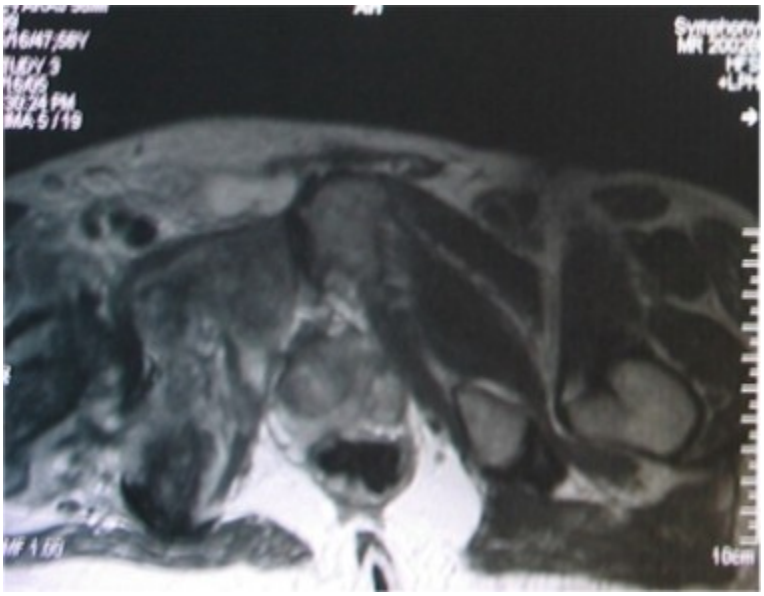
PROSTATITIS / ABCESS

Fig 11: TRUS-AXIAL

Fig 12: T-2 CORONAL


CARCINOMA PROSTATE WITH RT FEMORAL AND ILLIAC BONE METASTASIS

Fig 13: T2 – AXIAL

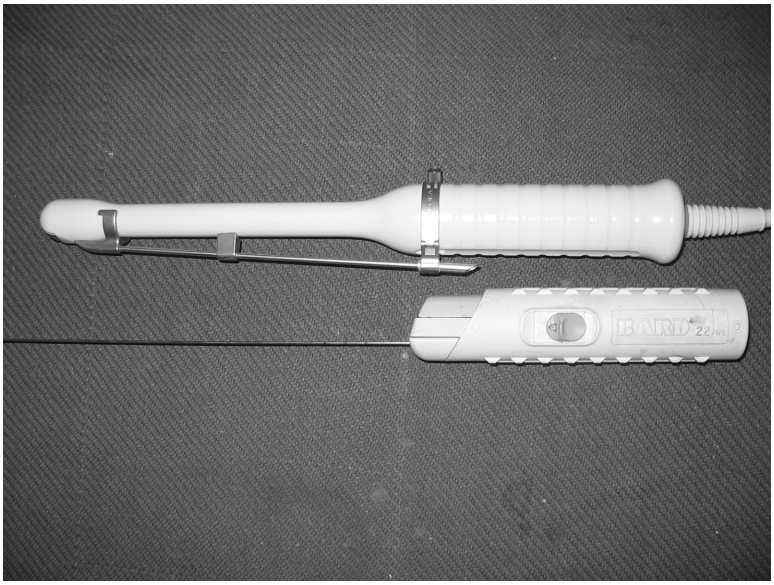


DEGENERATIVE PROSTATIC CYST

Fig 14: TRUS AXIAL


BIOPSY GUN AND ITS HOLDER ATTACHED TO TRANSRECTAL PROBE

Fig 15:



TRUS AXIAL SECTION WITH BIOPSY NEEDLE INSITU

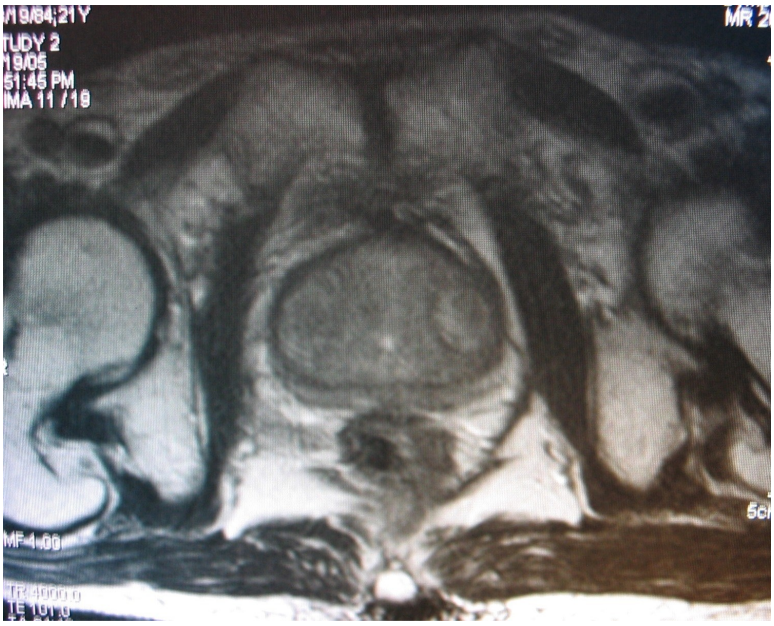
Fig 16:

NODULAR BPH

Fig 17: TRUS AXIAL


NODULAR BPH

Fig 18: T2 WI AXIAL

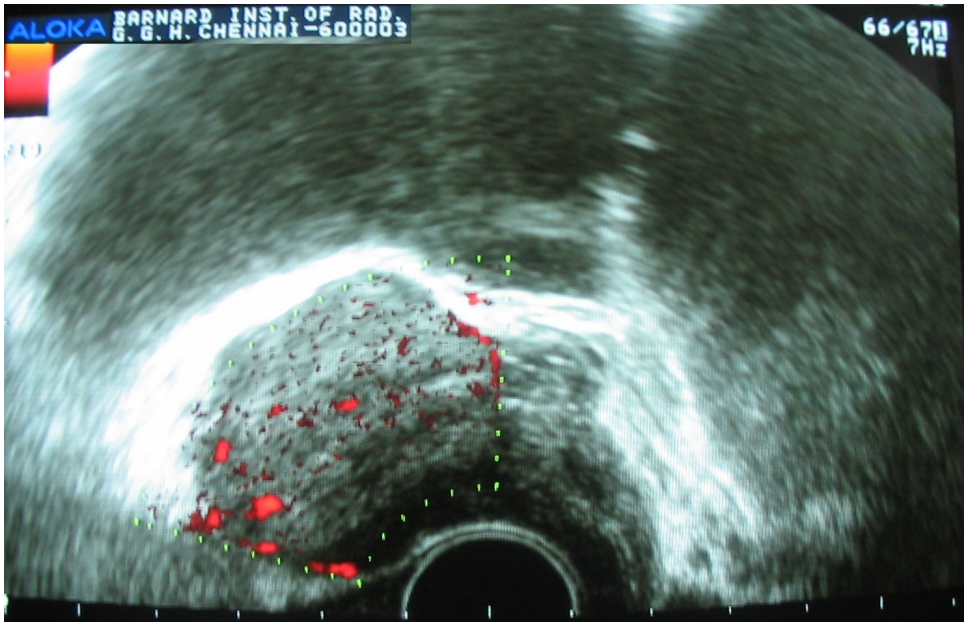


BOTH SEMINAL VESICLE AND AMPULLA OF VAS DEFERENS

Fig 19: TRUS AXIAL


CA PROSTATE SHOWING INCREASED VASCULARITY

Fig 20: COLOR DOPPLER



# RESULTS AND ANALYSIS

Our study included those patients having prostatic problems or palpable nodules in the prostate detected by digital rectal examination. They were between age groups 44-78 years.

We examined 50 patients by transrectal sonography with colour Doppler and MR examination.

All patients were classified depending on the sonographic appearance of prostate into various groups as follows

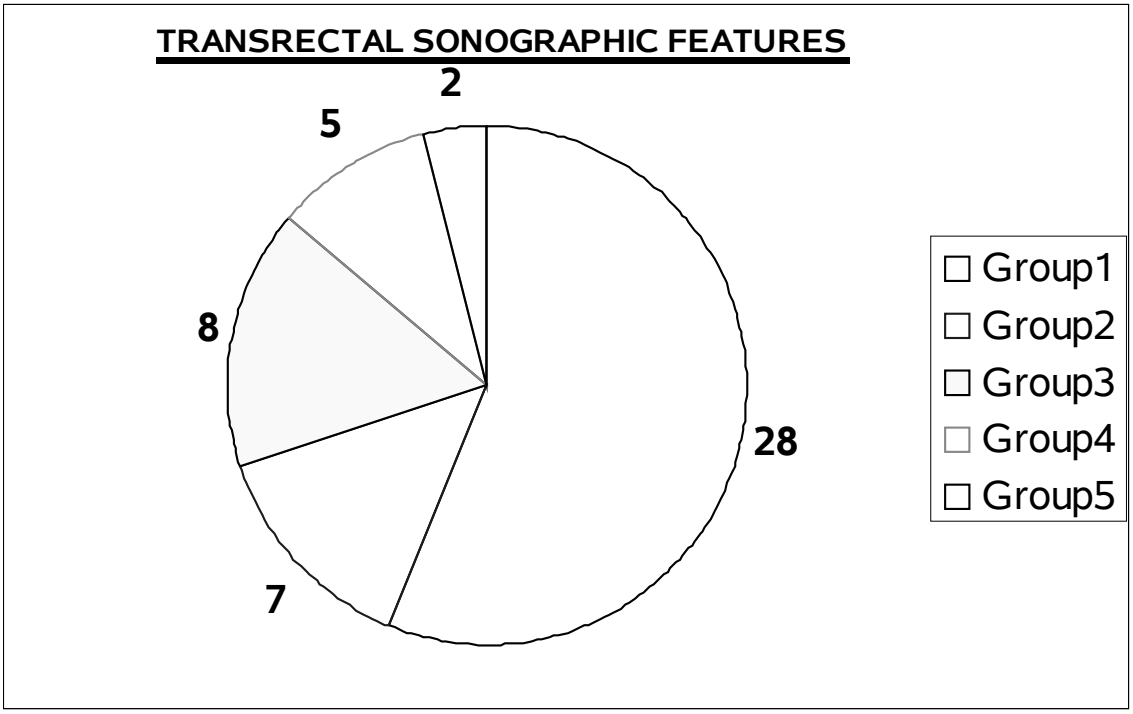
Group - 1: Enlarged prostate showing homogenous echotexture 28/50

Group - 2: Enlarged prostate showing inhomogenous echotexture 7/50.

Group - 3: Prostate showing nodular lesions 8/50

Group - 4: Tender enlarged mixed echogenic prostate with cystic areas 5/50.

Group - 5: Prostate showing echolucent cystic lesions without septations 2/50.




All Group 1 patients were assigned as benign prostatic enlargement and were sent for transurethral resection of prostate. No histopathologic results were reported as malignancy.

All Group 2 and Group 3 patients were subjected for guided biopsy of prostate. 15 were subjected for guided biopsy of which 6 results came as malignancy 4 as benign and 5 turned to be negative biopsy (Inconclusive).

All Group 4 patients were treated with a course of antibiotics and they were re-examined with transrectal sonography. Repeat examination shows reduction in the size of lesions in 4 patients, and 1 patient did not show any size reduction and he was subjected for biopsy. Biopsy turned out to be malignant.

All group 5 patients are assigned as cases of prostatic cyst and no treatment offered for them.

By ultrasonographic examination we assigned 28 patients as cases of BPH. Biopsy results of 2 nodular lesions and 2 prostate showing inhomogenous echoes turned out to be benign.

Out of 8 nodular lesions 4 presented as hypoechoic nodules in the peripheral zone. Two lesions were isoechoic nodules with diffuse involvement of prostate with loss of normal zonal anatomy and surface irregularity, and 2 other lesions were hyperechoic nodule in transition zone. Of these lesions we suspected 6 as malignancy because of surface irregularity and because they were in the peripheral zone, 2 lesions as inconclusive, of which 5 tuned out to be malignant, and 2 as benign. One biopsy from group 4 turned out as malignant.

The ability of TRUS to localise &to diagnose various benign and malignant lesions depending on their sonographic features were compared with HPE results using various statistical tests.

McNemar’s and Chi square test were used to evaluate whether there is any significant difference between TRUS and HPE results.

## *TRUS Vs. HPE*

| | Malignant | Benign |
|---|---|---|
| Malignant | 6 | 2 |
| Benign | 1 | 36 |

| | ***Estimate*** | ***95% CI (Confidence interval)*** |
|---|---|---|
| Sensitivity | 85.7 | 42.1-99.6 |
| Specificity | 94.7 | 82.3-99.3 |
| Correct classification rate | 93.3 | 81.7-98.6 |
| Missed classification rate | 6.7 | 1.4-15.5 |
| Positive predictive value | 75 | 35-97 |
| Negative predictive value | 97 | 86-99 |
| False positive rate | 5.2 | 0.0-18 |
| False negative rate | 14.2 | 0.0-57 |
| Kappa agreement | 0.76 | 0.5-1 |
| Likelihood ratio + | 16.3 | 4.1-64.1 |
| Likelihood ratio – | 0.15 | 0.03-0.93 |
| McNemar's test | $\chi^2$= 0.33 | P = 1.00 (Not significant) |

***MRI RESULTS***

Taking nodular hypointense lesion in peripheral zone, with or without capsular breech as MR features suggesting malignancy, out of 8 patient 5 were assigned as malignant. More over MR picked up one patient with capsular breech which was not seen in TRUS.

Group I patients showed enlarged gland with mixed intense transition zone with normal hyperintense peripheral zone. In Group II patients enlarged gland with mixed intense signal were noted in transition & central zone. But no e/o capsular breech and surface irregularity were seen. Hyper intense peripheral zone also appeared normal.

In Group IV patient, MR showed mixed intense lesion in $T_2$ WI with irregular walls involving diffusely.

In Group V patients MR showed well defined hyperintense lesion in the centre of gland with normal peripheral areas.

In group III patients 5 of 8 patients showed hypointense nodular lesions involving the peripheral zone. 3 of which showed capsular breech and 1 patient also showed adjacent femoral & iliac bone involvement and of the other 3 in 2 patients mixed intense nodular lesions were noted in central gland and in 1 patient no nodule was detected in MR.

The ability of MRI to detect the various benign and malignant lesions depending on their signal characteristics were compared with HPE results

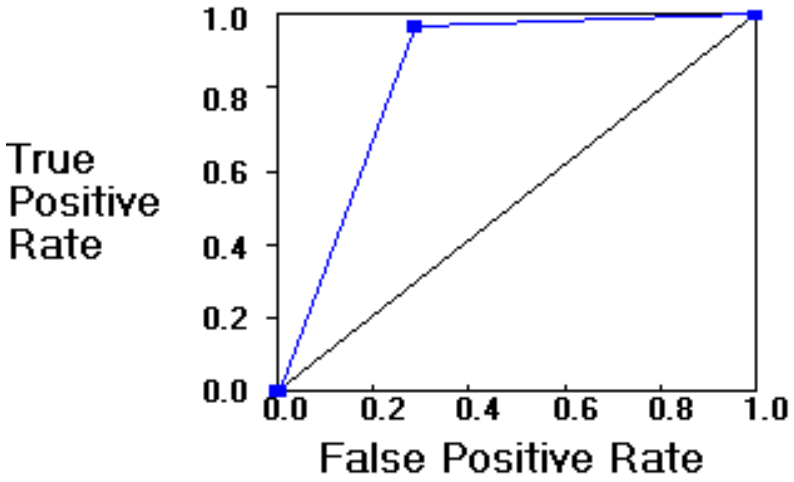
using various statistical tests. McNemar's and Chi square test were used to evaluate whether there is any significant difference between MRI and HPE results.

| | Malignant | Benign |
|---|---|---|
| Malignant | 5 | – |
| Benign | 2 | 38 |

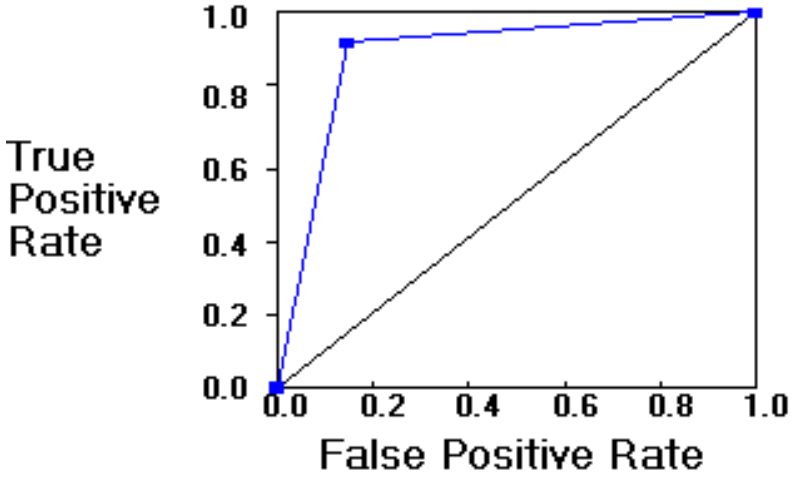
| | ***Estimate*** | ***95% (Confidence interval)*** |
|---|---|---|
| Sensitivity | 71.4 | 29-96 |
| Specificity | 100 | 91-100 |
| Correct classification rate | 96 | 85-99 |
| Missed classification rate | 4 | 1-20 |
| Positive predictive value | 100 | 48-100 |
| Negative predictive value | 95 | 83-99 |
| False positive rate | 0 | 0-9 |
| False negative rate | 29 | 4-71% |
| Kappa agreement | 0.81 | 0.55-1 |
| Likelihood ratio + | NA | |
| Likelihood ratio – | 0.29 | 0.9-0.99 |
| McNemar's test | $\chi^2$= 2.01 | P = 0.48 |

## SENSTITIVITY AND SPECIFICITY GRAPH OF MRI AND TRUS Vs HPE

### MRI Vs HPE

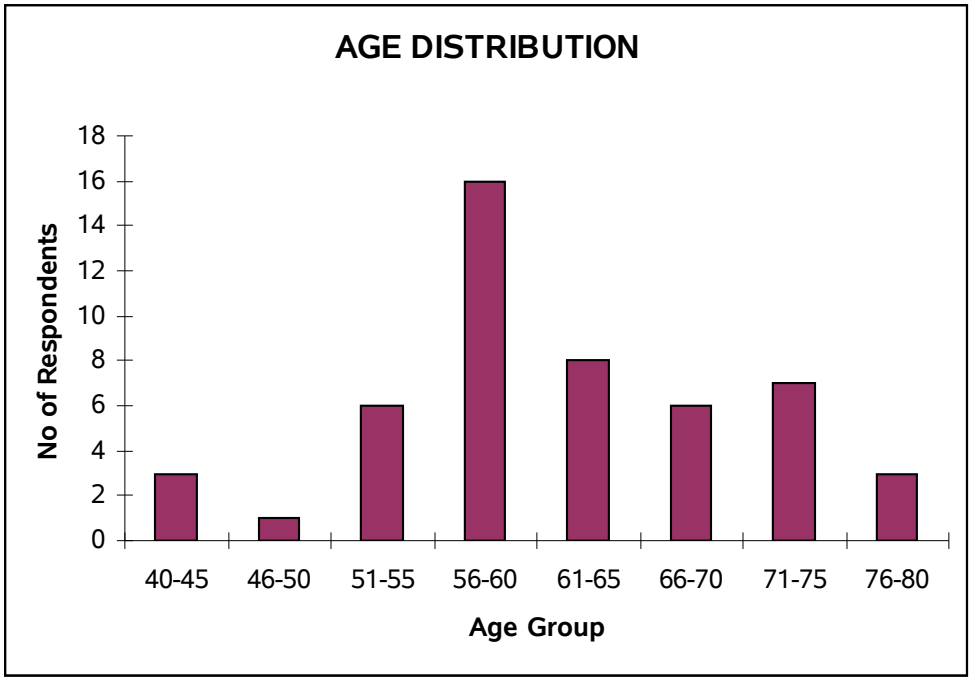



### TRUS Vs HPE



## AGE DISTRIBUTION

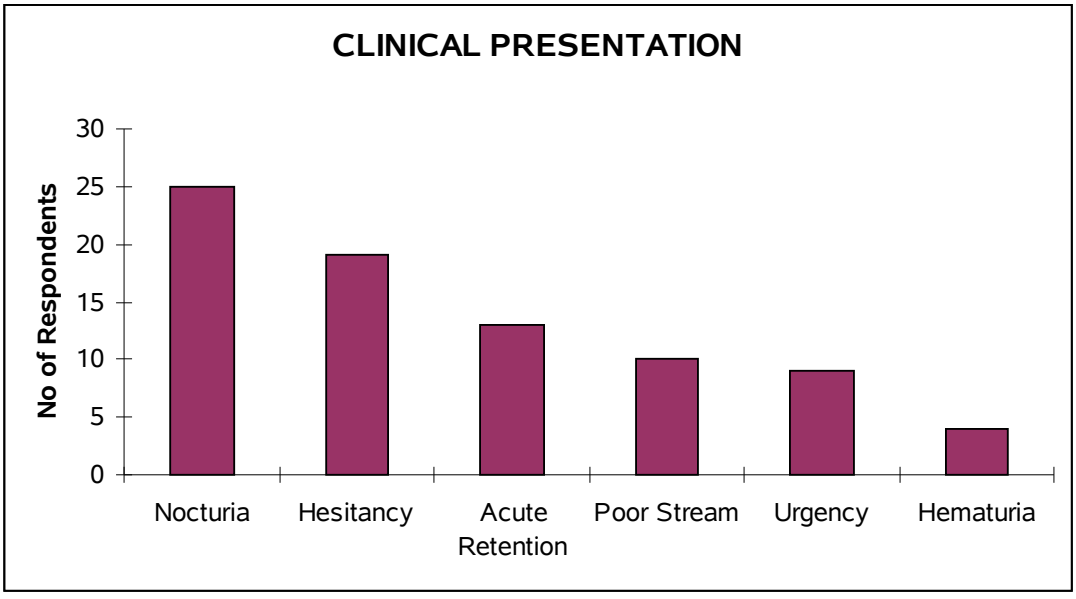
| *Age* | *No. of Respondents* | *Percentage* |
|---|---|---|
| 40-45 years | 3 | 6% |
| 46-50 years | 1 | 2% |
| 51-55 years | 6 | 12% |
| 56-60 years | 16 | 32% |
| 61-65 years | 8 | 16% |
| 66-70 years | 6 | 12% |
| 71-75 years | 7 | 14% |
| 76-80 years | 3 | 6% |



## PRESENTING COMPLAINTS

| *Complaint* | *No. of Respondents* | *Percentage* |
|---|---|---|
| Nocturia | 25 | 50% |
| Hesitancy | 19 | 38% |
| Acute Retention | 13 | 26% |
| Poor Stream | 10 | 20% |
| Urgency | 9 | 18% |
| Hematuria | 4 | 8% |

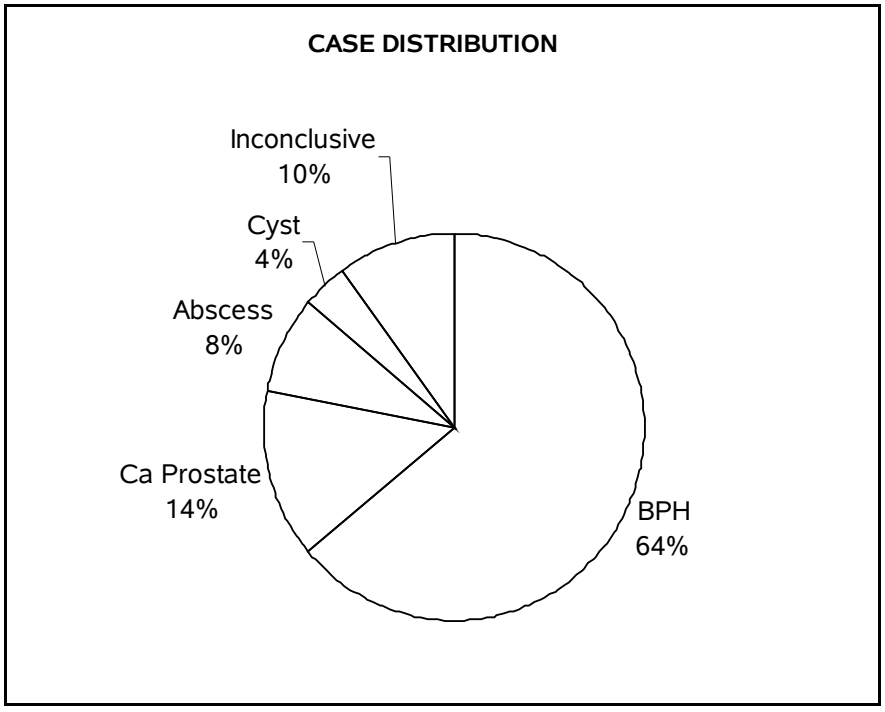
Most of our patients presented with more than one complaint.



## CASE DISTRIBUTION

| *Case* | *No. of Respondents* | *Percentage* |
|---|---|---|
| BPH | 32 | 64% |
| Ca Prostate | 7 | 14% |
| Abscess | 4 | 8% |
| Cyst | 2 | 4% |
| Inconclusive | 5 | 5% |

Most of our patients presented with more than one complaint.



Weighted **Kohen's Kappa** is calculated by observed frequency of agreement minus expected frequency of agreement divided by total observed minus expected frequency of agreement.

**Mc Nemar's** test – It is a variant of the **Chi Square** test, used only when both the independent and dependant variables are dichotomous.

Weighted Kohen's Kappa for TRUS with HPE correlation is 0.76 with intra class correlation coefficient ranging from 0.5 – 1

Similarly weighted Kohen's Kappa for MRI with HPE correlation is 0.81 with intra class correlation coefficient ranging 0.55 to 1.

Values of Kappa were classified as bad (less than 0.4) good (0.4 to 0.75) or excellent (greater than 0.75) following Landis and Koch's criteria.

# DISCUSSION

Although prostate cannot be directly visualized by conventional methods, Intravenous urography and cystourethrography can show the prostatic impression in the floor of the urinary bladder. The urethra may be elongated and it appears compressed, looking like a slit on A.P. View. During ascending urethrogram or voiding cysto-urethrogram it may produce a smooth filling defect in the floor of the bladder. At times intra-vesicle filling defect may be produced by enlargement of the periurethral and subvesicular part. I.V.U. may shows J-Shaped (fishhook deformity) distal ureters due to enlarged prostate pushing the bladder trigone upwards.

Early prostatic cancers cannot be picked up by conventional contrast studies or by transabdominal ultra sonography of the prostate. However in late stages when the prostatic carcinoma extends towards the urethra, irregular Contour of prostatic urethra and bladder base can be seen in voiding cystourethrography.

If seminal vesiculogram is performed the medial portion of the seminal vesicle are seen to be decrease in size, related to tumour infiltration and lateral portion of seminal vesicle may be dilated. The junction between the ductus deferens and the lateral part of seminal vesicle may also be dilated, and the junction between the ductus deferens and the ejaculatory duct may be depressed. Contrast medium may have a greater

tendency to flow distally rather than back into the bladder when entering the posterior urethra from the ejaculatory duct.

On transabdominal ultrasonography prostate appears as a homogenous, round to slightly ovoid structure, with uniform, low level echoes. The relationship between the bladder and the prostate can be demonstrated. But the normal zonal anatomy of the prostate cannot be demonstrated. Early hypo echoic cancers in the peripheral zones cannot be picked up. The prostate and periprostatic tissue are well visualized using computed tomography. But neither the zonal anatomy nor the differentiation between the prostatic parenchyma and the prostatic capsule were visualised.

On magnetic resonance imaging the ability to demonstrate the zonal anatomy of the prostate and the distinction between the gland and periprostatic tissue varies with the imaging plane and sequences used .On spin echo T1 WI, regardless of field strength, the prostate shows a homogenous signal of intermediate intensity and the zones cannot be differentiated .On T2 WI the zonal anatomy is well delineated with prostatic urethra as a key point .Endorectal coil MRI is the imaging modality of choice at present for detecting and accurate staging of prostate cancer but it is much costlier and is not available in all places.

**Robert L.Bree et al.,**[22] described that the sonographic appearance of BPH is varied and depends on the histopathological changes. Diffuse

enlargement of the transition zone with homogenous echoes will be seen in fibromuscular hyperplasia, inhomogenous echoes, in cases showing combination of fibromuscular and adenomatous element, hyperechoic nodules in cases of prostatic adenoma.

In our series out of 32 cases of BPH, 28 patients[87%] showed diffuse homogenous hypoechogenicity of transition zone, 2 patients [6.25%] showed hyperechoic nodules in the transition zone. 1 patient [3.1%] showed inhomogenous echotexture of transition zone.

**Mathew D. Rifkin et al**[9] reported presence of smooth and regular capsule as a sign of benign lesion. In his series 93% cases of BPH had a smooth capsule. In our series all 32 cases [100%] of BPH had smooth and intact capsule.

**R.Malik et al**[37] in his study showed sensitivity &specificity of TRUS to diagnose carcinoma prostate to be 87%and72% respectively, our study showed a sensitivity of 86% and specificity of 90%.

**Fred Lee et al**[6] in his series reported 8 hyperechoic nodules of which 7 were proved to be BPH by histopathology. In our series we came across 2 hyperechoic nodules and both turned out to be benign lesions. So our results are closely matching with his results.

The mean age of patients with prostatic cancer was 69yrs in Fred Lee et al[6] studies. In our study the mean age of patients with prostatic cancer is 66.5yrs.

**Katsuto Shinohara et al**[7] in their series reported 67% of cancers presenting as hypoechoic lesions, 32% as isoechoic lesions and 1% as hyperechoic lesions. In our studies 5 of the 7 malignant lesions were hypoechoic forming 71% and 2 of 7 were seen as isoechoic lesions forming 29%. We have not come across hyperechoic malignancy in our study.

Most of the study materials showed 70% of carcinomas arise from peripheral zones, 20% in transition zone and l0% in central zone. In our study out of 7 malignant lesions 4 were seen in peripheral zone (57%), 1 in transition zone (15%) and 2 cases were diffuse (38%). This disparity may be because of small representative volume.

A tumour occupying most of the prostate may not be visible on ultra sonography. This is called superscan phenomenon, where a tumour virtually replaces the entire prostate so that there is little normal tissue for comparison, as a result the gland has uniform echo pattern and the cancer is not appreciated. **Salo et al**. reported that poorly differentiated tumour diffusely involving the prostate often appear as mixed echoic or isoechoic. In our study 2 cases of malignant lesions were diffusely involving the prostate causing obscuration of normal zonal anatomy of prostate and they were seen as isoechoic. This is because of superscan phenomenon.

**Katsuto Shinohara et al**[7] reported that obviously irregular asymmetric gland often signals malignancy even in the absence of an identifiable hypoechic lesion. In our study we identified 2 isoechoic malignancy mainly because of the surface irregularity of prostate.

**Peter T. Scardino et al**[8] said hyperechoic tumours are rare. They explained that they are ductal carcinomas with comedo type tumour nests containing calcifications and necrotic debris causing multiple acoustic interfaces to give a hyperechoic appearance. In our study we have not come across hyperechoic malignancy.

**Katsuto Shinohara et al**[7] in their series detected 67 cancers by sonography and all 67 were palpable by digital rectal examination. In our study out of 7 cancers 6 were palpable lesions.

**Kathryn K. Hodge** and **John E. McNeal et al**[16] in their series reported that out of 136 patients subjected for biopsy 86 were positive for cancer (61%). The mean number of biopsy per patient was 7. In our study out of 15 prostatic biopsy we have come across 7 malignancies forming 46%. The mean number of biopsy per patient is 1.

**Andrew Doble** and **Simon St. C. Carter et al**[19] formulated ultrasound signs in inflammatory prostatic diseases. They are as follows,

- Hyperdense echoes
- Midrange echoes

- Echolucent zones
- Ejaculatory duct calcification
- Capsular thickening
- Periurethral zone irregularity

We have come across 5 lesions showing hypoechogenicity with midrange echoes out of which 4 were abscesses and 1 turned out to be malignant. (Probably because of necrosis of tumour).

.According to **Bezzi M et al**[23] majority of the prostatic malignant lesion shows hypointensity in $T_2$WI. In our study also out of 7 malignant lesion 6 were (85%) of lesion were hypointense in $T_2$WI.

Studies done by **Yu et al**[28] and **McNeal JE et al**[16] shows that MR is more sensitive than TRUS in detection of Transcapsular extension and spread. In our study also 2 cases of transcapsular extension was detected by MR where TRUS detected only 1 case and thus the staging was changed from stage 2 to stage 3.

Experience with MRI of prostatitis and abscess is limited and reported findings differ. Some investigators report on Inhomogenous appearance of the gland in c/c prostatitis with signal intensity similar to that of normal prostate. Other report that both a/c and c/c prostatitis may show multiple small areas of increased signal intensity scattered throughout the

prostate on SE-$T_2$WI. In our study also enlarged prostate with heterogenous signal intensity were noted.

Studies done by **Shigeno K et al**[31] (BJU-2000) shows the use of CDI when used along with TRUS where hyper vascular malignant lesion, could be located more accurately and it increases the sensitivity and negative predictive value in detecting carcinoma prostate. Inflammatory lesions also show increased vascularity.

In our study out of seven malignant lesions 5 showed increased vascularity and four benign lesions also showed increase vascularity, which proved to be of inflammatory cause.

# SUMMARY

TRUS with colour Doppler and MRI were performed in 50 patients referred from the department of Urology. Patients belonged to age group 41-78 years. The results were compared with the histopathological results obtained by TRUS guided biopsy and TURP specimen.

A majority of the patients (64%) were having generalised enlargement of prostate with main symptoms as nocturia (50%) and Hesitancy (38%).

Taking Inhomogenous echoes and hypoechoic nodular lesions in PZ with surface irregularity as sign of malignancy TRUS proved to be very sensitive in detecting malignant lesion. **Sensitivity** (85.7%).

By MRI the extent and invasion of prostate cancer into periprostatic tissues were better delineated. Also taking a hypointense lesion in the PZ in T2 WI as sign of malignancy, MRI showed **sensitivity** of 71.4%.

However in our study, Nodular lesions detected by TRUS were missed by MRI. It may be due to the decreased resolution of Body coil MRI.

A weighted **Cohen's kappa** coefficient measure of TRUS was found to be 0.64 and for MRI it was 0.77. Values of Kappa were classified as bad

(less than 0.4), Good (0.4 - 0.75) or excellent (greater than 0.75), following **Landis** and **Koch's** criteria.

Similarly, intra class correlation coefficient with 95% confidence interval for TRUS were found to be 0.36 - 0.93 and for MRI was 0.48 - 1.00. Value of intra class correlation coefficient which are nearer to 1.00, indicates an excellent correlation.

Using Doppler it was able to localise better the vascular lesions. But both malignant and inflammatory lesions show increased vascularity.

TRUS is also an excellent modality to do guided Biopsy and helps to increase the yield of procedure comparing to the blind biopsy technique.

# CONCLUSION

Transrectal sonography is a good modality to characterize prostatic lesions as benign and malignant.

Hypoechoic lesion distributed in peripheral zones with surface irregularity is a reliable sign of malignancy.

Increased AP dimension causing more rounded configuration of prostate with smooth capsule is a good sign of benignity

It is a good modality to identify local spread of malignancy. It is a good guiding system for prostatic biopsies

It is minimally invasive and easy to perform.

It is safe, no radiation hazard, comparatively cheap and can be repeated for any number of times.

MRI is also a good modality to localise the lesion in prostatic carcinoma. It is better than TRUS in determining the extent of the disease.

MRI also gives the surgeon a three dimensional picture of the lesion and prostate before surgery so that he is able to plan better.

MRI helps us to know the involvement of other organ and lymph nodes in case of metastatic disease.

MRI is also safe without any radiation hazard.

TRUS appeared to be more sensitive than MRI in detecting the lesions, maybe because of body coil we used in MR examination

Even with body coil MRI we are able to localise the lesion and extension of the disease to greater extent with additional advantage of larger FOV compared to Endorectal MRI.

In colour Doppler increased vascularity is seen in both malignant and inflammatory lesions, and it helps to accurately localize the lesions, while performing biopsies.

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# ANNEXURE

## ABBREVIATION

| | |
|---|---|
| TRUS | Transrectal ultrasonogram |
| MRI | Magnetic Resonance Imaging |
| CT | Computed Tomography |
| CDI | Colour Doppler Imaging |
| BPH | Benign Prostatatic Hyperplasia |
| CZ | Central Zone |
| PZ | Peripheral Zone |
| TZ | Transitional Zone |
| A/c | Acute |
| C/C | Chronic |
| WI | Weighted images |
| NVB | Neuro vascular bundles |
| TR | Relaxation Time |
| TE | Echo time |
| STIR | Short Tau Inversion Recovery |
| 3D MRSI | Three Dimensional Magnetic Resonance Spectroscopic Imaging |
| FOV | Field of view |
| MHz | Megahertz |
| HPE | Histopathological Examination |

# PROFORMA

SL. NO: NAME: AGE:

IP. NO:

Presenting complaint:

Past History:

Vital signs:

General Examination:

Digital Rectal Examination:

**Investigations:**

1. **PSA:**
2. **Trans abdominal USG:**

**3. Trans Rectal USG :**

Volume:

Site of lesion:

Echogenecity:

Gland Asymmetry:

**4. Colour Doppler:**

**5. MRI :**

**6. TRUS guided biopsy:**

**7. Summary:**

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 1 | Muthukumar | 62 | poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH TURP-no malignancy |
| 2 | Madasamy | 57 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH |
| 3 | Sakthivel | 53 | nocturia, hematuria | Enlarged prostate, No nodules | Tz hypertrophied, Inhomogenous echos,Cz Pz-normal | Enlarged mixed intense Tz in T2WI with normal hyperintense Pz | peripheral vascularity | negative |
| 4 | Elumalai | 60 | A/C retention | Enlarged tender prostate | enlarged mixed echogenic prostate with hypoechoic areas on rt side with internal echos treated with antibiotics pain subsided (PROSTATITIS) | Enlarged prostate with illdefined hyperintense lesion in Tz measuring1.2 * 1.1 cm | increased vascularity | prostatitis/abscess |
| 5 | Kumar | 58 | Nocturia | Enlarged prostate | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH |
| 6 | Ezhilan | 78 | hematuria ,poor stream | multiple hard nodules | Enlarged prostate with surface irregularity, zonal anatomy lost | Enlarged prostate with loss of hyperintensity in Pz in T2WI with capsular breech, no e/o seminal vesicle involvement | diffusely increased vasculrity | carcinoma prostate |
| 7 | Rajkumar | 73 | Nocturia | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH |
| 8 | Ramalingam | 61 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 9 | Karthikeyan | 58 | hesitancy poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal vascularity | BPH |
| 10 | Thangasamy | 71 | Nocturia poor stream | hard nodule in mid line | nodular hypopechoic lesion measuring 1cx1.3cm seen in pz in mid line, capsule intact SV -normal | hypointense nodular lesion seen involving the Tz ,capsule intact ,SV - N | normal | carcinoma prostate |
| 11 | Irulandi | 72 | Nocturia, A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 12 | Mohammed abbas | 75 | Nocturia, A/C retention | hard nodule RT side | Irregular hypoechoic lesion measuring 1.4x1.2cm in the rt lobe | ill defined hypointense lesion in T2 WI seen in Pz on rt side .no e/o capsular breech /seminal vesicle invasion | the lesion shows increased vascularity | carcinoma prostate |
| 13 | Karuppaiah | 68 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 14 | Nazar | 74 | poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 15 | Manickam | 69 | nocturia, hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, Inhomogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | negative |
| 16 | Subbair | 77 | nocturia, hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 17 | Manikam | 48 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 18 | Selvam | 74 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 19 | Subramani | 64 | hesitancy poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 20 | Raman | 63 | Nocturia | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | mixed intense enlarged Tz with normal hyperintense Pz | normal | BPH |
| 21 | Chinnappa | 67 | nocturia | Enlarged prostate, No nodules | Tz hypertrophied, Inhomogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | Negative |
| 22 | Raju | 41 | pain in the perineum, retention | enlarged tender prostate | Enlarged mixed echogenic left lobe displacing the folleys catheter to the rt, Repeat USG after antibiotic course shows reduction in size of lesion s/o a/c prostatitis. | enlarged mixed intense prostate involvivg left lobe with folleys Insitu | diffusely increased vasculrity | prostatitis/abscess |
| 23 | Ramar | 51 | Nocturia | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 24 | Velan | 42 | hesitancy | Enlarged prostate, No nodules | well defined cystic lesion measuring 1.2x1.1cm seen on rt side in T2 WITH acoustic enhancement | well defined hyperintense lesion in T2WI | Avascular | prostatic cyst |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 25 | Hariharan | 60 | Nocturia, hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 26 | Chinnasamy | 62 | hesitancy, hematuria | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 27 | Chelladurai | 57 | nocturia, poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Mixed intense enlarged Tz with normal hyperintense pz | normal | BPH |
| 28 | Muthu | 67 | hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 29 | Ponnaiah | 59 | hesitancy, nocturia | hard nodule on rt side | irregular hypoechoic lesion measuring 1.5x1.1cm in the rt lobe, seen invading sv with capsular breech | hypointense lesion in Rt Pz with focal bulge and capsular breech and sv involvment seen in T2WI. Also there is e/o femoral and illiac bone involvement | increased vascularity seen in the hypoechoic lrsion | carcinoma prostate |
| 30 | Alagappan | 55 | Nocturia. a/c retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 31 | Lingappan | 46 | urgency | smooth enlarged prostate | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH TURP-no malignancy |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 32 | Pitchai | 44 | A/C retention | firm nodule on rt side | prostate more rounded in configuration hyperechoic nodule measuring 1.7x1.7cm seen in rt tz causing compression of urethra CZ&PZ--normal | Enlarged Tz with an mixed intense lesion measuring 1.6x1.5 cm Cz &Pz--N | normal | BPH TURP-no malignancy |
| 33 | Ismail | 69 | Hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 34 | Sami | 45 | Nocturia , hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 35 | Ramasamy | 65 | Nocturia. a/c retention | multiple hard nodules | enlarged prostate with surface bulge , zonal anatomy lost | enlarged prostate with hypointense lesion seen involving both peripheral & central zone without capsular breech | diffusely increased vasculrity | carcinoma prostate |
| 36 | Karuppiah | 59 | A/C retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 37 | Muthiah | 64 | urgency , hesitancy | enlarged prostate ,no nodule | enlarged heterogenous central gland with hypoechoic nodular lesion noted in left side Pz | shows mixed intense enlarged central gland , no lesion was detected in Pz | increased vascularity | carcinoma prostate |
| 38 | Mani | 76 | Nocturia , hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 39 | Muthu | 50 | Nocturia, Pain in perineum | Tender enlarged prostate | Ill defined hypoechoic lesion with internal septations seen on left side in TZ measuring 1.5x1.5 cm, repeat sonogram shows reduction in size of the lesion | Enlarged prostate with ill defined hyperintense lesions in TZ measuring 1.2 x 1.1 cm | diffusely increased vasculrity | Abscess / Prostatitis |
| 40 | Shankar | 64 | Hestancy | Enlarged prostate, No nodules | Tz hypertrophied, Inhomogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | Negative |
| 41 | Munnian | 54 | Hesitancy & hematuria | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 42 | Vellaichamy | 60 | nocturia,poor strem ,pain in the perineum | enlarged tender prostate ,no nodules | well defined hypoechoic lesion with echogenic wall & internal echoes seen on rt side in TZ ,treated with antibiotics ,rpt usg revealed same findings | mixed intense well defined lesion seen in the Tz in rt side it is predominantly hyper intense in T2WI | normal | Carcinoma prostate |
| 43 | Thulasiraman | 67 | Nocturia. a/c retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 44 | Ramadoss | 60 | Nocturia , hesitancy | Enlarged prostate, No nodules | Tz hypertrophied, Inhomogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | Negative |
| 45 | Sreeni | 52 | hesitancy, a/c retention | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |

| SL.No. | NAME | Age | Clinical history | DRE | TRUS | MRI | Doppler | Biopsy |
|---|---|---|---|---|---|---|---|---|
| 46 | Kulanthaisamy | 60 | nocturia, poor stream | Enlarged prostate, No nodules | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |
| 47 | Thoogapillai | 60 | poor stream | Enlarged prostate, No nodules | a well defined cystic lesion seen measuring 1.5 x1.2cm in Tz in midline with acoustic enhancement | well defined hyperintense lesion in T2WI in Tzin the midline | Avascular | prostatic cyst |
| 48 | Alladeep | 58 | Nocturia, hesitancy | firm nodule on lt side | Round hyperechoic nodule measuring 1.2 x1.2 cm seen in lt side of Tz | hyperintense lesion seen in the enlarged Tz on lt side .Pz normal | normal | BPH |
| 49 | Subramani | 36 | painful micturition with pyuria | tender prostate | e/o ill defined hypoechoic lesion seen in the rt lobe involving central gland ,Rpt usg after antibiotics shows reduction in size | Enlarged prostate with a hyperintense lesion in the rt lobe in T2 WI , no e/o surface irregularity/ capsular breech | normal | prostitis/ abscess |
| 50 | Subbaiah | 57 | hesitancy | smooth enlarged prostate | Tz hypertrophied, homogenous echos,Cz Pz-normal | Enlarged mixed intense TZ with hyper intense PZ | normal | BPH |

# KEY TO MASTER CHART

| | |
|---|---|
| SB No | Serial Number |
| TZ | Transitional Zone |
| PZ | Peripheral Zone |
| CZ | Central Zone |
| DRE | Digital Rectal Examination |
| TRUS | Trans rectal  Ultra Sonogram |
| MRI | Magnetic Resonance Imaging |
| BPH | Benign Prostatic Hyperplasia |
| TURP | Transurethral Resection of prostate |
| SV | Seminal vesicle |
| ED | Ejaculatory Duct |