# Sudan University of Science &Technology

College of Graduate Studies

# Evaluation of Urinary Tract in Patients with Benign Prostatic Hyperplasia Using Ultrasonography

تقويم المسالك البولية لدي مرضى تضخم البروستاتا الحميد باستخدام التصوير بالموجات فوق الصوتية

A Thesis Submitted for Partial Fulfillment of the Requirements of (M.Sc.) Degree in Medical Diagnostic Ultrasound


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# الآيـــة

**بسم الله الرحمن الرحيم**

**قال تعالي:**

( وَمَا كَانَ لِرَسُولٍ أَن يَأْتِيَ بِآيَةٍ إِلَّا بِإِذْنِ اللَّهِ ۗ لِكُل أَجَلٍ كِتَابٌ)

صدق الله العظيم

سورة الرعد الآية 38

# Dedication

I dedicate this work to the sake of Allah, my Creator and my Master.

To my Dad and Mom whom is the authentic meaning of kind and love and whom support me to believe in myself, in God and in my dreams

To My beloved brothers, sisters and all my family, the symbol of love and giving

I also dedicate this work to my beloved husband, who leads me through the valley of darkness with light of hope and support.

To  my uncle Abdelmahmoud who being my guardian during my educational career.

Also to my friends whom encourage and support me especial thanks for shimaa.

Finally to my Homeland Sudan and all the people in my life whom touch my heart.

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Frist I would like to thank Allah for gave me patience and power to complete this study.

I would like to express my gratitude and respectfulness to my supervisor Dr.Caroline Edward for her support and valuable guidance, then to Dr. Abbas Osman For their support and giving me a great chance and time to collect my cases and helping me whenever I needed help.

Finally I would like to thanks anyone who gave me any type of support .

## Abstract

This study was descriptive cross sectional conducted in Khartoum state, Sudan, in the Radiology Department of Omdurman Teaching Hospital in the period from October 2018to April 2019, There were 50 males were scanned using ultrasound, all patients are with age 52-84 years, patient mean age was (69.4±8.22) ,The study aimed to evaluate the urinary tract in patient with prostatic hyper plasia using ultrasonography.

The data was collected using data collection sheet and analyzed using the Statistical Packages for Social Science (SPSS ) program.

All patients were scanned transabdomen by ultrasound Mindary machine of curvilinear probe frequency ranged from 3.5 to 5 MHZ, prostate volume ,kidneys volume, urinary bladder volume pre and post micturition and urinary bladder wall thickness had been evaluated.

The results of this study showed that patient mean height (166.7±4.87),patientweightwas(68.4±6.62),BMIwas(24.9±2.10),PSAlevel(2.9±3.82),RTkidneylength(10.6±0.72),RTkidney width(4.6±0.41),RTkidney thickness(4.1±0.27) ,RT kidney volume(99.3±16.06) ,LT kidney length(11.0±0.96), LT kidney width(4.8±0.48), LT kidney thickness(4.3±0.42) and LT kidney volume(112.4±25.60) ,also showed that46% of cases had homogeneous 26 % heterogeneous and 28%calcified prostate echotexture .all of them was diagnosed as benign Prostatic hypertrophy.also showed that 52% of cases had regular capsule and 48 % had irregular prostate capsule which all of them was diagnosed as benign Prostatic hypertrophy ,the study also showed that 30% of cases had normal bladder volume post micturation and 70% abnormal. also the results showed that 62% of cases had normal urinary tract findings and 38% of cases are abnormal which distributed as 16 % had cystitis , 6% vesical stone , 4%simple renal cyst , 2% multiple renal cyst , 6% renal hydronephrosis , 2% bladder diverticulum and 2% renal stone and also confirmed that there is no significant relationship between the prostate volume and patient age , BMI , right kidney volume , left kidney volume , bladder wall thickness and bladder volume pre micturation , the study showed there is significant relationship between the prostate volume and PSA.

المستخلص
كانت هذه الدراسة وصفية مقطعية أجريت في ولاية الخرطوم السودان ، في قسم الأشعة بمستشفى أم درمان التعليمي في الفترة من أكتوبر 2018 إلى أبريل 2019 ، تم مسح 50 ذكر باستخدام الموجات فوق الصوتية ، وجميع المرضى تتراوح أعمارهم بين 52-84 سنة ، مريض متوسط العمر كان (69.4 ± 8.22) ، هدفت الدراسة إلى تقييم المسالك البولية لدى المريض المصاب بفرط تنسج البروستاتا باستخدام الموجات فوق الصوتية.
تم جمع البيانات باستخدام ورقة جمع البيانات وتحليلها باستخدام برنامج الحزم الإحصائية للعلوم الاجتماعية.
تم فحص جميع هؤلاء المرضى عبر البطن باستخدام الموجات فوق الصوتية جهاز منداري من التحقيق المنحني مع تردد يتراوح بين 3.5 إلى 5 ميجا هرتز ، وحجم البروستاتا ، وحجم الكلى ، وحجم المثانة البولية قبل وبعد التبول وتم تقييم سمك جدار المثانة البولية.
أظهرت نتائج هذه الدراسة أن متوسط ارتفاع المريض (166.7 ± 4.87) ، وزن المريض (68.4 ± 6.62) ،مؤشر كتلة الجسم( 24.9±2.10 )، مضاد البروستاتا المحدد(3.82 ±2.9)، طول الكلية اليمنى (10.6±0.72)، عرض الكلية اليمنى ( 4.6 ±0.41)، سمك الكلية اليمنى(4.1± 0.27) ، حجم الكلية اليمنى (99.3 ± 16.06) ، طول الكلي الكلية اليسري (0.11±0.96)، عرض الكلية اليسري (4.8 ± 0.48) ، سمك الكلية اليسري (4.3±0.42) وحجم الكلية اليسري ( 112.4 ± 25.60) ، أظهرت أيضًا أن 46 ٪ من الحالات كانت متجانسة ، 26 ٪غير متجانسة و 28 ٪ من البروستاتا المتكلسه ، تم تشخيص جميعها على أنها تضخم البروستاتا الحميد. وأظهرت أيضًا أن 52 ٪ من الحالات كانت لها كبسولة منتظمة و 48 ٪ لديها كبسولة بروستاتا غير منتظمة والتي تم تشخيصها جميعها على أنها تضخم البروستاتا الحميد ، أظهرت الدراسة أيضًا أن 30٪ من الحالات كانت بها حالة طبيعية بعد حدوث مثانة بحجم غير طبيعي و 70٪ غير طبيعية. كما أظهرت النتائج أن 62 ٪ من الحالات كانت لها نتائج طبيعية في المسالك البولية و 38 ٪ من الحالات غير طبيعية والتي وزعت على 16 ٪ لديهم التهاب المثانة ، 6 ٪ الحجر الفيزيائي ، الكيس الكلوي البسيط 4 ٪ ، 2 ٪ الكيس الكلوي المتعدد ، 2 ٪ التلف الكلوي ، 2 ٪ جيب المثانة و2 ٪ حصي الكلوي وأكدت أيضا أنه لا توجد علاقة بين حجم البروستاتا وعمر المريض ، ومؤشر كتلة الجسم ، وحجم الكلى الأيمن ، وحجم الكلى الأيسر ، وسمك جدار المثانة وحجم المثانة قبل التبول ، وأظهرت الدراسة هناك هي علاقة كبيرة بين حجم البروستاتا ومضاد البروستاتا المحدد.

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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| AAH | Atypical Adenomatous Hyperplasia |
| BMI | Body Mass Index |
| BPH | benign prostatic hyperplasia |
| CKD | Chronic Kidney Disease |
| CM | Centimeter |
| CT | Computed Tomography |
| HIFU | High Intensity Focused Ultrasound |
| LT | Left |
| LUTS | Lower Urinary Tract symptoms |
| MHZ | Mega hertz |
| ML | Milliliter |
| mmHg | Millimeter of mercury |
| Ng\ml | Nanogram per milliliter |
| PIN | Prostatic Intra Epithelial |
| PSA | Prostate Specific Antigen |
| PV | Post voiding |
| RT | Righ |
| SPSS | Statistical Packages for Social Science |
| TAS | Trance Abdominal Ultrasound |
| TRUS | Trance Rectal Ultra Sound |

# Chapter One

# Introduction

# Chapter One

# Introduction

## 1-1 INTRODUCTION:

The benign enlargement of the prostate gland is termed benign prostatic hyperplasia (BPH). BPH affects about 50% of men over age 60yearsand90%over age 70. The weight of the gland in a young manisapproximately 20 g. From age 50, the doubling time of prostate weightisapproximately 10 years. Prostates weighting more than 40 g aregenerallyconsidered enlarged in older men. The etiology of BPH is unclear butprobably related to hormonal changes with aging. The process resultsinhypertrophyandhyperplasiaofthefibrous,muscular,andglandularelements,primarilyaffecting the transition and periurethralzones.Bladder outlet obstruction, lower urinary tract symptoms (LUTS) canrelate to increases in prostate size and muscular tone, both of which result in urethral constriction.DARKE,R .and ANDROW, W .(1995)

The enlargement of the median and lateral lobes of the gland produces elongation and lateral compression and distortion of the urethra so thatthe patient experiences difficulty in passing urine and the stream is weak.Back-pressure effects on the ureters and both kidneys are a commoncomplication.
The enlargement of the uvula vesicae (owing to the enlarged medianlobe) results in the formation of a pouch of stagnant urine behind theurethral orifice within the bladder. The stagnant urine frequently becomesinfected, and the inflamed bladder (cystitis) adds to the patient'ssymptoms.DARKE,R .and ANDROW, W .(1995)

Symptoms include frequency, nocturia, weak stream, intermittence,incomplete emptying, and urgency. Many men have a misguided concern about prostate

size. The issue is urinary obstruction, not prostate size,which correlates only somewhat with obstruction.

Thesonographic appearance of BPH varies and depends on underlying histopathologicchanges. The typical sonographic feature of BPH isenlargement of theinner gland (transition zone). With BPH, the enlarged transition zone canexhibit diffuse enlargement or distinct hypoechoic, isoechoic, orhyperechoic nodules. DARKE,R .and ANDROW, W .(1995)

BPH may cause bladder outlet obstruction which can lead tohydronephrosis, cystitis, pyelonephritis and other complications.Hydronephrosis is a general term that is defined as the dilation of the renal collecting system secondary to the obstruction of normal urine flow.

Accordingly, hydronephrosis is dilation of the calices, infundibula, and renal pelvis. It may also be described as mild, moderate, and severe or marked. DARKE,R .and ANDROW, W .(1995)

**1-2 Problem of the study:**

The kidney is an important organ for the human body and the BPH maycause some disorders in the kidneys. Benign Prostatic Hypertrophy is main cause of residual urine in old men; many tools of investigations are used to find out the right diagnosis. This includes clinical examination, urine investigation, ultrasonography and different types of other radiological modalities. By conducting this research,

The questions to be answered are: Can the **B**PH affected the urinary tract in elderly patients. Are there any relationship between the prostate volume and patient demographic data and PSA.

## 1-3 Objectives:

### 1-3-1 General Objective:

To evaluate the urinary tract in patients with benign prostatic hyperplasia using ultrasonography .

### 1-3-2 Specific Objectives:

To measure the volume of the prostate and capsule.

To determine the echogenicity of the prostate gland. .

To co-relate the prostate size with PSA.

To determine the effect of enlarged prostate on the urinary tract

To correlate patient age and prostate volume.

To diagnose the cystitis complaining of benign prostatic hypertrophy.

To measure the volume of the kidneys.

To correlate between history of BPH and effects on the kidneys.

To evaluate urinary bladder pre and post micturation o f urine, measured dilated ureter in patients with benign prostatic hypertrophy**.**

## 1-4 Thesis overview:

This study consists of five chapters:

Chapter one: contains introduction and objectives (general and specific).

Chapter two: literature review anatomy, physiology,pathology , normal sonographic appearance of the prostate and urinary tract and previous study.

Chapter three: contains the materials and methods.

Chapter four: contains the results presentation.

Chapter five: contains the discussion, conclusion and recommendations.

# Chapter two

# Literature Review

# Chapter two

# Literature Review

## 2.1 Literature Review:

### 2.1.1Anatomy :

#### 2.1.1.1 Kidney:

The kidneys excrete the end products of metabolism and excess water. These actions are essential for the control of concentrations of various substances in the body, maintaining electrolyte and water balance approximately constant in the tissue fluids. The kidneys also have endocrine functions, producing and releasing erythropoietin, which affects red blood cell formation; renin, which influences blood pressure; 1,25-di-hydroxycholecalciferol (the metabolically active form of vitamin D), which is involved in the control of calcium absorption and mineral metabolism; and various other soluble factors with metabolic actions. (Standring, S. 2008)

In the fresh state, the kidneys are reddish-brown. They are situated posteriorly behind the peritoneum on each side of the vertebral column and are surrounded by adipose tissue. Superiorly they are level with the upper border of the 12th thoracic vertebra, inferiorly with the third lumbar vertebra. The right is usually slightly inferior to the left, reflecting its relationship to the liver. The left is a little longer and narrower than the right and lies nearer the median plane (Fig.1). The long axis of each kidney is directed inferolaterally and the transverse axis posteromedially, which means that the anterior and posterior aspects usually described are in fact anterolateral and posteromedial. An appreciation of this orientation is important in percutaneous and endo urologic renal surgery.

Each kidney is typically 11 cm in length, 6 cm in breadth and 3 cm in anteroposterior dimension. The left kidney may be 1.5 cm longer than the right; it is rare for the right kidney to be more than 1 cm longer than the left

### 2.1.1.2 Relations:

The superior poles of both kidneys are thick and round and each is related to its suprarenal gland. The inferior poles are thinner and extend to within 2.5cm of the iliac crests. The lateral borders are convex. The medial borders are convex adjacent to the poles, concave between them and slope inferolaterally.In each a deep vertical fissure opens anteromedially as the hilum, which is bounded by anterior and posterior lips and contains the renal vessels and nerves and the renal pelvis. The relative positions of the main hilar structures are the renal vein (anterior), the renal artery (intermediate) and the pelvis of the kidney (posterior). Usually an arterial 1branch from the main renal artery runs over the superior margin of the renal pelvis to enter the hilum on the posterior aspect of the pelvis, and a renal venous tributary often leaves the hilum in the same plane. Above the hilum the medial border is related to the suprarenal gland and below to the origin of the ureter. (Standring, S. 2008)

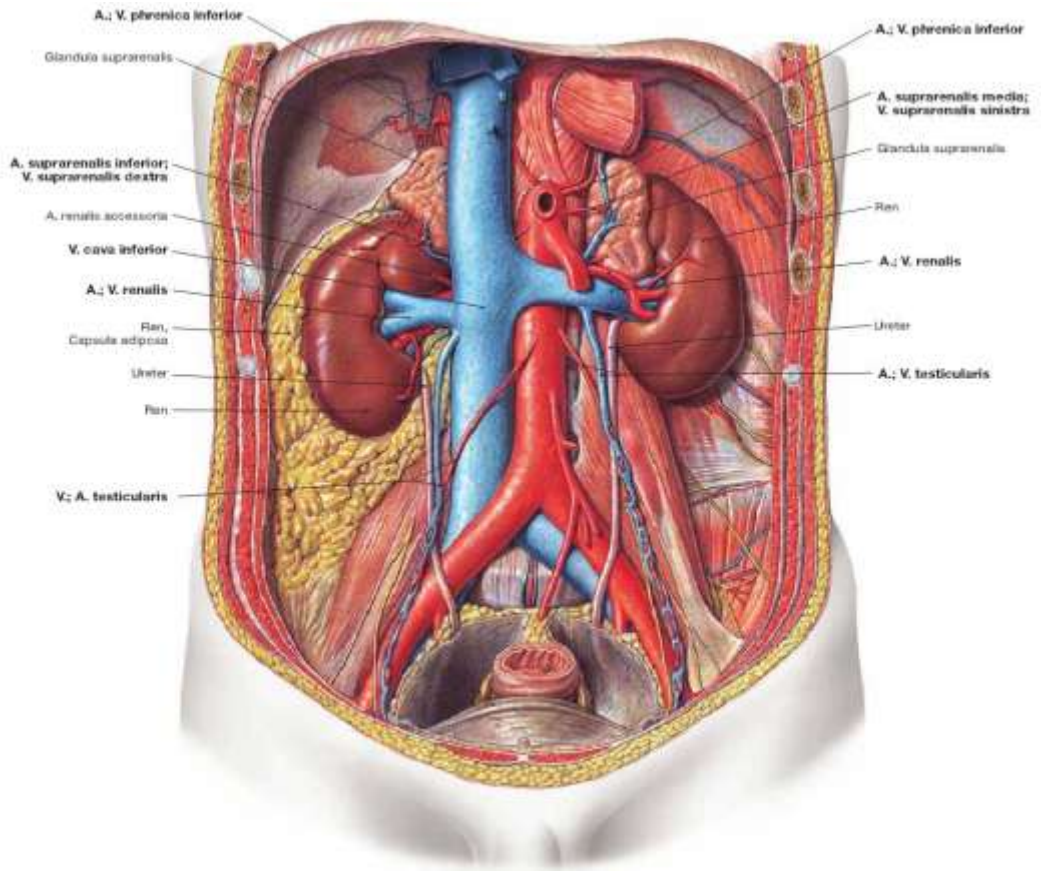



**Fig 2.1 Relationships of the kidneys and ureters in the male retroperitoneum. (Paulsen,F. and Waschke, J.2011)**

The kidney itself can be divided into an internal medulla and external cortex. The renal medulla consists of pale, striated, conical renal pyramids, their bases peripheral, their apices converging to the renal sinus. At the renal sinus they project into calyces as papillae. (Standring, S. 2008)

The renal cortex is subcapsular, arching over the bases of the pyramids and extending between them towards the renal sinus as renal columns (Standring, S.2008)

### 2.1.1.3 Renal pelvis and calyces:

The hilum of the kidney leads into a central renal sinus, lined by the renal capsule and almost filled by the renal pelvis and vessels, the remaining space being filled by fat. Dissection into this plane can be challenging but is important in surgery on the renal pelvis, particularly open stone surgery.

Within the renal sinus, the collecting tubules of the nephrons of the kidney open onto the summits of the renal papillae to drain into minor calyces, which are funnel-shaped expansions of the upper urinary tract, see fig.2. The renal capsule covers the external surface of the kidney and continues through the hilum to line the sinus and fuse with the adventitial coverings of the minor calyces. (Standring, S. 2008)

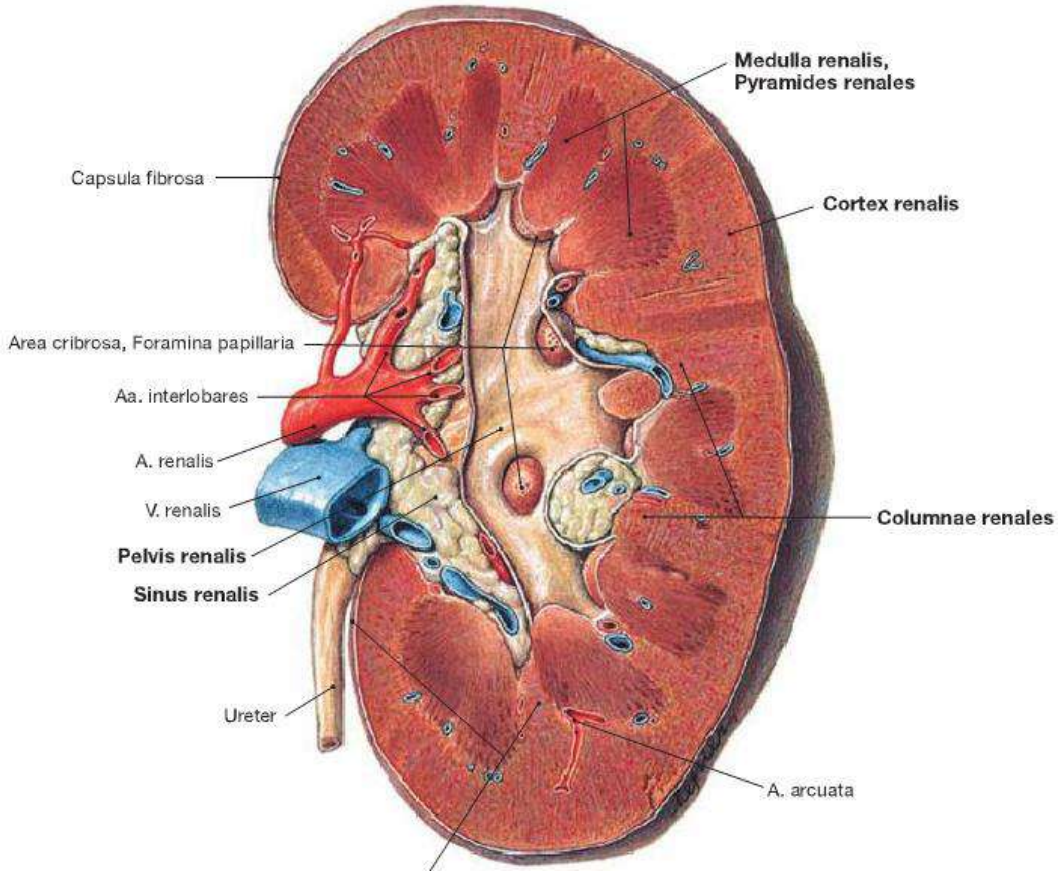



**Fig 2.2 Left kidney, oblique vertical hemi section: normal macroscopic appearance of the renal cortex and renal medulla and the major structures at the hilum of the kidney. (Paulsen,F. and Waschke, J.2011).**

### 2.1.1.4 Ureter:

The ureters are two muscular tubes whose peristaltic contractions convey urine from the kidneys to the urinary bladder. Each measures 25–30 cm in length, is thick-walled and narrow, and is continuous superiorly with the funnel-shaped renal pelvis.

Each descends slightly medially, anterior to psoas major, and enters the pelvic cavity where it curves initially laterally, then medially, to open into the base of the urinary bladder. The diameter of the ureter is normally 3 mm, but is slightly less at its junction with the renal pelvis, at the brim of the lesser pelvis near the medial border of psoas major, and where it runs within the wall of the urinary bladder, which is its narrowest part. These are the commonest sites for renal stone impaction.

### 2.1.1.5 Relations:

In the abdomen the ureter descends posterior to the peritoneum on the medial part of psoas major, which separates it from the tips of the lumbar transverse processes. During surgery on intraperitoneal structures, the ureter can be tented up as the peritoneum is draw n anteriorly, resulting in inadvertent ureteric injury. Anterior to psoas major it crosses in front of the genitofemoral nerve and is obliquely crossed by the gonadal vessels. It enters the lesser pelvis anterior to either the end of the common iliac vessels or at the origin of the external iliac vessels. (Standring, S. 2008).

### 2.1.1.6 Urinary bladder:

The urinary bladder is a reservoir. Its size, shape, position and relations all vary according to its content and the state of neighbouring viscera. When the bladder is empty, it lies entirely in the lesser pelvis, but as it distends it expands anterosuperiorly into the abdominal cavity. An empty bladder is somewhat tetrahedral and has a base (fundus), neck, apex, a superior and two inferolateral surfaces. (Standring, S. 2008)

### 2.1.1.7 Relations:

The base of the bladder is triangular, it is related to the rectum although it is separated from it above by the rectovesical pouch, and below by the seminal

vesicle and vas deferens on each side and Denonvillier's fascia. The neck, which is most fixed, lies most inferiorly, 3–4 cm behind the lower part of the symphysis pubis and just above the plane of the inferior aperture of the lesser pelvis. The bladder neck is essentially the internal urethral orifice, which lies in a constant position, independent of the varying positions of the bladder and rectum. In males the neck rests on, and is in direct continuity with, the base of the prostate, In both sexes the apex of the bladder faces towards the upper part of the symphysis pubis. The median umbilical ligament (urachus) ascends behind the anterior abdominal wall from the apex to the umbilicus, covered by peritoneum to form the median umbilical fold.( Standring, S. 2008)

**2.1.1.8 Trigone:**

The superficial trigonal muscle is relatively thin but is generally described as becoming thickened along its superior border to form the inter ureteric bar. Similar thickenings occur along the lateral edges of the superficial trigone. In both sexes the superficial trigone muscle becomes continuous with the smooth muscle of the proximal urethra, and ex tends in the male along the urethral crest as far as the openings of the ejaculatory ducts. (Standring, S. 2008)

**2.1.1.9 Ureteric orifices:**

The sit-like ureteric orifices are placed at the posterolateral trigonal angles In empty bladders they are approximately 2,5 cm apart, and 2.5 cm from the internal urethral orifice: in distension these measurements may be doubled. (Standring, S. 2008)

**2.1.7 Internal urethral orifice:**

The internal urethral orifice is sited at the trigonal apex, the lowest part of the bladder, and is usually somewhat crescentic in section. There is often an elevation immediately behind it in adult males (particularly past middle age) which is caused by the median prostatic lobe. (Standring, S. 2008)

**2.1.1.10 Male urethra:**

The male urethra is 18–20 cm long, and extends from the internal orifice in the urinary bladder to the external opening, or meatus, at the end of the penis.

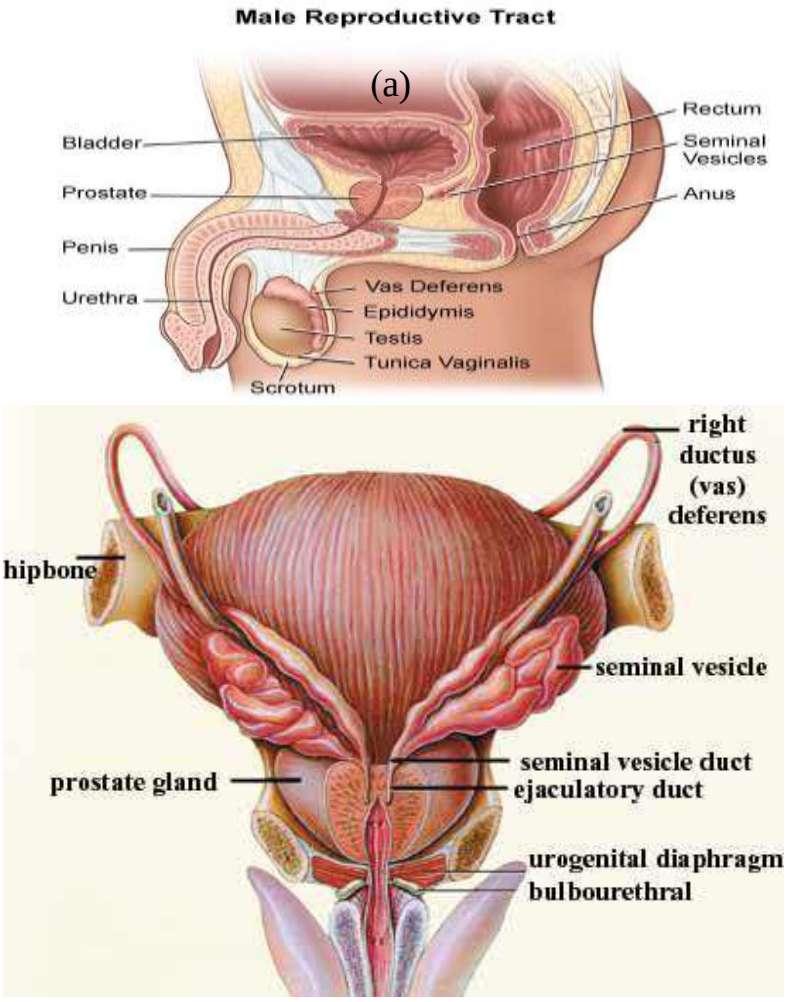
### 2.1.1.11 Anatomy of prostate:

The prostate is firm fibro muscular, glandular organ. It is retroperitoneal organ which lies beneath urinary bladder and above urogenitaldiaphragm and is penetrated by the proximal part of the urethra. It is female homologue is the small group of Para urethral glands. It is normally boarder that it is long, approximately 3-8cm cephalocaudaly (long axis). 4.0 cm transversely, 3.0 cm antero-posterior diamension (thickness). Homma Y. et a(1996).

The somewhat conical prostate has abased and an apex, anterior, posterior and inferolateral surfaces. The base is upper surface,fused with the neck of the bladder and perforated by the urethra which traverses the whole length of the gland, the blunt apex is the lowest part, and the prostatic urethra emerges from the front of the apex to becamemembranous urethra, the inferolateral surfaces are clasped by levator prostate part of the levator ani, the posterior surface is in front of the rectum but separated from it by rectovesical fascia, ejaculatory ducts pierce the posterior surface just below the bladder and pass obliquely through the gland for about 2cm to open into the prostatic urethra about half way down, the prostate own ducts also open into this part of Urethra .AUFFENBERG, GB. (2009).

The prostate have different relation with adjacent organs(Fig.3) inferiorly, the base of the prostate is continuous with the neck of the bladder, the smooth muscle passing without interruption from one organ to the other. The urethra enters the center of the base of the prostate. Inferiorly, there is the urogenital diaphragm, and the urethra leaves prostate just above the apex on the anterior surface. Anteriorly, the anterior surface of the prostate is related to the symphysis pubis, separated from it by the extra peritoneal fat in the retro pubic space (caveof Retzius) the fibrous sheath of the prostate is connected to the posterior aspect of the pubic bones by the puboprostatic ligaments. These ligaments lay one on either side of the midline and are condensations of pelvic

ligaments lay one on either side of the mid line and arecondensations of pelvic fascia. Posteriorly, the posterior surface of the prostate is closely related to the anterior surface of the rectal ampulla and is separated from it by the recto-vesical septum (fascia of Denonvillier), this septum is formed in fetal life by the fusion of the wall of the lower end of the recto vesical pouch of the peritoneum, which originally extended down to the perineal body. Laterally, the lateral surface of the prostate is embraced by the anterior fibers of the levator ani as they run posterioly from the pubis symphysis.Homma Y. et a(1996).




(b)

**Fig 2.3 a ,b Show the different prostate gland relations with adjacent organ (Webb med llc2008)**

A thin strong layer of connective tissue at the periphery of the gland forms the true capsule of the prostate, and outside this there is condensation of pelvic fossa forming the false capsule. Between these
two capsules lies the prostatic plexus of veins .The gland consists of acini of varying shapes sizes embedded in a fibro muscular stroma. A mixture of connective tissue and smooth muscular stroma, this is the characteristic histological feature.

The prostatic urethra, 3-4cm in length, passesthrough the substance of the prostate closer to the anterior than posteriorsurface of the gland. It runs down wards and backwards from the internalmeatus, then bends at the middle of its length and continues downwardand forward to emerge from the anterior aspect of the apex. A midlineridge, urethral crest, project into the lumen from the posterior wallthroughout most of the length of prostatic urethra. The shallowdepression on either side of the crest is termed the prostatic sinus. Ataboutthemidlengthofthecrestthe seminalcolliculus .verumoentanum,forms a midline rounded eminence. The prostate utricle, a small recess repressing the fused of the paramesonephric (mullerian) ducts open intothe middle of the verumotanum and the ejaculatory ducts open in theother side of the utricle. The proximal part of the prostatic urethra, alsotermed the preprostatic part, is surrounded by a cylinder of smoothmuscles and extension of circular muscle at the bladder neck, as beennoted above , this muscles contract to prevent seminal regurgitation intothe bladder during ejaculation. .Auffenberg,Gb. (2009).

Posteriorly the sheath is continuous above with the fascial layers which enclose the ampullae of the ductus deferentes and the seminal vesicles, and it is adherent to the peritoneum of rectovesical pouch. In this position it is spoken of as rectovesical septum. AYALA, AG. and Ro, JY.(2007).

The fibrous sheath of the prostate is dense fibrous portion of the pelvic fascia, and closely invested the prostate. Inferiorly, the sheath becomes continuous with the superior fascia of the urogenital diaphragm, and through it, gains attachment to the sides of the pubic arch. In front and at the sides, it is fused with the puboprostatic ligaments, by which it is connected with pubic bones, and the fascia on the levatores ani, between the puboprostatic ligaments of the two sides there is a shallow depression, the floor of which is formed by a thin layer of fascia which connects the anterior parts of sheath of prostate with the back of symphysis public.

The medical edges of the levatores ani muscles are immediately below the puboprostatic ligaments, and embrace the lower part of prostate posteriorly to form the levator prostate. The lower fibers of the pubovesical muscle, which follow the puboprostatic ligament, constitute the puboprostatic muscle. Classically, the prostate has been divided into five lobes; the anterior lobe which lies in front of the urethra and is devoid of glandular tissue, the median, or the middle lobe is situated between the urethra and the ejaculatory ducts. The posterior lobe is situated behind the urethra and, below the ejaculatory ducts, and also contains glandular tissue.

The right and left lateral lobes are lie on eitherside of the urethra .The contain many glands; the glandular portion of the prostate is divided into zones (Fig.2.3), rather than being made up of lobes, the central zone wedge shaped and forms the base of the gland with its apex at the verumotanum; it extends from the base of the prostate to the verumotanum, it surrounds the ejaculatory ducts as they course through the gland. Benign prostatic hyperplasia occurs in the central zone. The duct of the central zone opens on the verumoentanum around the orifices of the ejaculatory ducts. The central zone occupies 25% of the glands volume. The peripheral zone is located posterior and lateral to the distal prostatic urethra, it surrounds the central zone from behind and below,

but does not reach up to the base; it extends downwards to form the lower Part of the gland. The ducts of peripheral zone open into the prostatic sinuses. The peripheral zone is almost exclusively the site of origin for carcinoma of the prostate. Peripheral zone occupies 70% of the gland. The transition zone is located on both sides of the proximal urethra. Normally, it is the smallest zone. The peripheral glandular tissue or zone contains the tissue that lines the proximal prostatic urethra. The anterior part of the prostate being mainly fibromuscular; it is overlapped from above by the detruser muscle of the bladder and from below by the striated muscle of the urethral sphincter. Homma Y. et a(1996).

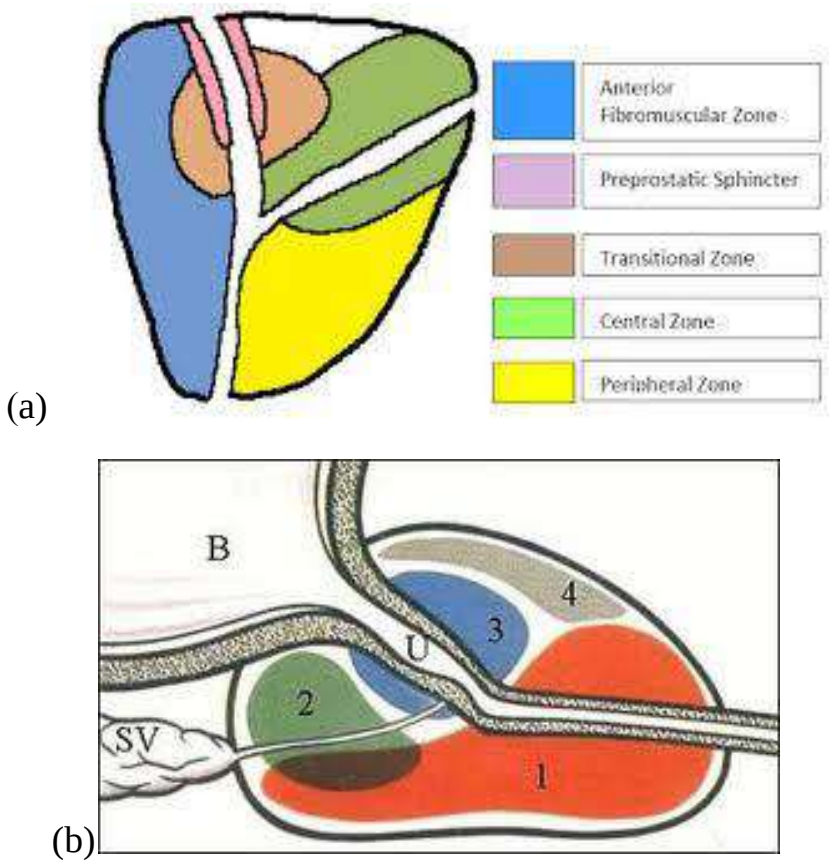



**Fig 2.4 a, b Show zonal anatomy of the prostate**

At birth, the prostate has a system of ducts embedded in a stroma which forms a large part of the gland. Follicles are represented by small buds on the ducts

.The hyperplasia and squamous metaplasia of the epithelium of the ducts, colliculus, seminal is and prostatic utricle which preceded birth , possibly due to maternal estrogen in the fetal blood , subside and aregression period after birth is followed by a period of quiescence lasting for 12-14 year . At puberty, between the ages of approximately 14 and 18, the prostate gland enters a maturation phase and approximately12 month during this time, it more than doubles in size, due almost entirely to follicular development, partly from end buds on ducts and partly from modification of the ductal branches.

Morphogenesis and differentiation of the epithelial cords starts in an intermediate part of the epithelial anlagen and proceeds to the urethral and subcapsular part of the gland, the latter being reached by the age of 17-18 years. Initially multilayered squamtransformed into a pseudo-stratified epithelium consisting ofbasal, exocrine secretory (including mucous) and neuroendocrine cells.

The mucus cells are temporary, and are lost as the gland matures.

The remaining exocrine secretory cells produce a number of products including acid phosphatase, prostate specific antigen and B-microsemino protein. Immature glandular pouched are immunopositive for basic fibroblast growth factor (b-FGF), the role of which remains to be established. This growth of the secretary component is associated with condensation of stroma, which diminished relative to the glandular tissue.

These changes are probably due to the secretion of testosterone by the testes.

During the third decade the glandular epithelium grows by irregular multiplication of the epithelial folding into the lumen of the follicles. After the third decade the size remain virtually unaltered until 45-50 years. When the epithelial folding tends to disappear, follicular outlines became regular and amyloid bodies increase in number. All these changes are signs of prostatic involution. After 45-50 years the prostate may undergo benign hypertrophy,

increasing in size until death, or alternatively it may undergo progressive atrophy. .AYALA, AG. and Ro, JY.(2007).

The pelvic parts of endodermal urogenital sinus gives rise to lateral epithelial buds which became the prostatic acini of the peripheral zone. Dorsal outgrowths from above the level of the entry of mesonephric ducts form the acini of the central zone. The fibromuscular stroma develops from the surrounding mesenchyme. The different sites of the origin of the inner and outer zone acini may account for the different sites of incidence of benign and malignant disease. AUFFENBERG, GB. (2009).

The main arterial supply of prostate is from the prostatic branch of the inferior vesicles artery, with some small branches from the middle rectal and internal pudendal vessels (Fig. 2.4). The veins run into a plexus between the true and false capsules and this joins the vesicoprostatic Plexus situated at the groove between bladder and prostate. This plexus receives the deep dorsal vein of the penis, and drains backward into the inferior vena cava. (Ivc) Homma Y. et a(1996).

The lymphatic of the prostate pass across the pelvic floor mainly to internal iliac nodes; a few may reach external iliac nodes. AUFFENBERG, GB. (2009).

The nerve supply to the prostate is from the inferior hypogastric plexus, the sympathetic nerves simulate the smooth muscle of the prostate during ejaculation. Homma Y. et a(1996).

**2.1.2 physiology:**

**2.1.2.1 Functions of the kidney (Formation of urine):**

The kidneys form urine which passes through the ureters to the bladder for storage prior to excretion. The composition of urine reflects the activities of the nephrons in the maintenance of homeostasis. Waste products of protein metabolism are excreted, electrolyte balance is maintained and the pH (acid-

base balance) is maintained by the excretion of hydrogen ions. There are three processes involved in the formation of urine:

• simple filtration • selective reabsorption • secretion. (Waugh A. & Grant A. 2004)

**2.1.2.2 Simple filtration:**

Filtration takes place through the semipermeable walls of the glomerulus and glomerular capsule. Water and a large number of small molecules pass through, although some are reabsorbed later. Blood cells, plasma proteins and other large molecules are unable to filter through and remain in the capillaries.

**2.1.2.3 Autoregulation of filtration:**

Renal blood flow is protected by a mechanism called autoregulation whereby renal blood flow is maintained at a constant pressure across a wide range of systolic blood pressures (from 80 to 200mmHg). Autoregulation operates independently of nervous control; i.e. if the nerve supply to the renal blood vessels is interrupted, autoregulation continues to operate. It is therefore a property inherent in renal blood vessels; it may be stimulated by changes in blood pressure in the renal arteries or by fluctuating levels of certain metabolites, e.g. prostaglandins. (Waugh A. & Grant A. 2004)

**2.1.2.4 Selective reabsorption:**

Selective reabsorption is the process by which the com position and volume of the glomerular filtrate are altered during its passage through the convoluted tubules, the medullary loop and the collecting tubule. The general purpose of this process is to reabsorb into the blood those filtrate constituents needed by the body to maintain fluid and electrolyte balance and the pH of the blood. (Waugh A. & Grant A. 2004).

**2.1.2.5 Secretion:**

Filtration occurs as the blood flows through the glomerulus. Substances not required and foreign materials, e.g. drugs including penicillin and aspirin, may not be cleared from the blood by filtration because of the short time it remains

in the glomerulus. Such substances are cleared by secretion into the convoluted tubules and excreted from the body in the urine. Tubular secretion of hydrogen (H+) ions is important in maintaining homeostasis of blood pH.

**2.1.2.6 Composition of urine:**

Water 96%,Urea 2%,Uric acid, Creatinine, Ammonia, Sodium, Potassium 2%Chlorides, Phosphates, Sulphates, Oxalates.

**2.1.2.7 Water balance and urine output:**

Water is taken into the body through the alimentary tract and a small amount (called 'metabolic water') is formed by the metabolic processes. Water is excreted in saturated expired air, as a constituent of the faeces, through the skin as sweat and as the main constituent of urine. The amount lost in expired air and in the faeces is fairly constant and the amount of sweat produced is associated with the maintenance of normal body temperature. (Waugh A. & Grant A. 2004).

**2.1.2.8 Ureter function:**

The ureters propel the urine from the kidneys into the bladder by peristaltic contraction of the smooth muscle.

**2.1.2.9 The urinary bladder:**

The urinary bladder is a reservoir for urine. It lies in the pelvic cavity and its size and position vary, depending on the amount of urine it contains. When distended, the bladder rises into the abdominal cavity. (Waugh A. & Grant A. 2004).

**2.1.2.10 Micturition**:

The urinary bladder acts as a reservoir for urine. When 300 to 400 ml of urine have accumulated, afferent autonomic nerve fibres in the bladder wall sensitive to stretch are stimulated. In the infant this initiates a spinal reflex action and micturition occurs.

Micturition occurs when autonomic efferent fibres convey impulses to the bladder causing contraction of the detrusor muscle and relaxation of the internal urethral sphincter. (Waugh A. & Grant A. 2004).

**2.1.2.11 Physiology of prostate :**

The scientists do not all the prostates functions. The prostate gland secrets a thin, milky fluid that contains calcium, citrate ions, phosphate ion, aclotting enzyme, and aprofibrinolysin. During emission, the capsule of the prostate gland contracts simultaneously with the contractions of the vas deferens so that the thin, milky fluid of the prostate gland adds to the bulk of the semen. A slightly alkaline characteristic of the prostatic fluid may be quite important for successful fertilization of the ovum, because the fluid of the vas deferens is relatively acidic owing to the presence of the citric acid and metabolic end products of the sperm and,consequently, helps to inhibit sperm fertility. Also, the vaginal secretions of the female are acidic (ph of 3.5 to 4.0). Sperm does not become optimally motile until the ph of surrounding fluids arises to about 6.0 to 6.5. Consequently it probable that the slightly alkaline prostatic fluid helps to neutralize the acidity of the other seminal fluids during ejaculation, and thus enhances the motility and fertility of the sperm.

The prostate secretion is a thin opalescent liquid; it is rich in amylase and proteases, in particular in fibrinolysin. It is from the prostate that the semen receives its high concentration of citric acid and of acid phosphatase. Recently the prostate and seminal vesicles have been shown to be a rich source of substance known as prostaglandins: these are unsaturated hydroxy acid which, amongst other functions, stimulate the smooth muscle of the female genital tract to contract. SUKKAR, M.Y. (1996).

Just now generally believed that the normal glandular activity of the prostate is controlled by the androgens and estrogens circulating in the blood stream.

The secretions of the prostate are poured into the urethra during ejaculation, and are added to the seminal fluid. Acid phosphatase is an important enzyme present in the secretion in large amounts. When the glandular cells producing this enzyme cannot discharge their secretions into the ducts, as in the carcinoma of the prostate, the serum acid phosphatase level of the blood rises.It has been shown the trance amounts of proteins produced specifically by prostatic epithelial cells are found in peripheral blood. In certain prostatic disease, notably cancer of the prostate, this protein appears in the blood in increased amounts.

The specific protein level can be measured by a simple laboratory test called the PSA (prostatic specific antigen) test. The differences between the urinary tracts of men and women result in different incidence of pathologies. Women have much shorter urethra than men and are therefore much more susceptible to bacterial invasion of the bladder. In men, the urethra penetrates the prostate gland, which is about have of men over 60 undergoes benign hyperplasia. This enlargement only presents a problem when the prostate compresses the urethra to such a degree that the bladder cannot empty properly. In the early stages, the detrusor muscle hypertrophies, so helping to force urine out against the increases resistance. As the condition progress, the discomfort of a constantly over bladder and damage to bladder and kidneys the retention can cause require treatment of the condition. This can be by drugs that shrink the prostate by interrupting the action of hormones the stimulate it or by surgical removal of the gland . (RichardS. Snell .1992 ).

### 2.1.3 Pathology:

#### 2.1.3.1 Prostate pathology:

Only three pathologic processes affect the prostate gland with sufficient frequency to merit discussion inflammation, benign nodular enlargement, and tumors. Of these three, the benign nodular enlargement is by far the most common and occurs so often in advanced age that they can almost

be construed as a (normal) aging process. Prostatic carcinoma is also an extremely common lesion in men and therefore merits careful consideration. The inflammatory processes are, for the most part of less clinical significance and can be treated briefly (Rnm. et al.1992).

### 2.1.3.2 Prostatitis:

Is inflammation of prostate gland..Acute prostatitis, is not common, but is most likely to occur in young men. The majority of cases of acute prostatits are due to ascending infections caused by Ecoli, catheterization, cystoscopies and urethral dialations also frequently result in acute prostatis. A related complication of prostatic abscessis uncommon. .(Potts.2001).

Chronic prostatitis, may follow the acute form but in the majority of cases no causative organism is identified and no previous acute state has been noted.Clinically, both acute and chronic forms are associated low back pain, disyuria, frequency and urgency. Sometimes the prostate is enlarged and tender. Fever may be noted with acute form. Frequently chronic prostatitis is a symptomatic and result in repeated urinary tract infections by constant seeding of bacteria. Prostatitis can elevate the serum prostatic specific antigen (PSA), but generally not more than double normal, and generally not increasing significantly over time.

Sonographic finding of Acute prostatitis appear asmoderately enlarged gland with focal hypoechoic or hyperechoic area, with poor margination in the peripheral prostate. The prostate may also appear normal.Color and power Doppler imaging demonstrates marked hyper vascularity.Prostatic abscess appears as mixed lesion within the parenchyma. It is a vascular on color Doppler, but may have increased flow at the margins. Chronic prostatitis, appear as focal masses of different degrees of echogencity, ejaculatory calcifications, thickening or irregularity of thecapsule, periurethral irregularities, dilation of periprostatic veins adestended seminal vesicles.(Hanley&Belfus.2004).

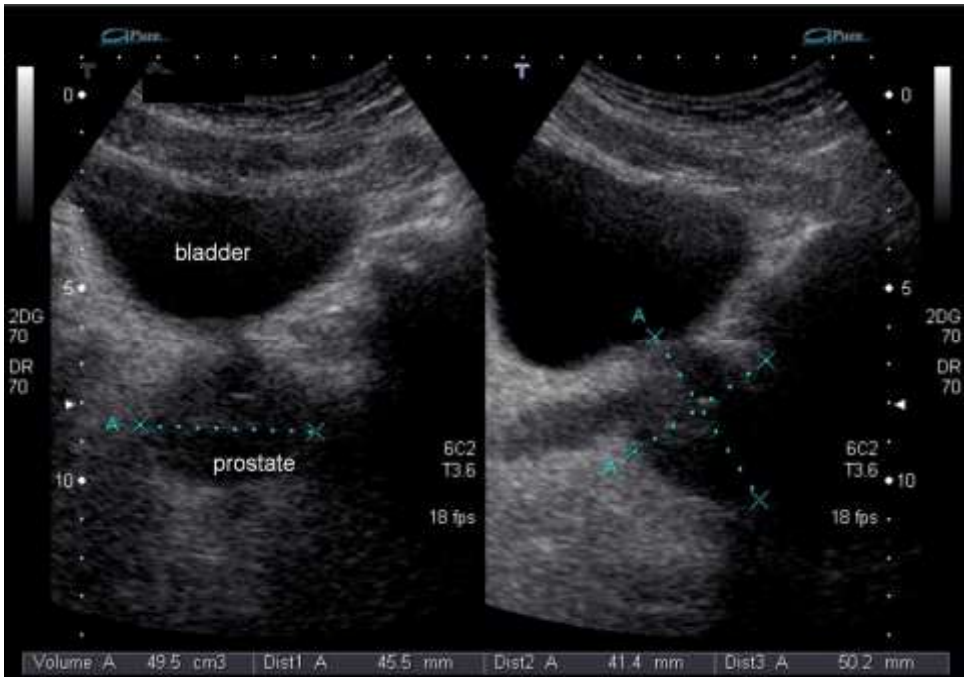



**Fig 2.5 1Shows songraphic appearance of prostatitis..(Viable ultra sonnd CD.ROM)**

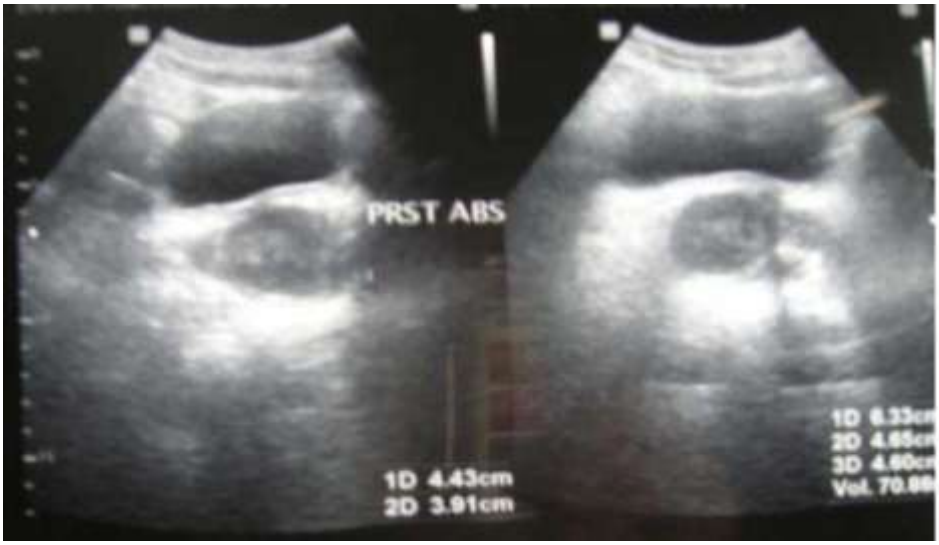



**Fig 2.6 Showssonographic appearance of prostate abscesses..(Viableultra sonnd CD.ROM)**

### 2.3.1.3 Prostatic cyst:

1- Congenital.Mullerian duct cysts.

Are derived from the embryologic mullerian ducts and most commonly are located to mid line at the level of the veruentum.

2- Utricle cysts:

Are derived from another embryological structure called utricle. This is small blind sac extending from posterior urethra at the level where the ejaculatory ducts enter the prostatic urethra. Utricle cysts are located in the mid live near the vermontanum. Utricle cysts are associated with other genitourinary abnormalities such as unilateral renal agenesis and cryptorchidism. Sonogrphic finding**:**

Most utricle cyst are tube shaped and < 1cm length. They may fill with urine and empty with voiding.

Mullerian duct cyst are often large and extend beyond the prostate and present as cystic pelvic masses.

Acquired cysts: These are more common than congenital cysts.

Ejaculatory duct cysts, are usually due to obstruction by hyper plastic nodules or as a result of surgery. They may cause infertility, ejaculatory pain or hematospermia. Ejaculatory duct cysts are located along the course of the ejaculatory duct.

Cystic degeneration of BDH nodules, due to necrosis and infarction with hyper plastic gland result in cystic looking areas within the innergland.

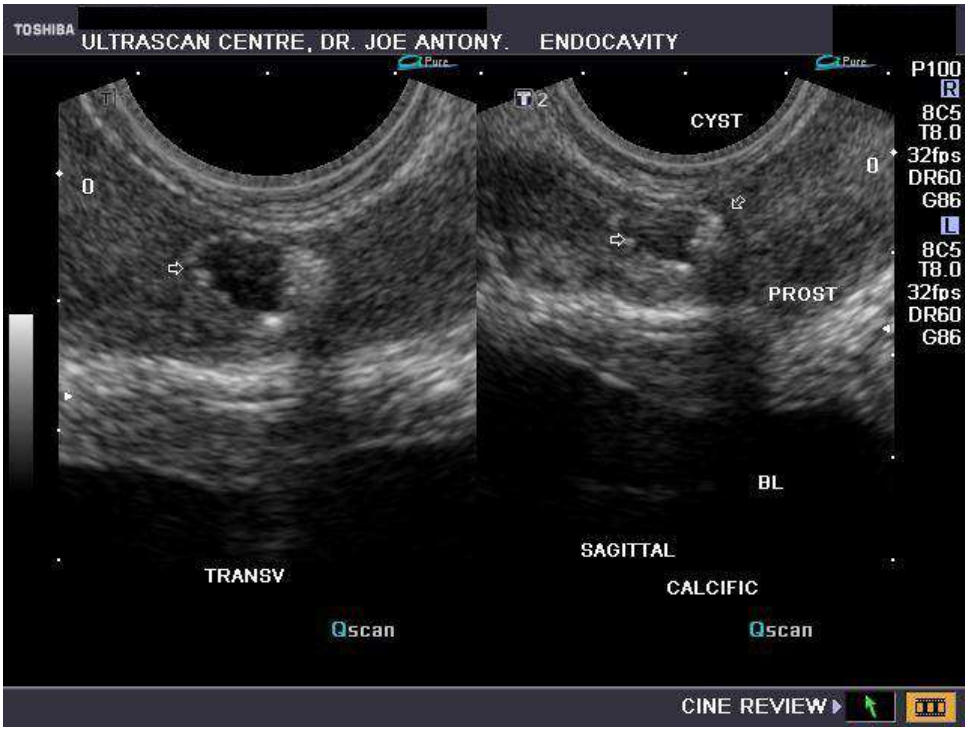
These cyst are very common and are usually small (< 1cm) and within nodule.

They can contain calculi or echogenic fluid cause by hemorrhage or necrosis.

Retention cysts, are caused by obstruction of prostatic ductules resulting In cystic dilatation of glandular acini.

The cyst do not contain sperm and are a symptomatic on ultrasound, retention cyst are anechoic, smooth walled, unilocular, 1.2cm in diameter and located away from mid line(Deam.et.al.2002).

**(a)**




**(b)**

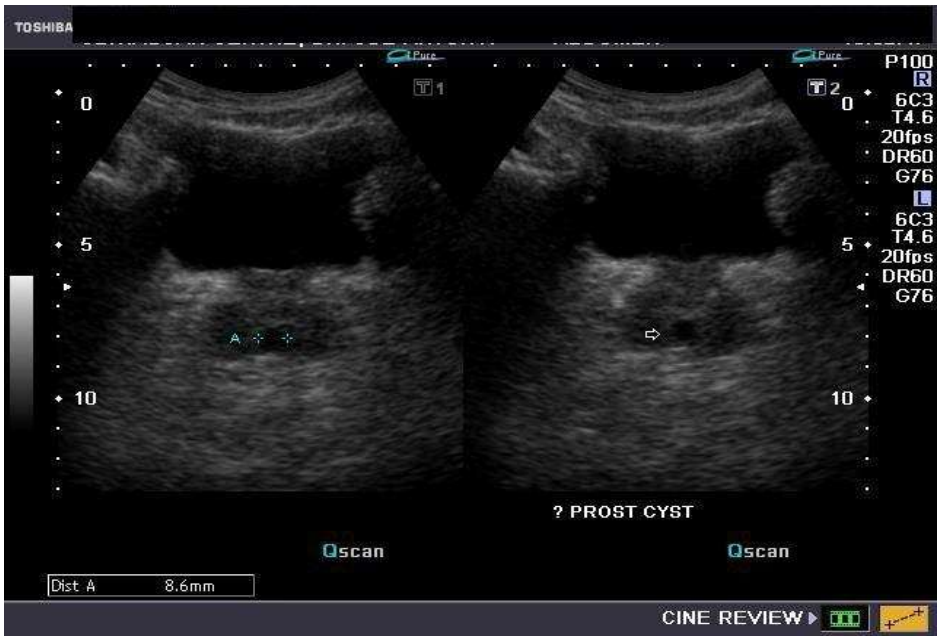



**Fig 2.7 a,b: Shows prostate cyst(a) withTRUS(b) withTAS..(Viable ultrasonnd CD.ROM**

### 2.3.1.4 Prostatic hyperplasia:

Nodular prostatic hyperplasia (also termed benign prostatic hyperplasia or BPH) is a common condition as ménage; perhaps a fourth of men has some degree of hyperplasia by the fifth decade of life. By the eighth decade, over 90% of males will have prostatic hyperplasia. However, in only a minority of cases (about 10%) will this hyperplasia be symptomatic and sever enugh to require surgical or medical therapy.

The mechanism for hyperplasia may be related to accumulation of dihydrotestosterone in the prostate, which then binds to nuclear hormone receptors which then trigger growth. The normal prostate weigh's 20 to 30 gm, but most prostates with nodular hyperplasia can weigh from 50 to 100 gm. Hyperplasia begins in the region of the veru-monterum, in the inner zone of prostate and extends to involve lateral lobes. This enlargement impinges upon the prostatic urethra, leading to difficulty on urination with hesitancy that is typical for this condition.

Dysuria, dirbbling and nocturia are also frequent. The urinary tract obstructionlead to urinary retention and risk for infection. In sever, prolonged eases, hydroureter with hydrorephrosis and renal failure can ensure. (Auffenberg.et.al.2009)

Microscopically, nodular prostatic hyperplasia consists of nodules of glands and intervening stroma. Most of the hyperplasia contributed by glandular proliferation, but the stroma is also increased, and in rare cases may predominate. They gland may be more variably sized, with larger glands have more prominent papillary in folding nodular hyperplasia is not a precursor to carcinoma.

A typical adenomatous hyperplasia**:**

A typical adenomatous hyperplasia (AAH) is a term that has been utilized to describe changes histologically seen in prostatic gland in the apex, periurethral region and/or transition zone of prostate. AAH is a localized

proliferation of small acini within the prostate. Such proliferation may be confused with carcinoma, but the glands with AAH still have a fragmented basal layer. AAH can be difficult to distinguish from hyperplasia. There is no clear association between the presence of AAH and the development of prostatic adenocarcinoma.

Prostatic intra epithelial neoplasia:

Prostatic intra epithelial (PIN), which is dysplasia of the epithelium lining the prostate glands, is a probable precursor of prostatic carcinoma.

The appearance of PIN may precede car cinoma by 10 or more years. It can be divided into low grade and high grade PIN. Low grade PIN may be found even in men in middle age. PIN does not routinely increase the serum prostate specific antigen (PSA). PIN usually involves an acinus or a small duster of acini, but it can be more extensive on occasion. The acini are usually medium-sized to large, with rounded borders. The partial involvement of an acinus is helpful feature to distinguish PIN from adenocareinoma. PIN is characterized histologically by progressive basal cell layer disruption, loss markers of secretory abnormalities, increasing proliferative potential, increasing microvessel density variation in DNA content and allvulie loss. Unlike adenocarcinoma, with which is may coexist, glands with PIN retain an intact or fragmented basal cell layer.

The appearance of PIN warrants increased surveillance of prostate for development of an invasive carcinoma because the presense of PIN that is high grade suggests an increased risk for subsequent appearance of adenocarcinoma. PIN itself is not an indication for aggressive treatment.(Montironi.et.al.2007).

### 2.3.1.4.1 Sonographic finding:

BPH is demonstrated as an enlarged prostate (> 40g); the inner gland is hypoechoic and inhomogeneous compared to the PZ; multiple hyperechoic nodules are often present in the inner gland; nodules frequently undergo cystic degeneration and calculi from along the

Surgical capsule.

A post transurethral resection prostate appears thin with a preserved PZ and scant or abscent inner gland. The urethra is widened into a funnelshape with the widest portion at the bladder base. Deam.et.al.2002)

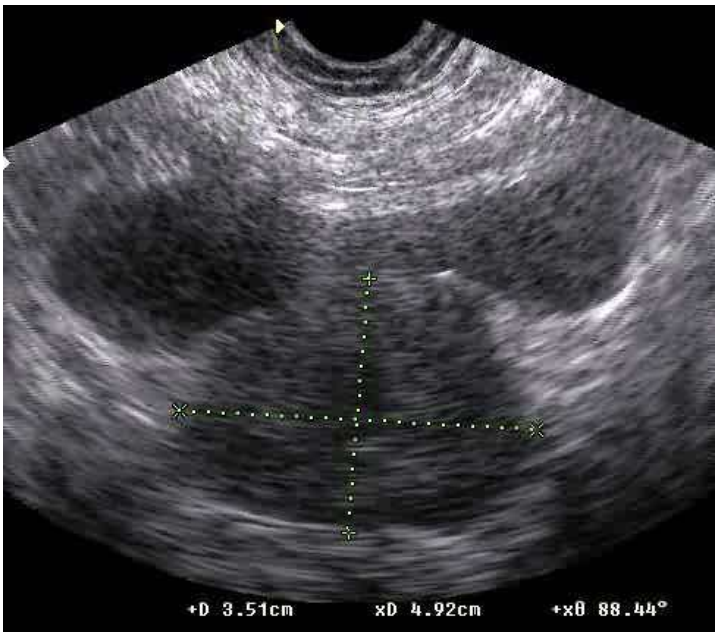



**Fig2.8 Shows sonographic appearance of BPH.Transverse scan(TAS) .**

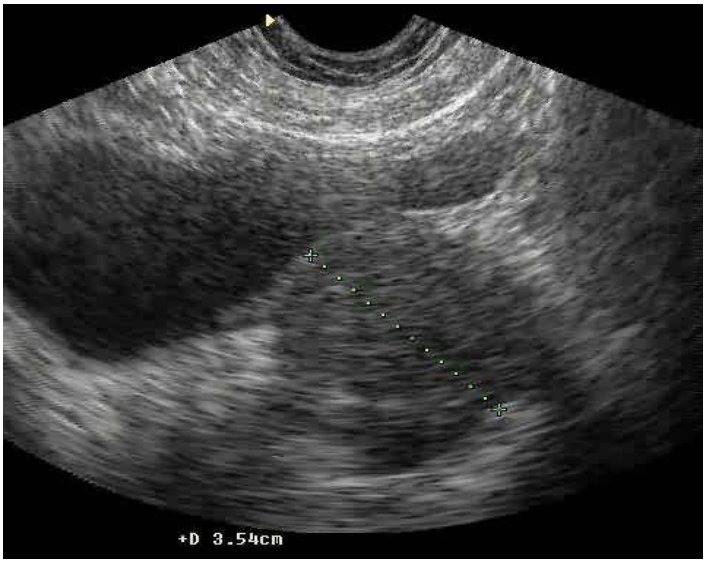



**Fig 2.9 shows sonographic appearance of BPH. Longitudinal scan(TAS).**

### 2.3.1.5 Prostatic adenocarcinoma:

Adenocarcinoma of the prostate is common. It is the most common nonskin malignancy in elderly men. It rare before the age of 50, but autopsy studies have found prostatic adenocarcinoma in 80% of men more than 80 years old. Many of these carcinomas are small and clinically in significant.

However, some are not, and prostatic adenocarcinoma is second only to lung carcinoma as a cause for tumor-related death among males.

Men with a higher likelihood of developing a prostate cancer (in the U.S) include those of older age, black race, and family history. Those with an affected first degree relative have a much greater risk prostate cancer may be detected by digital rectal examination, by ultrasonography (trans rectal ultrasound), or by screening with a blood test for prostate specific antigen (PSA).Nonofthesemethodscanreliably all prostate cancers,particularly the small cancers.

The only test that can fully confirm the diagnosis of prostate cancer is a biopsy of the prostate and examine it under a microscope further tests, such as CT scans and bone scan may be performed to determine whether prostate cancer spread.(Wollf,s.H.2005).

Prostatic adenocarcinoma are composed of small glands that are back-to

back, with little or no intervening stroma-cytologic features of adenocarcinoma include enlarged round, hyperchroromatic nuclei that have a single prominent nucleous. Mitotic figures suggest carcinoma.

Less differentiated carcinomas have fused glands called cribriform glands, as well as solid nests or sheets of tumor cells, and many tumors have two or more of these patterns. Prostatic adenocarcinomas almost always arise in the posterior outer zone of prostate and are often multifocal, prostatic adenocarcinomas are usually graded according to the Gleason grading system based on the pattern of growth. There are 5 grades (from 1 to 5) based upon the architectural patterns.

Adenocarcinoma of prostate are given two grades based on the most common and second most common architectural patterns. These two grades are added to get a final grade of 2 to 10. The stages is determined by the size and location of the cancer wether it has invaded the prostatic capsule or seminal vesicle, and whether it has metastasized. The grade and the stage correlate well with each other and with the prognosis.

The prognosis of prostatic adenocarcinoma varies widely with tumor stage and grade. Cancer with a Gleason score of < 6 are generally low grade and no aggressive. Advanced prostatic adenocarcinoma typically cause urinary obstruction, metastasize to regional (pelvic) lymph nodes and to the bones causing blastic metastases in most cases. Metastases to the lungs and liver are seen in a minority of cases. (Epstein.et.al.2005)

Treatment options of prostate cancer with intent to cure are primarily surgery, radiation therapy, stereotactic radiosurgery, and proton therapy.

Other treatments, such as hormonal therapy, chemotherapy, cry surgery and high intensity focused ultrasound (HIFU) also exist. . (Fitzpatric, JM 2008).

### 2.1.3.5.1 Ultra sound finding:

In ultrasound the prostate cancer may appear a symmetrically enlarged.

Tumor shape variable, variable echopattern: may be hyperechoic, hypoechoic, or isoechoic to normal prostate parenchyma. It may see calcifications with irregular distribution in the prostate, often accompanied by diffuse increased echo around them due to inflammation.

Color Doppler imaging may identify area of hyper vascularity. (Sundrl.2001)

70% of cancer sare seen as hypoechoic lesion in the peripheral zone.

Unfortunately these sonographicappearces are also similar to prostatitis fibrosis and injbbbbbNbfarction.

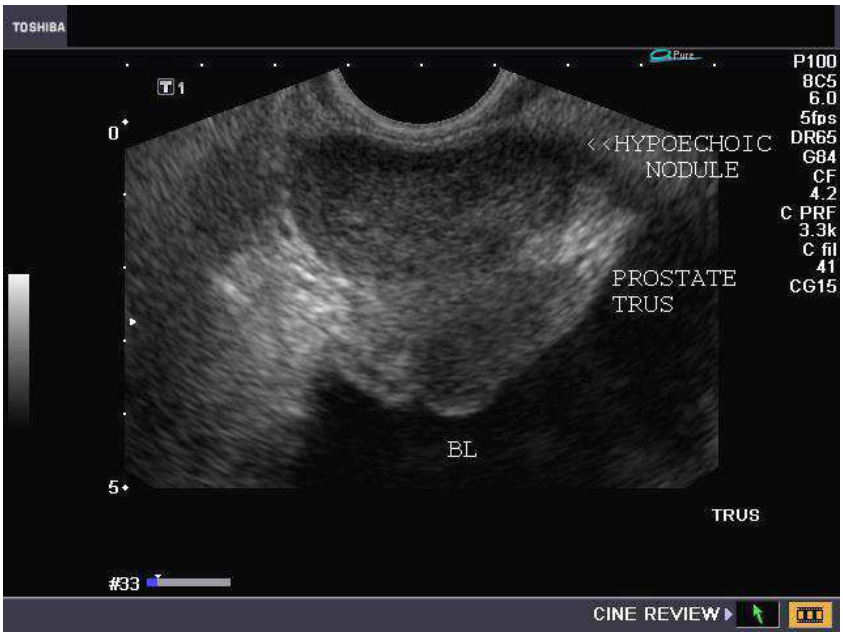



**Fig 2.10 Shows sonographic appearance of adenocarcenoma of prostate..(Viable ultra sonnd CD.ROM)**

### 2.1.3.1.1 Effects of BPH on renal system:

BPH may cause bladder outlet obstruction which can lead to hydronephrosis, cystitis, pyelonephritis and other complications. Sandra L.2012.

### 2.1.3.1.2 Hydronephrosis:

It is a general term that is defined as the dilation of the renal collecting system secondary to the obstruction of normal urine flow. Accordingly,

hydronephrosis is dilation of the calices, infundibula, and renal pelvis. It may also be described as mild, moderate, and severe or marked. Sandra L.2012.

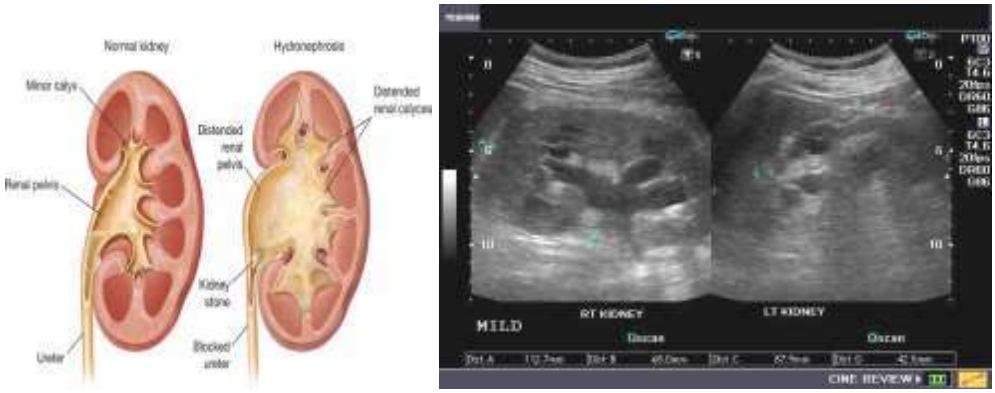



**Fig 2.11 Hydronephrosis. httpwww.ultrasound-images.comureteric-calculi(6.10.2018)**

### 2.1.3.1.3 Cystitis:

It may appear sonographicaly as diffuse bladder wall thickening. If cystitis is focal, pseudopolyps may form which are impossible to differentiate from tumor by ultrasound. Sandra L.2012.

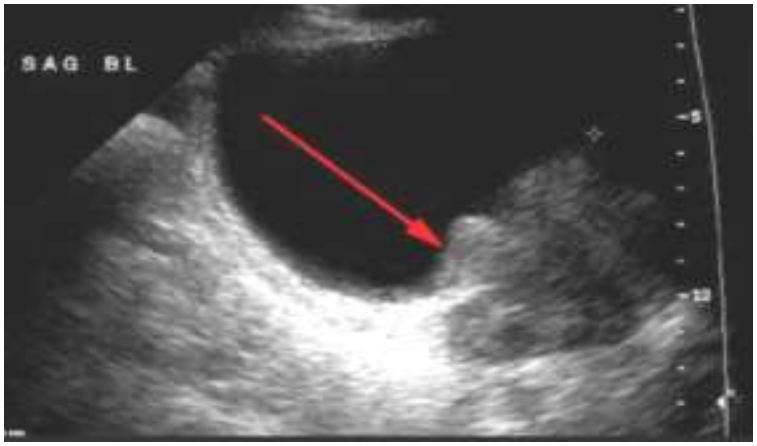



**Fig 2.12 thick bladder wall (cystitis).**
**www.meded.virginia.edu/courses/rad/gu/malepelvis/bph.html(6.10.2018)**

### 2.1.3.1.4 Acute pyelonephritis

Acute inflammation of the kidney rarely results in any ultrasoundabnormality. Occasionally the kidney may be enlarged and hypoechoic, the contrast between the kidney and the hepatic or splenic parenchyma increasing due to oedema, but the ultrasound changes are generallysubtle. The normally clear differentiation between the cortex and the medullary pyramids may become indistinct, but again may go unrecognized.Sandra L. 2012.

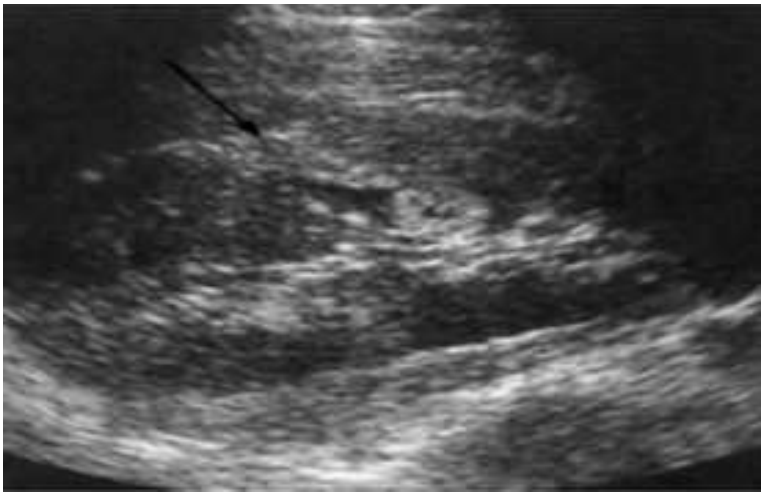


**Fig 2.13 Acute pyelonephritis. Radiology I information.plogspot.com (6.10.2018)**

### 2.1.3.1.5 Chronic pyelonephritis:

This chronic inflammatory state is usually the result of frequent previous inflammatory/infective episodes. The kidney may be small and often has focal scarring present. Scar tissue has the appearance of a hyper echoic; linear lesion which affects the smooth renal outline and crosses the renal cortex .The renal cortex is frequently thin in chronic pyelonephritis and may appear abnormally hyper echoic. Bladder diverticula Repeated infections can cause the bladder wall to thicken and become trabeculated. In such cases, a bladder diverticulum may form, making treatment of subsequent infections particularly difficult. The diverticulum may debris or stones and may fail to empty properly, often enlarging as the urine refluxes into it when the patient micturates.Sandra L. 2012.

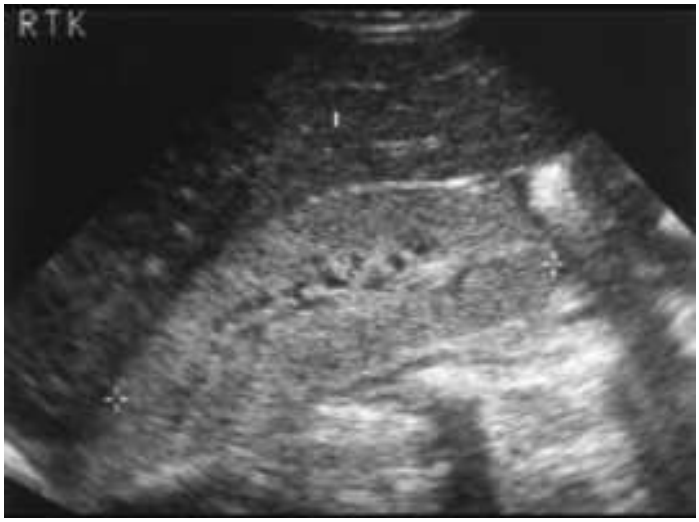



**Fig 2.14 chronic pyelonephritis. Ultrasoundcases.info\slide-view(6.10.2018)**

### 2.1.3.1.6 Obstructive uropathy:

Renal obstruction, particularly if long-standing, can irreversibly damage the kidney or kidneys, leading eventually to renal failure. If diagnosed early enough, renal function can be preserved and therefore ultrasound plays a prominent role as one of the first-line investigations in patients with loin pain, renal colic or micturition disorders. In the vast majority of cases, urinary tract obstruction causes dilatation of the collecting system proximal to the site of obstruction. Whether the hydronephrosis is bilateral or unilateral and whether or not it involves the ureter(s) depends on the cause and site of the obstructing lesion. Dilatation of the collecting system may be localized. Sometimes only one moiety of the kidney may be obstructed by a stone or tumour, whilst the rest of the kidney remains normal.Sandra L. 2012.

### 2.1.4 Prostate laboratory tests:

### 2.1.4.1 Serum acid phosphatase test:

This test is used to identify metastases of the prostate gland.

The normal gland and carcinoma of prostate are both rich in acid phosphatase however, only small amounts of this enzyme are found in serum if the gland is normal or if the carcinoma has not metastasized. Therefore, in proper clinical setting, an elevated serum acid phosphatase

Level indicates metastases from prostate gland. If the tumor has metastasized to the bone there will also be ahighalklinephosphtase level in addition to the elevated serum acid phosphates .If the tumor has metastasized to the liver, the secondaries may cause biliary obstruction resulting in Jaundice and elevation of both serum alkaline and serum acid phosphatase level. Note (unless given some indication of metastases to the liver or bone, consider that an elevated serum acid phosphateslevel indicates metastases of prostate gland (which is not associated withjaundice).

**2.1.4.2Prostate specific antigen (PSA):**

The PSA is glycoprotein produced exclusively by the prostate gland;
when elevated the possibility of prostate cancer exists. The higher the elevation, the more likely a cancer exists and that has spread. About 97%
Of men with normal prostate glands without hyperplasia have PSA levels
under 4 ng/ml. (PSA can be elevated by virtually any abnormality affecting the prostate, whether benign or malignant including BPH,atrophy, inflammation, infarction and manipulation).

**PSA levels**

0 – 4 ng/ml = normal

4 – 10 ng/ml = borderlines

> 10 ng/ml = abnormal (biopsies recommended) (Deam.et.al.2002surgical removal of the gland. Homma Y. et a(1996).

## 2.1.5 Sonographic appearance of the prostate:

### 2.1.5.1 Normal prostate:

A healthy human prostate is classically said to be slightly larger than a
Walnut. The mean weight of the normal prostate in adult males is about 11grams, usually ranging between 7 and 16 grams. It surrounds the urethra just below the urinary bladder and can be felt during a rectalexam(training.seer.cancer.gov).

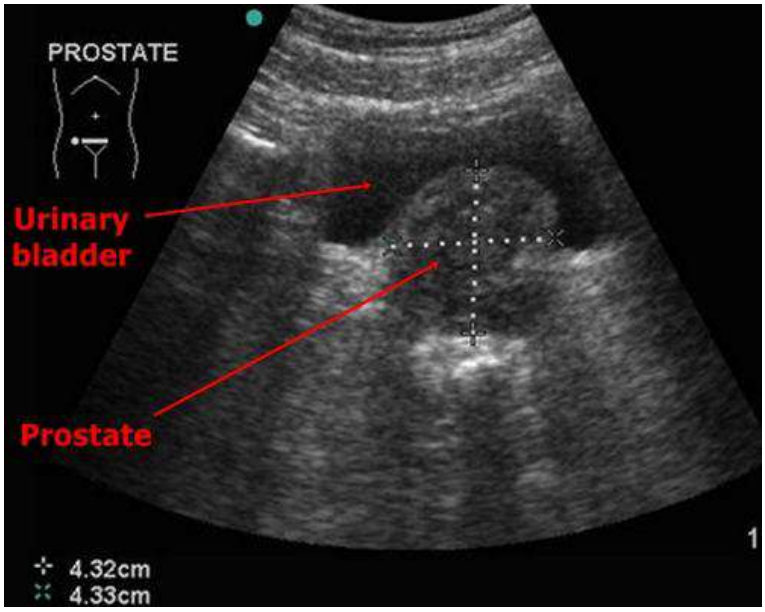



**Figure 2.15 Show normal ultrasound appearance of prostate (Trans abdomen image)**.

#### 2.1.5.1.1 Trans rectal ultrasound (TRUS) technique:

It is ideal to have a small amount of urine in the bladder.

Ask the patient to try and relax and 'bear down" to open the sphincter as the transducer in inserted slowly. Ensure the transducer has a latex free dedicated probe cover with plenty of gel. The highest frequency sector probe 7-12MHz should be used.

The scanning begins in the axial plane. The seminal vesicles are examined initially. As the probe is angled caudally the base of the prostate is seen.

Once the prostate is examined in its entirety in this plane the probe is turned 90 degrees in sagittal plane. The probe is angled from one side across to the other. A volume is taken by measuring height x length in the sagittal plane and x width in axial plane and multiply 0.52.

Normal volume of prostate = $20cm^3$.


**Fig 2.16 Show normal prostate images trans rectal (TRUS) {www.cancer.gov}**

### 2.1.5.1.2 Transabdominal technique:

The patient lies supine. The patient should have a half full bladder. 500 mls of water 1 hr before the scan if possible is recommended.

The probe is angled approximately 30 degrees caudal using the bladder as a window. Slight compression to ensure the inferior portion of the prostate is notobscuredbytheshadowartifactfromthebaseofbladder.

(www.innerbody.com/.../repo09-new4.ht...).

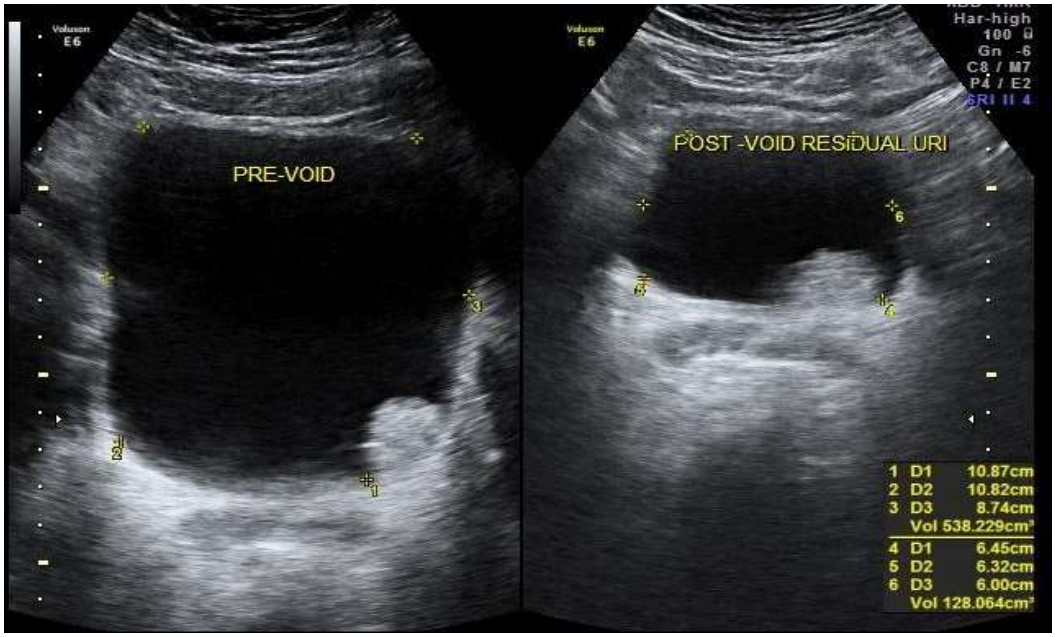
(a)

(b)

**Fig 2.17 Show prostate trans abdominal technique (a) sagittal viewand (b) transverse view with caudal angle {www.cancer.gov}**

### 2.1.5.2 Sonographic appearance of benign prostatic hypertrophy:

Ultrasound has become the standard first line investigation after the urologists finger. Typically there is an increase in volume of the prostate with a calculated volume exceeding 30cc ((A x B x C)/2 ). The central gland is enlarged. and is hypo echoic or of mixed echogenicity Calcification can beseen both within the hypertrophied gland as well as in the pseudo capsule(representing compressed peripheral zone). .(www.inner body.com/.../repo09-new4.ht...).




(a) (b)

**Fig 2.18 Show residual urine in the urinary bladder with benign prostatic hypertrophy: (a) full urinary bladder (b) residual urine post micturation {www.cancer.gov}.**

### 2.1.6 Previous studies:

- Study conducted by Zainab Abdullah Hammad Ibrahim titled as "sonographic measurement of residual urine volume in benign prostatic hyperplasia" the study involved 50 patients aged 49-90 years of age, the results showed that there is a significant relation between prostate volume and patient‘s age and, the residual urine, cystitis and calcification. The prostate enlargement is the main cause of obstruction of the bladder neck or narrowing of the urethral passage.

- Awad Ali etal(2014)Serum prostate-specific antigen as a predictor of prostate volume in Sudanese patients with benign prostatic hyperplasia. Enrolled patients had a median age of 63.5 years (51 to 94), a mean PSA of 2.94 ng/ mL and a mean PV of 46.96 mL, respec-tively. There is linear relationship between PSA levels and prostate size. Those with a prostate size of > 40 ml were found to be more likely to have high PSA meanlevel. PSA mean values were found to be associated with age (P<0.006).Conclusion:

Serum prostate specific antigen (PSA) issignificantly correlated with prostate volume in Sudanese men. PSA may be a useful tool in making therapeutic decisions and follow-up management in BPH patients.

- Study done by McNei II SA etal (2008). In there population of men with lower urinary tract symptoms suggestive of benign prostatic hyperplasia, the post void residual urine volume and bladder capacity were related to the baseline Omax (maximum flow rate). Alfuzosin significantly reduced the post void residual urine volume compared with placebo, and this effect was more marked in patients with a high post void residual urine volume at baseline. Acute urinary retention occurred mainly in patients with a post void residual urine volume greater than 100 mls and was less frequent in patients taking alfuzosin than in those taking placebo .No relationship was found between post void residual urine volume and age.

- M. Elsamani, H. Osman, Moh.Yasen, Ali. YaseAhm.Yasen(2016) Sonographic Finding of the prostate in Saudi Population .The results of study show that the enlargement of prostate is most common pathology which increases with age, and the other pathology is low incidence. The calcification changes are also low and due to aging or associated with pathology. The most prostatic pathology with enlargement of prostate is associated with abnormal micturition. The of result shown that there is 84% of the all patients present with abnormal micturition, and 97.14% among the patients with BPH present with abnormal micturition to only 2.86% present with normal micturition. Also there was 66.7% of BPH present with elevated PSA and 33, 3% present with normal PSA .There is a significantcorrelation between age incidence, and PSA level and the volume of theprostate at $p = 0.05$ with a correlation coefficient $r = 0.5$ and 0.44 respectively. This association dictates a direct relationship betweenthe PSA level, volume of the prostate and the age. Correlation issignificant at the 0.01 level . In slightly disagreement with previous.

# Chapter three

# Materials and methods

# Chapter three

# Materials and methods

## 3.1. Materials:

### 3.1.1 Type of study

Prospective descriptive study deals with the evaluation of the urinary tract in patients with benign prostatic hyperplasia.

### 3.1.2 Study area:

The study has been conducted in Khartoum state.

### 3.1.3 Study duration:

The study has been done from October 2018 to March 2019.

### . 3.1.4 Sampling and sample technique:

50 Sudanese males were selected randomly, their ages above 52years complaining of BPH.

#### 3.1.4.1 Inclusion criteria:

All Sudanese male patients aging above 52years were selected randomly.

#### 3.1.4.2 Exclusion criteria:

Patients with normal prostate.

### 3.1.5 Methods:

#### 3.1.5.1 Machine:

In this study using ultrasound machines that have been used are high resolution real time (Mindray DC8 and Aloka) ultrasound machines in Modern Medical Centre , mindray which contain curvilinear probe have a frequency from 3.5 to 5 MHZ, and ultrasound imaging system a B mode capabilities in Om Durman Teaching Hospital,Alemtiaz clinic and Elsanhori Medical Center was used.

### 3.2 Ultrasound gel:

Ultrasound gel was applied to the transducer to prevent any attenuation or artifact and thermal paper printer was used .a data collection sheet was used to collect the data and to number the patients.

Scanning technique for the prostate gland: The patient lies supine. The patient should have a half full bladder .500 mls of water 1 hour before the scan if possible is recommended. The probe is angled approximately 30 degrees caudal using the bladder as a window. Slight compression to ensure the inferior portion of the prostate is not obscured by the shadow artifact from the base of the bladder. Prostate volume is then calculated and it is normal up to 40cc. (Gleason DF ) .

Scanning technique for the urinary tract: A comprehensive examination of the renal tracts should always include assessment of the urinary bladder and prostate in males. Scan longitudinally right subcostally. Visualise the kidney inferior to the right lobe of the liver (RT) , or spleen (LT). Place the probe between iliac crest and the lower costal margin to examine in the coronal plane. Ensure the kidney is thoroughly examined from edge to edge. Rotate into transverse. Scan from beyond the superior margin to inferior. Document the normal anatomy and any pathology found, including measurements and vascularity if indicated.

measurements will be taken for fullness bladder volume with transverse and sagittal plane, and measurements will be taken for post voiding with transvers and sagittal plane. (Hum Pathol. 1992) **.**

### 3.3 Data collection:

Data were collected from ultrasound examinations of abdominal and pelvic scans using data collection sheet that include all variables of study such as patient age, weight ,height, patient clinical presentation (loin pain, urine retention, nocturia, urine incontinence, dysuria, urine frequency, urgency and dribbling), history of prostate, sonographic features of prostate

(Volume, echotexture and calcifications), sonographic features of right and left kidney (volume, corticomedullary differentiation, hydronephrosis, stones, simple cysts and solid masses) ,PSA level and bladder volume pre and post micturation.

**3.4 Data analysis:**

The data were analyzed by SPSS.

**3.5 Data presentation:**

The data were presented by tables and figures.

**3.6 storage:**

Patient data sheet was kept in local cabin and all data was storage in personal computer

**3.7 Ethical considerations:**

-The procedures of the scanning with ultrasound will be explained to the patient and the purpose of incorporating his data in the study, where written consent will be acquired in case of agreement.

-Permission from the hospital and the department will be granted.

-Data will be collected from different patient with maintain privacy and confidentiality.

# Chapter Four

# Results

# Chapter Four

# Results

## 4-1 Results:

About 50 cases having benign prostatic hypertrophy BPH to evaluate urinary tract. The results of this study are presented into tables and figures below.

**Table (4-1): Frequency distribution of prostate echo texture:**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | Homogeneous | 23 | 46.0 | 46.0 |
| | Heterogeneous | 13 | 26.0 | 26.0 |
| | Calcified | 14 | 28.0 | 28.0 |
| | Total | 50 | 100.0 | 100.0 |

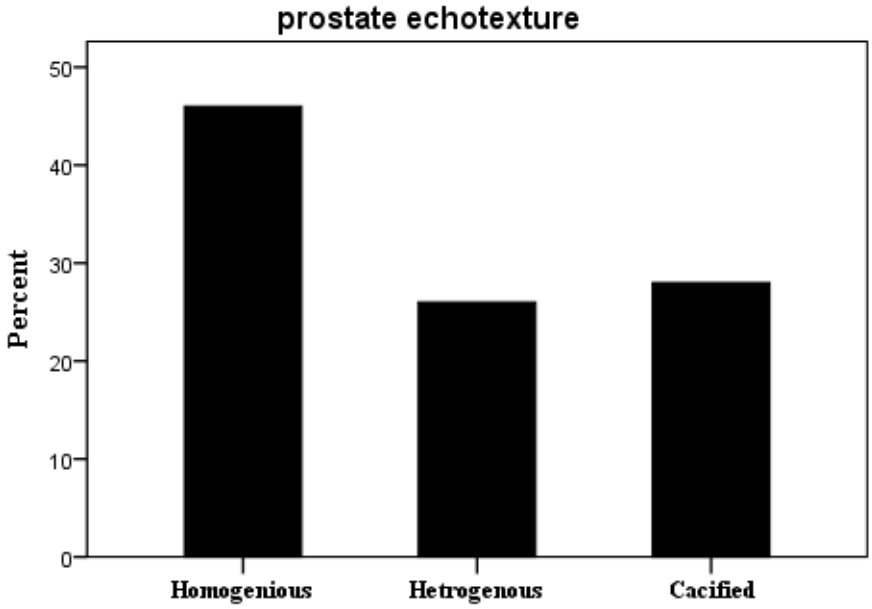



**Figure (4-1): shows bar graph displaying frequency distribution of prostate echo texture.**

**Table (4-2) : Frequency distribution of prostate capsule:**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | Regular | 26 | 52.0 | 52.0 |
| | Irregular | 24 | 48.0 | 48.0 |
| | Total | 50 | 100.0 | 100.0 |

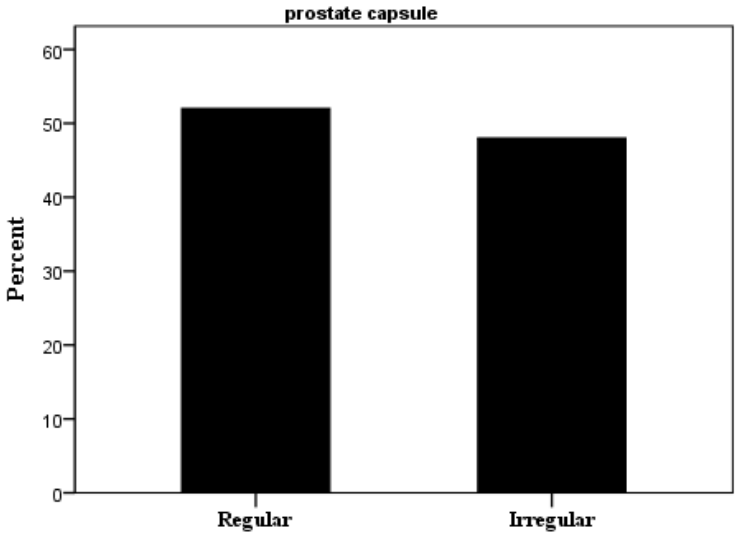



**Figure (4-2): shows bar graph displaying frequency distribution of prostate capsule .**

**Table (4-3): Frequency distribution of bladder volume post micturation:**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | Normal | 15 | 70.0 | 70.0 |
| | Abnormal | 35 | 30.0 | 30.0 |
| | Total | 50 | 100.0 | 100.0 |

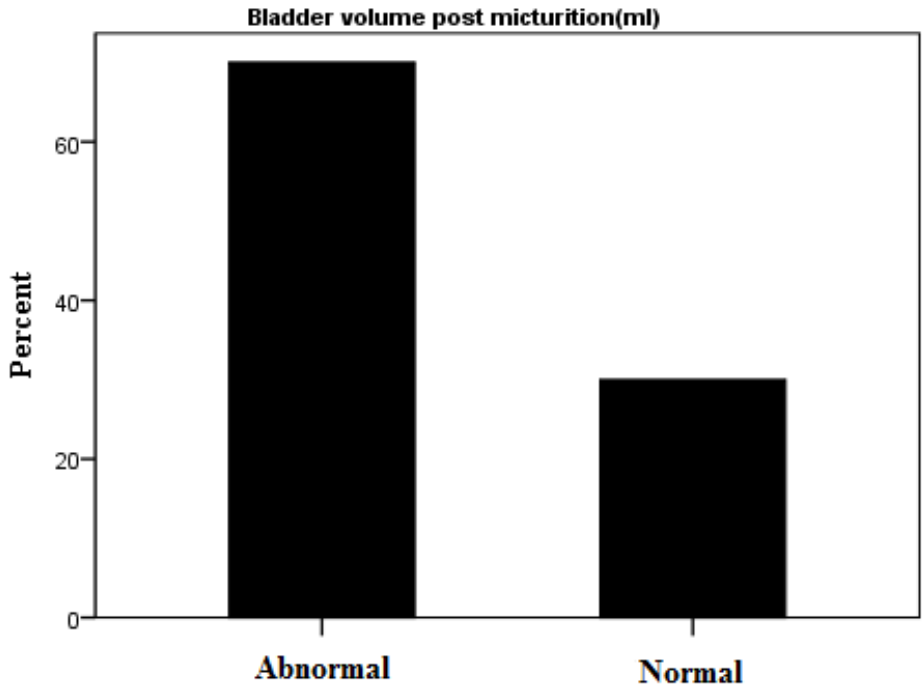



**Figure (4-3): shows bar graph displaying frequency distribution of bladder volume post micturation**

**Table (4-4) Model expressing descriptive statistics of bladder volume post micturation:**

| | Bladder volume post micturition(ml) | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Prostate volume(cm3) | Normal | 15 | 34.2227 | 54.74 | 9.25 |
| | Abnormal | 35 | 75.30 | 56.38 | 14.56 |

**Table (4-5) : Model expressing descriptive statistics of study variables:**

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age y | 50 | 52 | 84 | 69.4 | 8.22 |
| Height cm | 50 | 156 | 177 | 166.7 | 4.87 |
| Weight kg | 50 | 56 | 83 | 68.4 | 6.62 |
| BMI cm | 50 | 21 | 33 | 24.9 | 2.10 |
| PSA ng/ml | 50 | 1.00 | 28.00 | 2.9 | 3.82 |
| prostate volume(cm3) | 50 | 32.60 | 315.05 | 102.4 | 54.67 |
| Bladder wall thickness (mm) | 50 | 1.60 | 13.00 | 3.5 | 2.53 |
| Bladder volume pre micturition | 50 | 94.00 | 422.00 | 238.0 | 81.96 |
| RT Kidney length (cm) | 50 | 9.20 | 12.90 | 10.6 | 0.72 |
| RT kid width (cm) | 50 | 3.89 | 5.30 | 4.6 | 0.41 |
| RT kid thickness (cm) | 50 | 3.33 | 4.65 | 4.1 | 0.27 |
| RT KID volume (cm3) | 50 | 61.64 | 130.96 | 99.3 | 16.06 |
| LT Kidney length (cm) | 50 | 9.08 | 13.73 | 11.0 | 0.96 |
| LT kidney width (cm) | 50 | 3.89 | 5.70 | 4.8 | 0.48 |
| LT kidney thickness (cm) | 50 | 3.30 | 5.20 | 4.3 | 0.42 |
| LT Kidney volume(cm3) | 50 | 68.17 | 174.56 | 112.4 | 25.60 |

**Table (4-6): Frequency distribution of diagnosis findings:**

| | | Frequency | Percent | Valid Percent |
|---|---|---|---|---|
| Valid | Normal | 31 | 62.0 | 62.0 |
| | Cystitis | 8 | 16.0 | 16.0 |
| | Vesical Stone | 3 | 6.0 | 6.0 |
| | Simple Renal Cyst | 2 | 4.0 | 4.0 |
| | Multiple Cyst | 1 | 2.0 | 2.0 |
| | Hydronephrosis | 3 | 6.0 | 6.0 |
| | Bladder Diverticulum | 1 | 2.0 | 2.0 |
| | Renal Stone | 1 | 2.0 | 2.0 |
| | Total | 50 | 100.0 | 100.0 |

**Table (4-7) Frequency distribution expressing the relationship between the prostate volume and other study variables:**

| Model | P.value |
|---|---|
| (Constant) | .150 |
| Age | .106 |
| BMI | .562 |
| RT KID volume (cm3) | .953 |
| LT Kidney volume(cm3) | .298 |
| Bladder wall thickness (mm) | .131 |
| Bladder volume pre micturation(ml) | .237 |
| PSA | .029 |

**Table (4-8) Model correlation test expressing the correlations between the patient age, PSA, prostate volume and bladder volume pre micturation variables:**

| | | Age | PSA | prostate volume(cm3) | Bladder volume pre micturition(ml) |
|---|---|---|---|---|---|
| **Age** | Pearson Correlation | 1 | -.090 | -.231 | .057 |
| | Sig. (2-tailed) | | .534 | .106 | .693 |
| | N | 50 | 50 | 50 | 50 |
| **PSA** | Pearson Correlation | -.090 | 1 | .309* | .028 |
| | Sig . (2-tailed) | .534 | | .029 | .848 |
| | N | 50 | 50 | 50 | 50 |
| **prostate volume(cm3)** | Pearson Correlation | -.231 | .309* | 1 | .170 |
| | Sig. (2-tailed) | .106 | .029 | | .237 |
| | N | 50 | 50 | 50 | 50 |
| **Bladder volume pre micturition(ml)** | Pearson Correlation | .057 | .028 | .170 | 1 |
| | Sig. (2-tailed) | .693 | .848 | .237 | |
| | N | 50 | 50 | 50 | 50 |
| *. Correlation is significant at the 0.05 level (2-tailed). | | | | | |

# Chapter Five

# Discussion, Conclusion, and Recommendations

# Chapter Five

## Discussion, conclusion, and recommendations

### 5-1 Discussion:

This study was cross sectional descriptive study done to evaluate urinary tract in patient with Benign prostatic hyperplasia by ultrasound.

The results of this study showed that23 of cases had homogeneous 13 heterogeneous and 14 calcified prostate echotexture which all of them was diagnosed as benign Prostatic hypertrophy as shown in figure 4-1and table 4-1.

Also the study showed that 26 of cases had regular capsule and 24 had irregular prostate capsule which all of them was diagnosed as benign Prostatic hypertrophy as in figure 4-2and table 4-2.

The study also showed that 15 of cases had normal bladder volume post micturation and 35 abnormal cases as in figure 4-3and table 4-3 , normal bladder volume post micturation is less than 50ml(www. msdmanuals.com)

The results showed that normal bladder volume post micturation is 34.22 ± 54.74 and abnormal bladder volume post micturation is 75.30 ±56.38 as in table 4-4 .

The study also showed that patient age (69.4±8.22), patient height (166.7 ±4.87),patient weight(68.4±6.62,BMI(24.9±2.10),PSAlevel(2.9±3.82),prostate volume(102.4±54.67),bladderwallthickness(3.5±2.53),bladdervolume premicturation(238.0±81.96) ,RTkidney length(10.6±0.72),RT kidney width(4.6±0.41),RT kidney thickness(4.1±0.27) ,RT kidn volume(99.3±16.06) ,LT kidney length(11.0±0.96), LT kidney width(4.8±0.48), LT kidney thickness(4.3±0.42) and LT kidney volume(112.4±25.60) as in table 4-5 .

Also the results showed that 31 of cases had normal urinary tract findings and 19 of cases are abnormal which distributed as 8 had cystitis , 3 vesical

stone , 2 simple renal cyst , 1 multiple renal cyst , 3 renal hydronephrosis , 1 bladder diverticulum and 1 renal stone as in table 4-6 .

Also the results confirmed that there is no significant relationship between the prostate volume and patient age , BMI , right kidney volume , left kidney volume , bladder wall thickness and bladder volume pre micturation , because the value is 0.436 , 0.102 and 0.892 respectively which is more than 0.05.

But the study showed there is significant relationship between the prostate volume and PSA because the values is 0.029 which is less than 0.05.

These results agree with the result of pervious study done byAwad Ali M. Alawad et .al(2014) witch shown there is linear relationship between PSA levels and prostate size.

The study also confirmed that there is no significant relationship between patient age , PSA , prostate volume and bladder volume pre micturation , because the value is 0.436 , 0.102 and 0.892 respectively which is more than 0.05 but there is significant relationship between PSA and prostate volume as mentioned previously .

## 5-2 Conclusion:

Ultrasound scanning is very important modality to detect any prostatic Changes in old men patients and to diagnose it early.

the results confirmed that there is no significant relationship between the prostate volume and patient age , BMI , right kidney volume , left kidney volume , bladder wall thickness and bladder volume pre micturation , because the (2-tailed)" value is 0.436 , 0.102 and 0.892 respectively which is more than 0.05.

But the study showed there is significant relationship between the prostate volume and PSA because the (2-tailed)" value is 0.029 which is less than 0.05.

62% of cases were normal and 38% were abnormal.

## 5-3 Recommendations:

- Further studies should be carried out in this field on many aspects such as; increasing the number of the patients.

-Complete abdomenopelvic sonographic examinations should be done to detect any associated pathologies and /or complications.

-The government should encourage establishing ultrasonographic departments, and should supply primary health center and hospitals with high quality ultrasound machines (especially in rural areas).

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**{www.cancer.gov}**.

(www.inner body.com/.../repo09-new4.ht...).

(www. Msdmanuals.com)

# Appendices

## Appendix (A):

بسم الله الرحمن الرحمن الرحيم

# Sudan University of science and technology

**College of graduate studies**

**Evaluation of urinary tract in patients with benign prostatic hyperplasia by ultrasound**

**Data collection sheet**

**1-participant information:**

Age

Weight

Height

BMI

**2-Lap findings:**

PSA Level ( )

**3-Sonographic features of prostate:**

Length ( )cm width( ) cm height ( ) cm

Prostate volume ( ) cc

Echo texture:

Homogenous ( ) heterogeneous ( ) Calcification ( )

Prostate capsule :

Regular( ) irregular( )

Site of lesion:

Peripheral ( ) transition ( ) central ( ) NO ( )

**4-Sonographic features of the Rt kidney:**

Length ( )

Width ( )

Depth ( )

Volume ( )

**5-Sonographic features of the Lt Kidney:**

Length ( )

Width ( )

Depth ( )

Volume ( )

**6-Sonographic feature of urinary bladder**:

Urinary bladder wall thickness ( )ml

Urinary volume post micturation ( )ml

Urinary volume premicturation ( )ml

## Appendix (B):

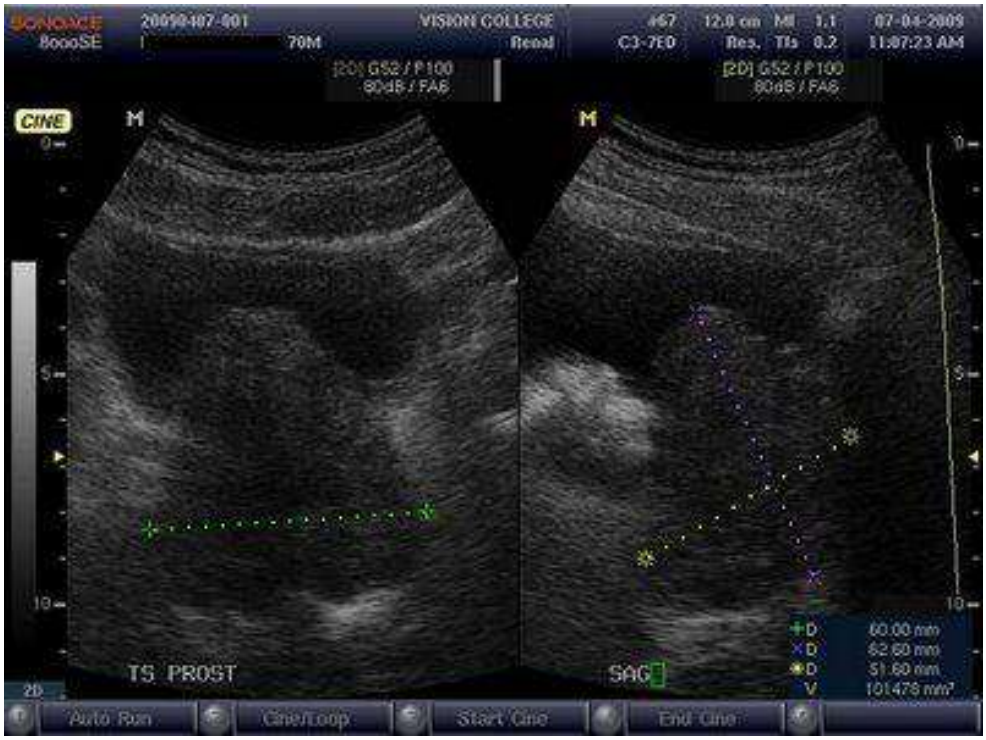


**Image (1) :Transverse and sagittal U/S images showing BPH**

Image 2:

Patient age 60 years

Image (2.1):prostate volume=200.6ml

Image (2.2):urinary bladder prevolumemicturition =278ml

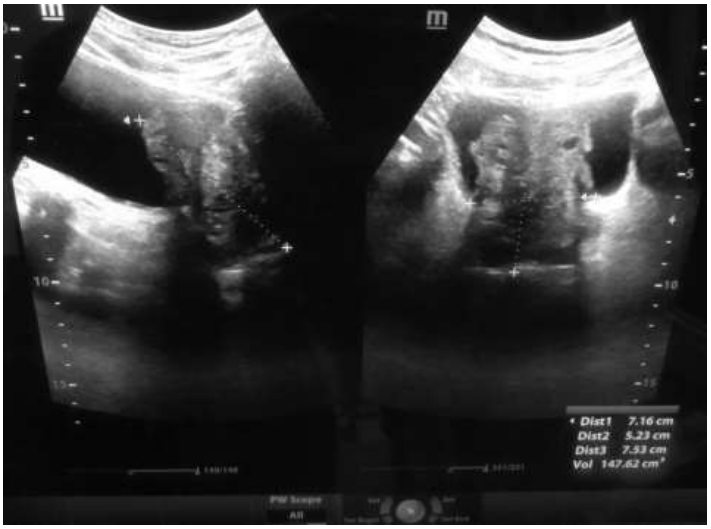


Image (3)**:**A 81year's old patient showed BPH with volume of (147cc).


Image (4): The same patient showed Rt single renal simple cyst.

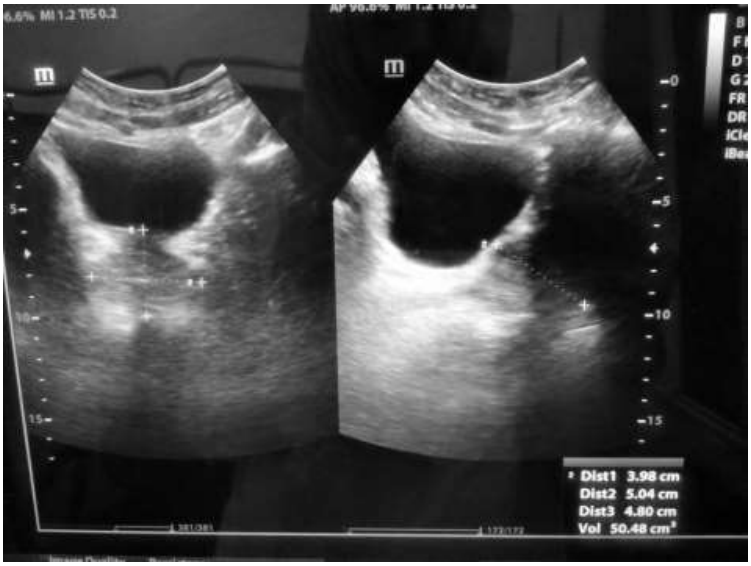


Image (5): 49 year's old patient showed BPH with volume of (50.4cc).


Image (6):The same patient showed multiple simple cysts on the LtKidney.


Image (7)**:**62 year's old patient showed normal prostate volume(34cc).


Image (8):The same patient showed Lt renal stone.


Image (9): A80 year's patient showed normal prostate volume (25.9cc)

with prostatic calcifications.


Image (10):The same patient showed mild hydronephrosis and simple Ltrenal cyst.


Image (11):A72 year's patient showed normal prostate volume (34.8cc)


Image (12): The same patient showed bilateral hydronephrosis

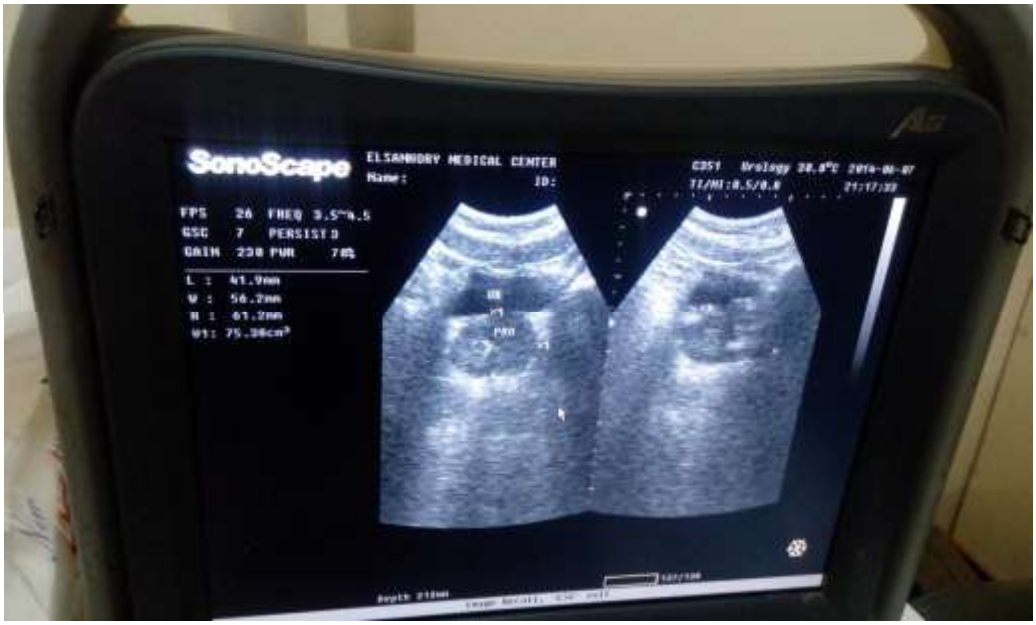


Image (13):BPH in(60)years male, prostate volume(75)cc

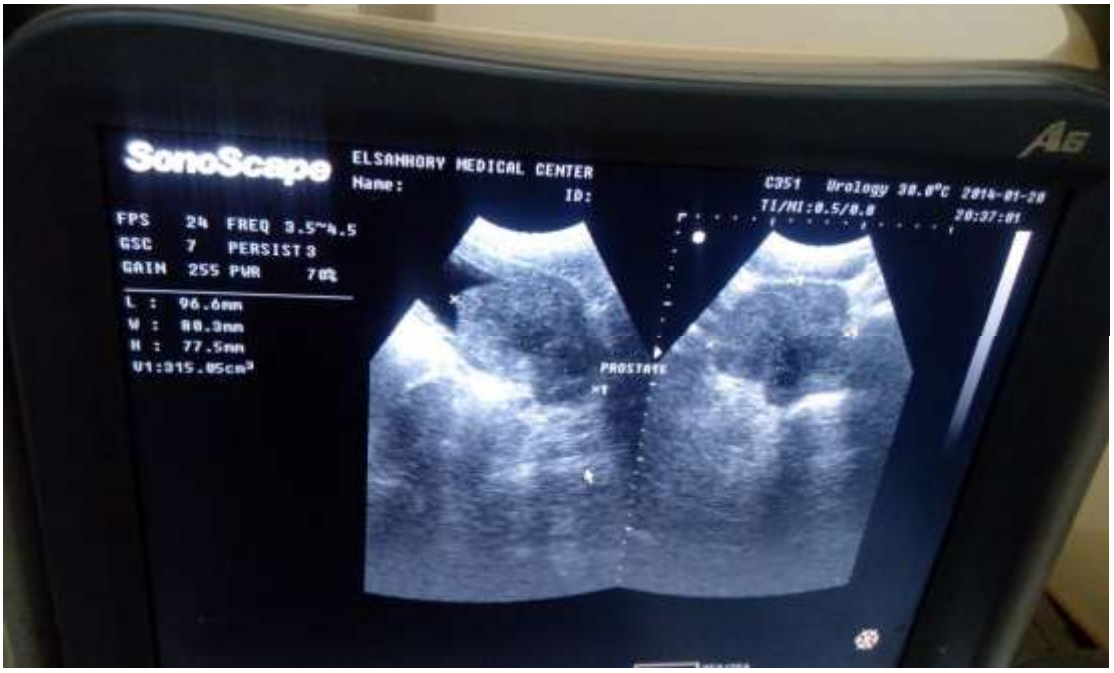


image :(14)BPH in (80)years male, prostate volume