



**Sudan university of Science and  
Technology Collage of graduate studies**



**Measurement of Normal Prostate Gland Volume in  
Adult using Ultrasonography**

قياس حجم غدة البروستاتا الطبيعي عند البالغين باستخدام التصوير  
بالموجات فوق الصوتية

**A thesis Submitted for Partial Fulfillment for the Requirement of  
M.Sc Degree in Diagnostic Medical Ultrasound**

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**2019**



## **Dedication**

**To my beloved mother**

**To the spirit of my dear father**

**To my sweet heart daughter (Leen)**

**To my family**

**To my friends**

## **Acknowledgement**

All thanks, praise and gratitude to god for giving me health and strength to accomplish this work and ask him to bless me in his graces and give me more and more

Special thanks and gratefulness to my supervisor Dr. Babiker Abd Elwahab

My thanks, appreciation and respect:

To all my teachers and staff of M.sc degree of US in sudan university ,

To my colloquies in ultrasound departments for giving me chance to gain knowledge and experience and help me to complete this thesis

## Abstract

This is a descriptive study, carried out in order to reference the normal volume , diameters, echogenicity and texture of prostate gland in adult Sudanese males using ultrasonography. The study was done in Bashair teaching hospital, Hillat Kuku health Centre , and other hospital, and health centers in Khartoum state , at duration from August to December , 2018. About 80 patients were randomly selected, aged from 20 to 80, referred to ultrasound department with no complain or symptoms related to prostate pathologies. Transabdominal ultrasound scanning by 2-5 MHz probes were performed ,in order to measure the maximum prostate depth, width ,and length to obtain the prostate volume.

The result found out the mean of these diameters were (2.9), (3.7) and (3.1) cm respectively, and the mean prostate volume obtained from above diameters was  $18.7 \pm 6.7$ ml ,and the mean prostate volume of the age group (20-40y) ,(40-60) and (60-80) were (14.7),(20.3) and (22.8) respectively , and the mean prostate volume of single and married participants were 14.9, and 20.7 respectively

This study also found out that prostate volume increases linearly with subject's parameters like age, weight ,height and affected by marital status of patient, the study find out the prostate volume increase more in married patients than in single ones.

Moreover the study reveals that most of participant's prostate was mid-grey level echogenicity, and homogeneous in Texture .

## ملخص الدراسة

أجريت هذه الدراسة الوصفية بغرض معرفة حجم، ابعاد، ظهور لون، وتجانس غدة البروستاتا فى الرجال البالغين السودانين باستخدام الموجات فوق الصوتية، أجريت هذه الدراسة فى مستشفى بشاير التعليمى ومركز صحى حلة كوكو ومستشفيات ومراكز صحية اخرى بولاية الخرطوم، وذلك خلال الفترة من اغسطس الى ديسمبر عام 2018م. اجريت الدراسة بقسم الموجات الصوتية لحوالى 80 مريض لايشكون من اعراض او امراض متعلقة بغدة البروستاتا ، وتم فحصهم بالموجات فوق الصوتية على منطقة اسفل البطن باستخدام محولات طاقة بتردد موجى يتراوح من 2\_5 ميغاهيرتز، وتم قياس اقصى ارتفاع وعرض وطول لغدة البروستاتا لحساب حجم البروستاتا ، اظهرت نتيجة البحث ان متوسط قياس تلك الابعاد هو (2.9)، (3.7)، (3.1) سم على التوالي ، ومتوسط حجم غدة البروستاتا طبقا لهذه الابعاد هو 18.7+6.7مل، ومتوسط حجم البروستاتا للفئات العمرية (20\_40)، (40\_60)، (60\_80) هو (14.7)، (20.3)، (22.8) على التوالي ، كما وجدت متوسط حجم غدة البروستاتا لغير المتزوجين (14.9)، وللمتزوجين (20.7)

واثبتت الدراسة كذلك ان حجم غدة البروستاتا يزيد بزيادة بعض العوامل كزيادة عمر، وزن ، وطول الشخص ،

كذلك وجدت الدراسة ان حجم غدة البروستاتا تتاثر بالحالة الاجتماعية للأشخاص، حيث وجدت ان حجم البروستاتا يزيد عند المتزوجين عن الغير متزوجين

وايضا وجدت الدراسة ان غدة البروستات لمعظم من اجريت عليهم الدراسة كانت متجانسة ومتوسطة درجة الرمادية .

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## **List of Abbreviations**

AP	Antero-posterior
BPH	Benign Prostatic Hyperplasia
CZ	Central Zone
E	Ejaculatory duct
P	Prostate
PSA	Prostatic Specific Antigen
PV	Prostate Volume
PZ	Peripheral Zone
SPSS	Statically Packed for Social Studies
SV	Seminal vesicle
TAUS	Trans abdominal ultrasound
TPUS	Trans perineal ultrasound
TRUS	Tran rectal ultrasound
TZ	Transitional Zone
U	Urethra
UB	Urinary bladder
US	Ultrasound
V	Vas deferens



# **Chapter One**

## **Introduction**



## Chapter One 1-1

### Introduction:

Prostate is compound tubuloalvular exocrine gland of the male reproductive system .The function of prostate is to secrete slightly alkaline fluid ,which has the characteristic of milky or white in appearance .The secretion usually constitutes 20%to30%of the volume of semen along with spermatozoa and seminal vesicle fluid

In medical practice ,most of the prostate abnormalities are diagnosed by measuring their volume .Normally, the prostate volume range between 0.250 at birth to 10.000ml sized in puberty .After puberty ,the prostate volume will continuously grow as the age increase for most of the male's life

The prostate secretes some of the fluid for semen ,stops urination during ejaculation , and enhances sexual pleasureable sensations(Patel and Jones ,2009)

Reliable and precise ultra sonography measurement of prostate volume is very important for the management of prostate diseases. It is crucial not only for diagnosis purposes but also in planning non-invasive treatment of prostate cancer and follow ups (Sun and Seung,2008) .

In clinical setting , measurement of prostate volume via ultrasonography is conducted in several ways, namely transperineal , transrectal and

Transabdominal ultra sound uses 3-5 MHz transducer through a partially or fully filled urinary bladder with caudal angulation to send the ultrasound beam under the pubic arch and permit global volume measurements of the prostate ,in this method ,the transmitted and reflected ultrasound waves visulize the organs through the abdominal wall. The advantage of transabdominal ultrasound is that procedure can be performed quickly and non-invasively (Walz,et al.,2006).

Measurements of prostate volume have become very important clinically since it's association with different diseases and variables of malignancy. The American Cancer society found that prostate cancer is one of the most common cancers in men (Marx and Karenberg,2009) and is getting from the world as it become asignificant cause of death every year.

Afew researches reported that prostate volume highly contribute in diagnosis of prostate cancer .Theses studies show that large prostate volume has an increased risk of malignancy( Evelyn,2010).

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

Prostate diseases now is widespread in sudan(prostate cancer, BPH, and prostatitis) ,and measurement of prostate volume by ultrasound is important investigation and frequently used to diagnose protsate pathologies , so this study try to asses the normal prostate volume in adult Sudanese males using ultrasonography.

### **1-3Objectives:**

#### **1.3.1 General objectives:**

-To measure the normal prostate volume in adult sudanese men using ultrasonography.

#### **1-3-2 Specific objectives:**

- To measure the normal prostate volume in adult sudanese men using ultrasonography.
- To determine the range of volumes of the prostate gland in adult males in local enviroment using ultrasound.
- To estimate refrence value of prostate volume for sudanese .
- To measure the diameters (depth, width ,and length) of prostate
- To correlate the prostate volume with Age,weight,height and marital status of the patient

- To identify the echo-pattern ,and texture of the normal prostate gland

**Over view of study:**

**Chapter one:** Include :an introduction, problem ,objectives and overview of the study.

**Chapter tow:** Include: anatomy, physiology, investigations done to prostate, sonogram of prostate and previous study.

**Chapter three:** Deals with the materials and methods.

**Chapter four:** Include result presentation.

**Chapter five:** Presents discussion,conclusion,and recommendations of the study followed by refrences and appendices.



# **Chapter Two**

## **Literature Review**

## **Chapter Two**

### **Literature review 2-1 Anatomy:**

#### **2-1-1 Shape and location:**

The prostate gland is a compact ,encapsulated organ that weight about 20 grams ,measuring approximately 2cm by 3 cm by 4 cm .it is located immediately inferior to the urinary bladder(Elsevier,2008).

The prostate gland includes sub mucosal glands that produce mucin and more than 30 tubuloalveolar glands that open directly through numerous ducts in to the prostatic urethra .Together , these glands contribute a component to the seminal fluid(Elsevier,2008).

The prostate is a fibro-muscular gland shaped like an upside-down pyramid, which surrounds the prostatic urethra, extending from the urinary bladder base to the urogenital diaphragm(Buiter,et.al,2013).The base of the gland is related to the urinary bladder above ,an apex inferiorly sitting on the pelvic (urogenital diaphragm), an anterior wall which is separated from the pubic symphysis by retro-pubic fatty space (of retzius). A posterior wall related to the rectum ,and two infrolateral walls related to the muscles of the pelvic side wall and the anterior part of the levator ani muscles on either side(Ryan,et.al,2007).

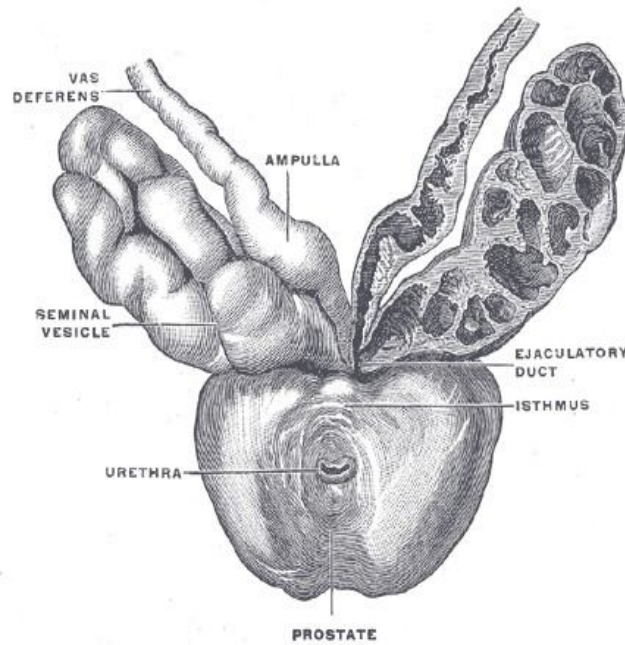


Fig 2-1 Prostate with seminal vesicles and seminal ducts, viewed from in front and above

### 2-1-2 Structure of prostate:

According to traditional anatomy, the gland is described as having the following five lobes which are not well demarcated from one another: a muscular anterior lobe (or isthmus) which is anterior to the urethra and composed mainly of fibro-muscular fibers, and contain little if any glandular tissue, a posterior lobe which is posterior to the urethra and inferior to the insertion of the ejaculatory duct, a median lobe between the urethra and the ejaculatory duct, and two lateral lobes, which form the bulk of the gland. The five lobes can only be differentiated in the fetus up to twenty weeks gestation, in mature gland only three lobes—two lateral lobes and one median—can be distinguished, with the fibro-muscular stroma anteriorly. These lobes can be palpated from the rectum by doing digital per rectum examination (Ryan, et.al, 2007).

The prostate may more usefully be described based on its internal architecture as having three glandular zones with the non-glandular isthmus

anteriorly (Ryan,et.al,2007)so as the following :the central zone comprise approximately 25%of glandular tissue, resistant to disease, and it's a midline wedge at the base of the prostate between the prephral and transitional zones ,the prephral zone comprises approximately 70%of glandular tissue,surrounds the distal urethral segment ,separated from the central zone by the surgical capsule ,occupies the posterior, lateral, and apical regions of the prostate and its site for most prostatic cancers, and finally the transitional zone comprises 5%of the glandular tissue and periurethral glands, consist of two small glandular areas adjacent to proximal urethral sphenicter, bound caudally by the verumontanum, separated laterally and posteriorly from the outer glands by the surgical capsule ,and it's an area where benign prostatic hypertrophy(BPH) originates (OVEL,2014).

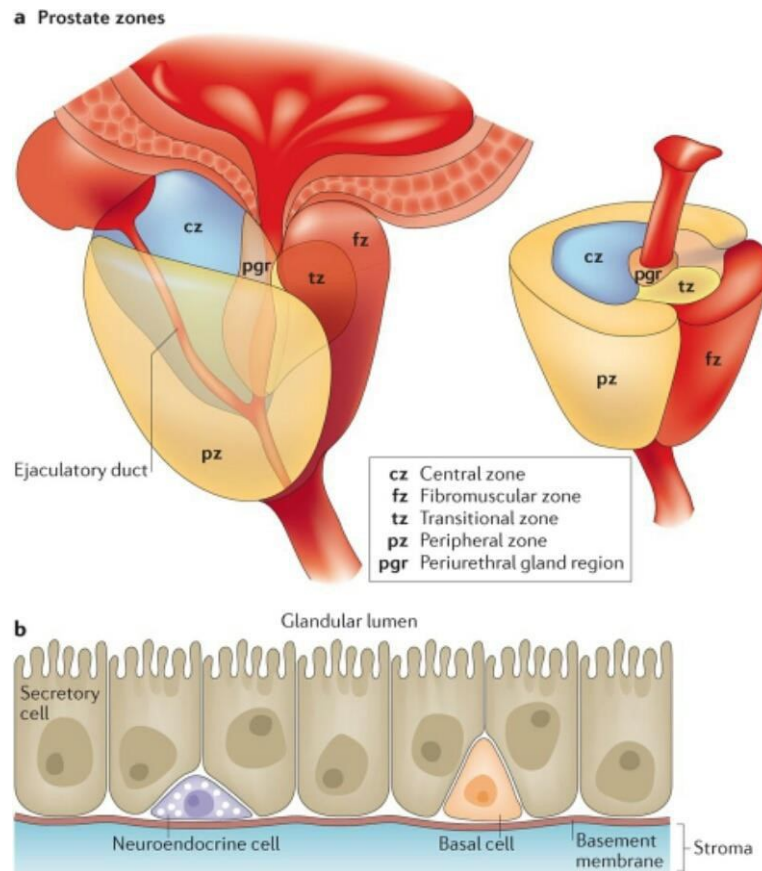


Fig 2-2 represents zonal anatomy of prostate gland



### **2-1-3 Relations:**

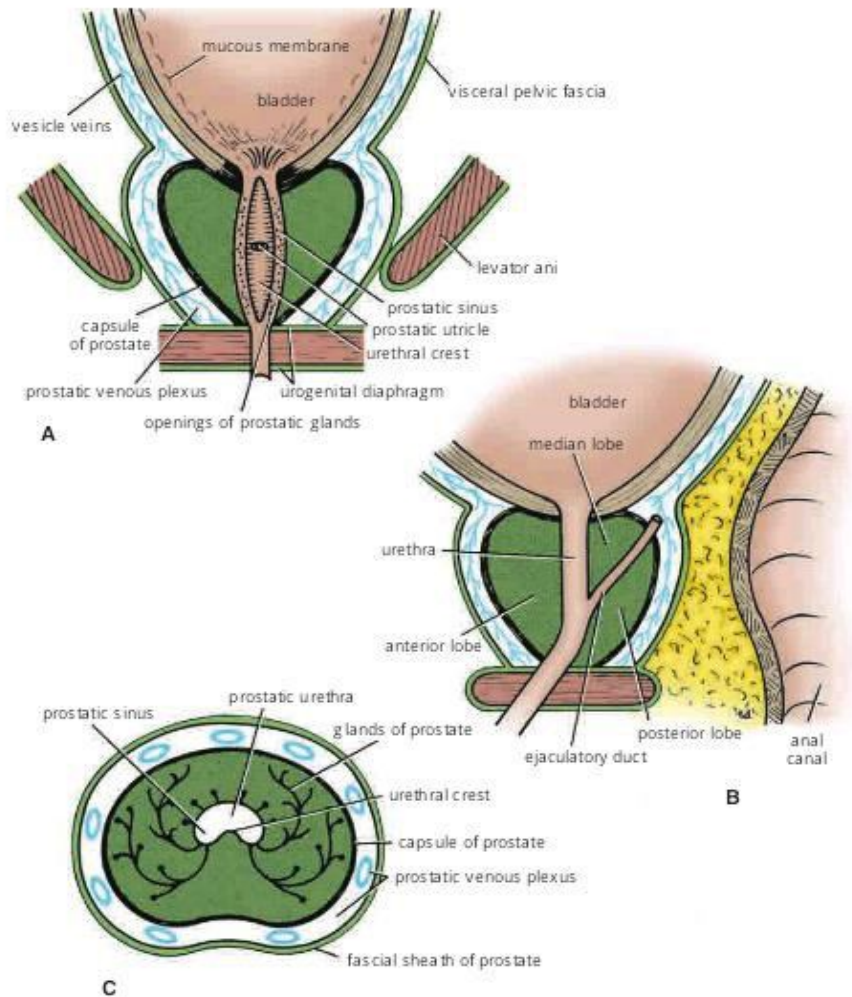
**Superiorly:** The base of the prostate is continuous with the neck of the bladder, the smooth muscle passing without interruption from one organ to the other. The urethra enters the center of the base of the prostate.

**Inferiorly:** The apex of the prostate lies on the upper surface of the urogenital diaphragm. The urethra leaves the prostate just above the apex on the anterior surface.

**Anteriorly:** The prostate is related to the symphysis pubis, separated from it by the extraperitoneal fat in the retropubic space (cave of Retzius). The prostate is connected to the posterior aspect of the pubic bones by the fascial puboprostatic ligaments .

**Posteriorly:** The prostate is Closely related to the anterior surface of the rectal ampulla and is separated from it by the rectovesical septum (fascia of Denonvilliers). This septum is formed in fetal life by the fusion of the walls of the lower end of the rectovesical pouch of peritoneum, which originally extended down to the perineal body.

**Laterally:** The prostate is embraced by the anterior fibers of the levator ani as they run posteriorly from the pubis(Richard S.Snell,2012) .



**FIGURE 2-3** Prostate in coronal section (A), sagittal section (B), and horizontal section (C). In the coronal section, note the openings of the ejaculatory ducts on the margin of the prostatic utricle (Richard S.Snell,2012) .

**2-1-4 Prostatic urethra:**

The prostatic urethra is about 1.25 inches (3cm) long and begins at the neck of the bladder .it passes through the prostate from the base to the apex ,where it becomes continuous with the membranous part of the urethra on it is posterior wall is a longitudinal ridge called the urethral crest ,on each side of these ridges is a grooves. On the summit of the urethral crest is a depression

,the prostatic utricle, which is along of the uterus and vagina in females. On the edge of the mouth of the utricle are the opening of the two ejaculatory duct(Snell,1995).

#### **2-1-5 Peri urethral glands:**

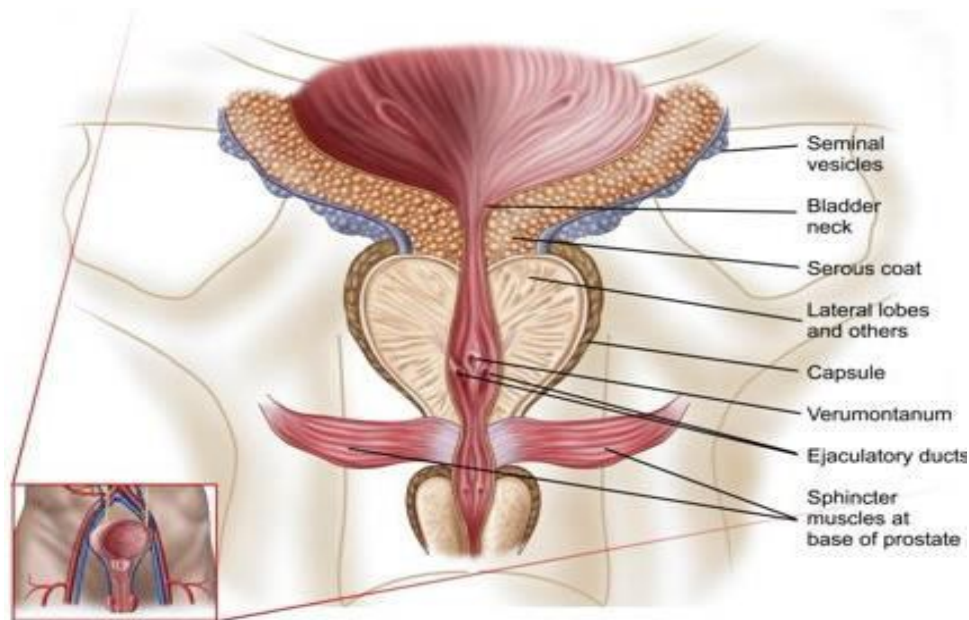
Comprise 1% of glandular tissue, also it's the tissue that lines the prostatic urethra(OVEL,2014).

#### **2-1-6 Verumontanum :**

It's the region where the ejaculatory ducts enter the urethra , and divides the urethra in to proximal and distal segments(OVEL,2014).

#### **2-1-7 Seminal vesicles:**

These are paired anatomical structures , lying superior to the prostate ,posterior to the bladder ,and lateral to the vas deferens. Ducts of the seminal vesicles enter the central zone of the prostate. It stores sperms, and joins the vas deferens to form the ejaculatory ducts (OVEL).



**Fig2-4 illustrate anatomy of prostate with bladder,seminal vesicals,verumontanum,ejaculatory ducts,capsule,and sphincter muscles of the base of prostate**

## **2-1-8 Blood supply of the prostate gland:**

### **Artries:**

The prostate is supplied from the inferior vesical , internal pudendal and middle rectal arteries, they perforate the gland along a posterolateral line from the junction of the prostate with the bladder down to the apex of the gland. **Veins:**

The veins run in to a plexus around the anterolateral aspect of the prostate ,posterior to the arcuate pubic ligament and the lower part of the symphysis pubis, anterior to the bladder and prostate.

The chief tributary is the deep dorsal vein of the penis , the plexus also receives anterior vesical and prostatic raim (which connect with the vesical plexus and internal pudendal vein),and drains in to vesical and internal iliac veins.

### **Lymphatic Drainage:**

Collecting vessels from the vas deferens end in the external iliac nodes,while those from the seminal vesicle drain to the internal and external iliac nodes. A vessel from the posterior surface accompanies the vesical vessels to the external iliac nodes and one from the anterior surface reaches the internal iliac group by joining vessels which drain the membranous urethra(mundy AR,et.al,1999)

### **Nerve supply:**

The nerve supply of the prostate is from para sympathetic nerve fibers from pelvic splanchnic nerves(S2-S4)(Ryan,et.al'2007).

## **2-2 Physiology of the prostate gland:**

The function of the prostate is to secrete a slightly alkaline fluid, milky or white in appearance ,usually constitutes 50-70% of the volume of the semen along with the spermatozoa and seminal vesicle fluid. Semen is made

alkaline overall with the secretions from other contributing glands, including at least , the seminal vesicle fluid.

The alkalinity of semen helps neutralize the acidity of the vaginal tract ,prolonging the lifespan of sperm .The alkalization of semen is primarily accomplished through secretion from the seminal vesicles. The prostatic fluid is expelled in the first ejaculate fractions, together with most of spermatozoa .In comparison with the few spermatozoa expelled together with mainly seminal vesicular fluid ,those expelled in prostatic fluid have better motility, longer survival and better protection of the genetic material. The prostate also contains some smooth muscle that help expel semen during ejaculation.

#### **2-2-1 Male sexual response:**

During male ejaculation , sperm is transmitted from the ductus deferens in to the male urethra via the ejaculatory duct, which lie with in the prostate gland .It is possible for men to achieve orgasm solely through stimulation of the prostate gland ,such as prostate massage or receptive anal intercourse (Komisaruk,et .al,2009).

#### **2-2-2 Secretions :**

Prostatic secretions vary among species. They are generally composed of simple sugars and often are slightly acidic. In human prostatic secretions , the protein content is less than 1% and includes proteolytic enzymes ,prostatic acid phosphate , beta microsmimoprotein , and prostate –specific antigen.The secretions also contain zinc with aconcentration 500-1,000times the concentration in blood.

## **2-3 Investigatoins done to prostate:**

### **2-3-1 Physical examination :**

This examine done by a physician through the rectum and it is more important as a primary procedure to detect any enlargement in the prostate, which may be due to benign prostatic hyperplasia or carcinoma of prostate (Harsh Mohan,2002).

### **2-3-2 Laboratory investigation:**

These are including:

#### **Urine gerenal and for culture if needed:**

This is use in cases of inflamed prostate for isolation the organism "e.i E.coli and other gram negative rods". Entrococcus or staphylococcus .( Kumar /Cotran/ Robbins 1997-Harsh Mohan. 2002).

#### **Serum prostatic antigen levels :**

Serum PSA levels are elevated in patients with both localized and advanced carcinoma monitoring so this examine is useful in diagnosis of disease ,also it's a useful in assessing response to therapy or prognosis of disease (Harsh Mohan.2002).

### **2-3-3 Prostate sonogram:**

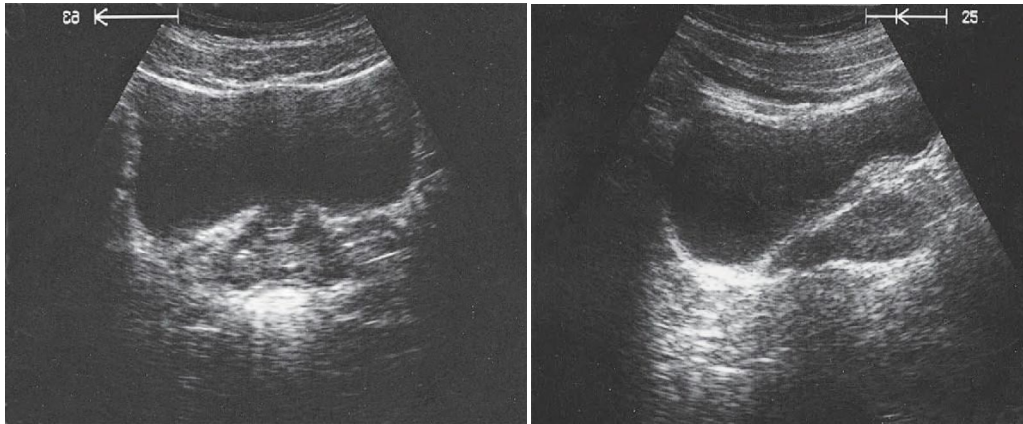
Now a day's prostate sonography is a frequently used imaging modalities to detect it's abnormalities ,from this point of view here are information about the normal appearance, different sonographic techniques, in addition to prostate biopsy.

## **2-4 Ultra sound technique :**

### **2-4-1 Trans-abdominal approach :**

Done by using a 3.5 to 5 MHz and a full bladder ,the prostate may be identified by angling slightly inferior longitudinal and transverse images and measurements may be obtained post-void residual with in the bladder to be

determined by the (length x width x height x 0.523) (SANDERS and WINTER ,2007).



**Fig(2-5) :TAUS . transverse(right) ,and sagittal (left) planes of prostate (Block and Telger, 2004).**

#### **2-4-2 Trans –perineal approach:**

A perineal approach can be used scanning between legs posterior to scrotum ,but this is not an ideal way to evaluate the prostate by ultra sound .Both transverse and longitudinal images can be obtained and the prostate volume can be calculated ; however internal architechture may not be well appreciated ,This approach can be used for biopsy if the patient has surgically removed rectum (SANDERS and WINTER,2007).

#### **2-4-3 Trans-rectal approach:**

The most accepted scanning approach when evaluating the prostate .It's done by using 5-9 MHz endocavitary tranducers .It's convenient ,not invasive ,and good image quality .Prepration ;needed adequate defecation , bladder filling with up to 100cc, condom or protective sheath,careful probe water filling ,and the patient should be placed in aleft lateral decubitus position with the knees bent(SANDERAS and WINTER,2007).

#### **2-4-4 Trans-urethral approach:**

Require local anesthesia for intra- urethral insertion with rotation. There is good visualization of capsule and intra-capsular spreading tumour. Not appropriate method because of no delineation of periurethral region and more or less invasive (Lee, and Young ,2011).

#### **2-4-5 Ultra sound and prostate biopsy :**

Prostate biopsy is taking a sample from the gland to be sent for histopathological study to find out the definite diagnosis .Two methods of prostate biopsy may be used:trans-rectal and trans- perineal . The trans-rectal approach is more common and less painful but carries a greater risk of infection .The trans-perineal approach is generally only used if the rectum is absent e.g, surgically removed (SANDERS and WINTER,2007 ).

#### **2-5 Sonographic appearance of the normal prostate gland:**

Transrectal US of the prostate has revolutionized our ability to examine this organ. It provides excellent visualization of the prostate in the axial and sagittal planes.

In the axial plane ,scanning usually begins at a level just above the seminal vesicle and by sequential withdrawing of transducer in a caudal direction ,the ,mid gland and the apex is visualized.

When scanning the most cephalad areas, the vas deferens will be visualized .They will appear as bilateral round cystic structures .Then the seminal vesicles will come in to view as the vas deferens joins with them superior to the prostate.They usually appear as bow-tie configuration ,but they may be rounded ,lobulated or flattened.

As the level of the base of the prostate ,the prostate appears as asymmetrical crescent shape with triangular postero-lateral margin.The normal prostate will appear hyperechoic to the seminal vesicles and will have a homogenous echopattern .The CZ and TZ can not be individually distinguished by their



echogenicity , however the PZ appears more echogenic with homogenous echotexture .At the level of mid gland ,the prostate becomes ovoid in shape.The anterior fibromuscular tissue is seen and has an echogenicity equal to or less than that of the glandular areas .The apex of the prostate appears more rounded. The obturator internus and levator ani muscles appear as hyperechoic structures lateral to prostate apex .

The prostate is surrounded by hyperechoic layer comprising the prostatic capsule and surrounding fat and fascia .

The normal prostatic urethra is rarely visualized .The advantages of axial scanning include visualization of the left-right symmetry and echotexture,visualization of the anterior lateral portions of the PZ in a single view and assessment the lateral extracapsular spread of carcinoma (Rifkin,1997).

In the sagittal plane ,scanning starts in the midline where the entire prostate can be visualized in one image. The seminal vesicles will be superior and posterior to the base of the prostate , and the vas deferens will be seen anterior to the seminal vesicles.The seminal vesicles will be less echogenic than the prostate and will appear rounded in shape . In the mid line sagittal plane, the hypoechoic peri urethral tissue will be seen and may be difficult to differentiate from the anterior fibromuscular stroma. The rest of the prostate will be homogenous in echogenicity with the PZ slightly more echogenic than the CZ and TZ .

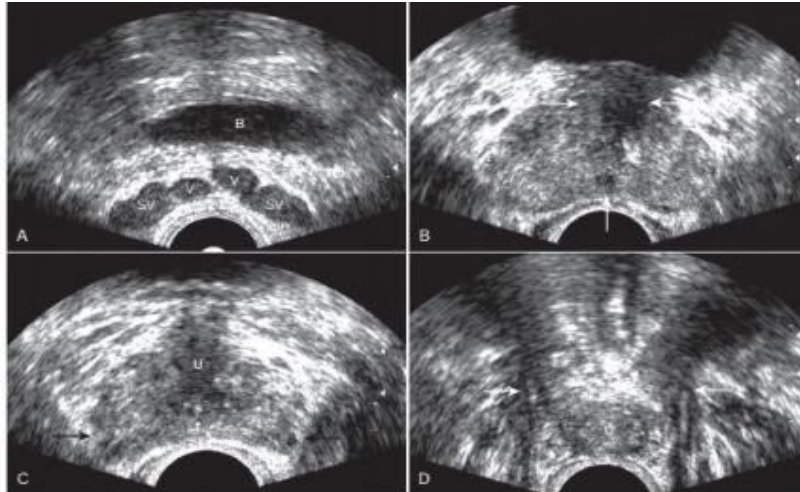
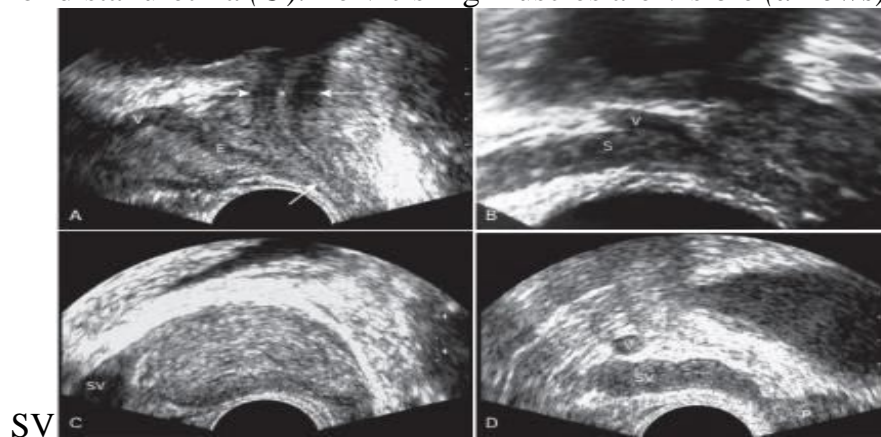


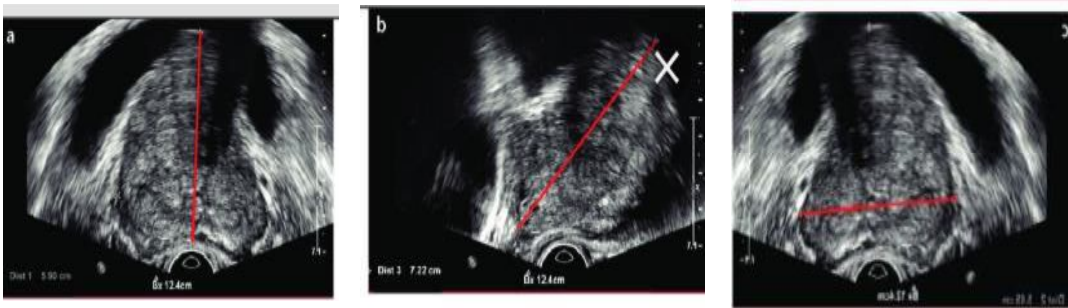
Fig 2-6 Axial sonograms of prostate. A, Transverse image above base shows the seminal vesicles (SV) and vas deferens(V); B, bladder. B, Axial scan at midgland level. Note the normal hypoechoic muscular internal urethral sphincter (*horizontal arrows*) and the ejaculatory ducts (*vertical arrow*). C, Axial scan at lower third of prostate shows hypoechoic urethra (U). Most of the visible gland at this level is peripheral zone. Note the irregular outline at the posterolateral aspects (*arrows*), resulting from the entrance of the neurovascular bundles. D, Axial scan just below apex of prostate shows cross section of distal urethra (U). Pelvic sling muscles are visible (*arrows*).



SV  
 V Fig 2-7 Sagittal views of prostate. A, Midsagittal view shows internal urethral sphincter (*white arrows*), which contains the echogenic collapsed urethra (\*). The ejaculatory ducts (E) course from the vas deferens (V) to the verumontanum (*oblique arrow*). B, Midsagittal view at base shows the vas deferens (V) and adjacent seminal vesicles (S) as they enter the prostate. C, Parasagittal view shows the lateral prostate, which is homogeneous and isoechoic and composed almost totally of peripheral zone tissue; SV, seminal vesicle. D, Parasagittal view above the prostate shows the normal seminal vesicles (SV) and vas deferens (V) in cross section above the prostate (P).

## 2-6 Prostate volume ultrasonography measurements:

In clinical setting measurement of prostate volume via ultrasonography is conducted in several ways namely transperineal (TPUS), transrectal (TRUS), and trans abdominal (TAUS).



**Fig 2-8 Axial(a,c)and sagittal(b) transrectal US images demonstrate measurement of prostate volume by obtain the depth,length and width of prostate respectively**

### 2-6-1 Measurement of prostate volume by using (TAUS):

Assessment of the prostate is an important and integral part of this procedure. Several formulas have been used, but the most common one is the ellipsoid formula, which requires measurement of 3 prostate dimensions. The probe is angled approximately 30 degree 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. Dimensions are first determined in the axial plane by measuring the transverse and anteroposterior dimension at the estimated point of widest transverse dimension.

The longitudinal dimension is measured in the sagittal plane just off the midline because the bladder neck often obscures the cephalad extent of the gland. The ellipsoid volume formula is applied, as follows  $\text{Volume} = \text{depth} \times \text{width} \times \text{length} \times 0.523$

## **2-7 Importance of prostate volume measurements:**

Measurement of prostate volume have become very important clinically since its association with different disease and variables of malignancy . The American Cancer Society found that prostate cancer is one of the most common cancers in men and is getting serious attention from the world as it has become asignificant cause of death every year .

Afew researches reported that prostate volume highly contributes in diagnosis of prostate cancer.These studies show that large prostate volume has an increased risk of malignancy (Evelyn, 2010).

However , another studies with the same scope concluded that prostate gland harbouring carcinoma were significantly smaller than in men men without malignancy. This include the most recent study on relationship between prostate volume and some histological criteria of malignancy which concluded that small prostate volume having weight smaller than or equal to 20g harbors tumors of great malignancy while those of large volume with weight greater than 90g is more often harbors unifocal and low grades tumors.

As the critical size related to malignancy is stated concisely in this study (\_20g\_90g ),it is yet to determine the range of normal volume of prostate since its volume is influenced by so many factors including adiposity, age,body size and frequency of sexual activity. Other than that , previous report also shows that prostate volume may also be influenced by ethnicity and migration .Therefore ,this presents study will investigate the correlation between body weight, height and age to healthy multiethnic sudanese population as an early base line study .

## **2-8 Previous studies:**

Number of studies were carried out to evaluate the volume, weight, echogenicity, texture pathologies of prostate gland.

Study conducted by Ismail Mohammed, carried out in order to know the normal measurements (volume and diameters) of prostate gland in North Kurdistan State. The study was done in Elopeid teaching hospital, police hospital, and Elgla'a, and Wad-elyas health centers, at duration from April to August, 2016. About 92 patients were randomly selected, aged from 18 years and above, whom have no any symptoms related to prostate pathologies. Transabdominal ultrasound scanning by 3.5 MHz probes was performed, and the maximum height, width, and depth of their prostate diameters were obtained, as well as their prostate volumes

The results of this thesis states that the prostate transverse, AP and longitudinal diameters mean values were (3.53) cm, (2.73) cm, and (2.98) cm respectively, the mean prostate volume obtained from the above parameters was  $15.27 \pm 4.7$  ml. The study also concludes that, there is an increase in the prostate volume in relation to increase in the patient's age, weight, and body mass index by 0.09 ml/year, 0.11 ml/kg, and 0.3 ml/kg/m<sup>2</sup> respectively

Moreover the study reveals that the normal prostate has mid-grey level echogenicity, and homogenous in texture (Fudal).

Another study was conducted by Yahya Hassan (2015) which carried out to determine the range of volumes of the prostate gland in adult Sudanese males in our local environment using trans-abdominal ultrasound, and to provide acceptable range of normal prostate gland volumes. Randomly selected fifty asymptomatic adult males were recruited and measurements of the maximum length, height, and width of their prostate gland were obtained and the volumes were calculated. The results of this thesis were

stated as follow: a transverse, AP, and longitudinal diameters mean values were (2.68)cm, (3.56)cm, and (3.02)cm respectively, the mean prostate volume obtained from the above parameters was 15.24ml. Also the findings show that prostate volume increases linearly with body weight and age (Abdallah, 2015).

Also there was another thesis which was conducted to measure the normal prostate among Sudanese patients above fifty years old by using transabdominal ultrasound. The study includes 100 cases aged from (50 to 89) years, with different complaints. The results of this study shows that the accuracy of ultrasound in prostate measurements and diagnosis is up to 95%, and it's improved due to the use of more effective machines with better resolution. Also the study reveals that a well preparation is a significant factor to obtain good results, and that the ultrasound findings are critically depends on the examiner training and experience. Moreover, the patient's age and prostate size, and that there is an inverse relation between the patient's height and the size of prostate (Anwar, 2010).

Moreover, we have this thesis which was also carried out in order to assess prostate volume measurement using trans-abdominal ultrasound scanning. In this study, 100 subjects from age 20 to 25 years old were selected to undergo trans-abdominal scans. The subjects were randomly selected with different height and weights. The subjects were the students whom do not have any bad habits like smoking and drinking. The subject's weight, and heights were measured and their body mass indexes were calculated, as well as their prostate volumes. The results of this thesis conclude that ultrasound is an easy and save way to measure the prostate size. In addition to that the results stated that there is an increase in the prostate volume by increasing the weight, or height of the patient. And finally as this thesis concentrates

on body mass indexes,the resut find out that the volume of the prostate increases in relation to increase in body size(Skadu,Malysia,2012).





# **Chapter Three**

## **Materials and Methods**

## **Chapter Three**

### **Materials and Methods**

#### **3-1 Materials:**

##### **3-1-1 Patients and Sampling:**

This is a descriptive study conducted in Khartoum state in order to state the volume of normal prostate gland in adult Sudanese males. This study was carried out in Teaching Bashair hospital, Hilat Kuku health centre and other hospitals and health centers in Khartoum state

This study was conducted in duration from August to December (2018). This study involve 80 patients whom reffered for abdominal US scan in Khartoum state ,who were have not complain or symptoms related to prostate gland pathology.

Any patients were have any symptoms of prostate diseases, pediatric ages, who are known cases of prostate diseases and patients have remnant prostate(after prostatectomy) were excluded from this study.

##### **3-1-2 Machines:**

This study was conducted by using Sefius-UF-890AG-FUKUDA DENSHI Ultrasound machine, which has three probes, and MINDARY Digi prince DP-6600 , the probe used in this study was convex probe with frequency of 2-5 MH. Moreover measurement equipments for the patient's height and weight were used

.The US departments were with full facilities and coupling gel.



Fig (3-1) Sefius-UF-890AG-FUKUDA DENSHI Ultrasound Machine

### **3-2 Methods:**

#### **3-2-1 Technique:**

##### **Transabdominal technique:**

The patient lies supine. The patient should have a half full bladder. 500 ml of water 1hr before the scan, if possible, is recommended. The probe is angled approximately 30 degree 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. Enough amount of gel is poured on the anterior part of pubic region. Sagittal and transverse scanning is then performed to assess the entire prostate in many planes.



**Figure (3-2) TAUS technique for normal prostate (Ultrasound pedia, 2014)**

### **3-002-2 Measurements:**

The volume of prostate was obtained by measuring the three dimensions of the prostate, depth and width of prostate obtained in transverse scanning and length in longitudinal scanning.

Some machines used in this study were automatically give the prostate volume after the measurement of the three prostate dimensions, and other volumes obtained by using the ellipsoid volume formula, as follows: Volume = depth x width x length x 0.523

### **3-2-3 Data collection methods:**

The data of this thesis is collected by using special data collection sheet, which contains eleven variables, divided into two parts: personal data, and sonographic findings. These data were collected in the following ways The personal data consists of five variables: patient's number, age, height, weight, and marital status. The patient's age, and marital status were picked up from the patient by direct questions to him (after taking a permission), and this process is done by the doctor in the office, the radiologist, or the technologist. After completing the scan the patient is sent to a nurse so as to complete the other two variables which are the height, and the weight. The

nurse do this by using an equipment that measures the weight automatically when the patient stand on it, but the height is calculated manually by another tool found in the same equipment

The sonographic finding data includes six variables which are: the depth, width,length,volume, echogenisity, and texture of the prostate gland. These variables are taken also by the radiologist or technologist from the US machine while they were doing the scan, also after the patient has been informed and agree of it .

#### **3-2-4 Data analysis and presentation:**

Data were analyzed using statistical packaged for social studies (spss).Various statistical tests were used according to the type of variables to be interpreted, the data were presented in tables and figures.

#### **3-2-5 Ethical consideration:**

Patient's data were requested by clinicians, the data was collected from those who had been sent to the ultrasound examination or who are selected for evaluation of the prostate .

Permission were take from patients and head managers of the hospital before the beginning of collecting data ,also the patients get sure that their details will not be exposed and no personal data will be published.

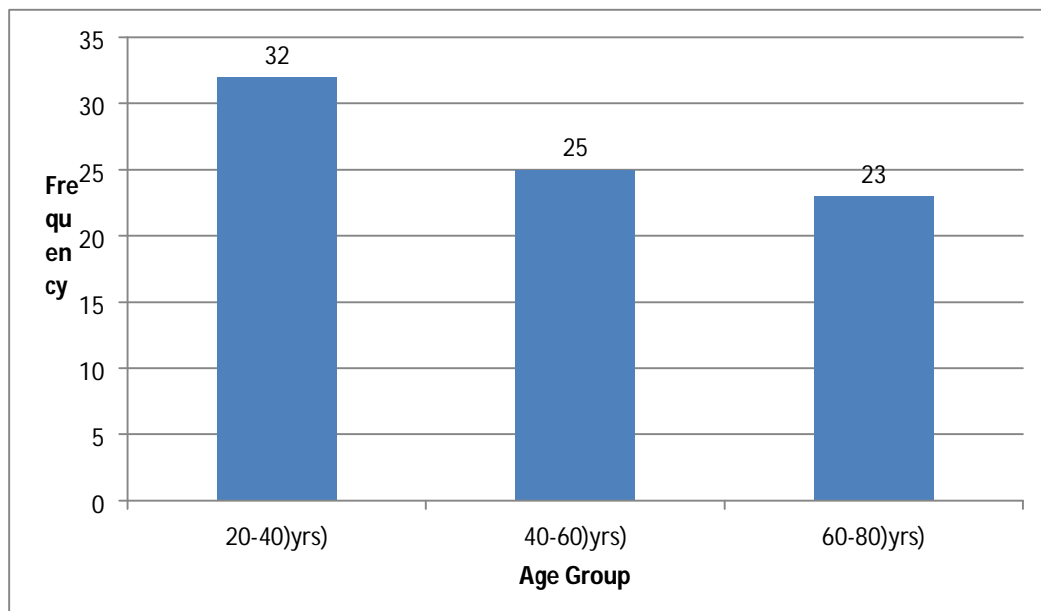


# **Chapter Four**

## **Results**

**Table(4-1) shows the subject's age groups**

40.60%	32	20-40)yrs)
30.50%	25	40-60)yrs)
28.90%	23	60-80)yrs)
100%	80	Total

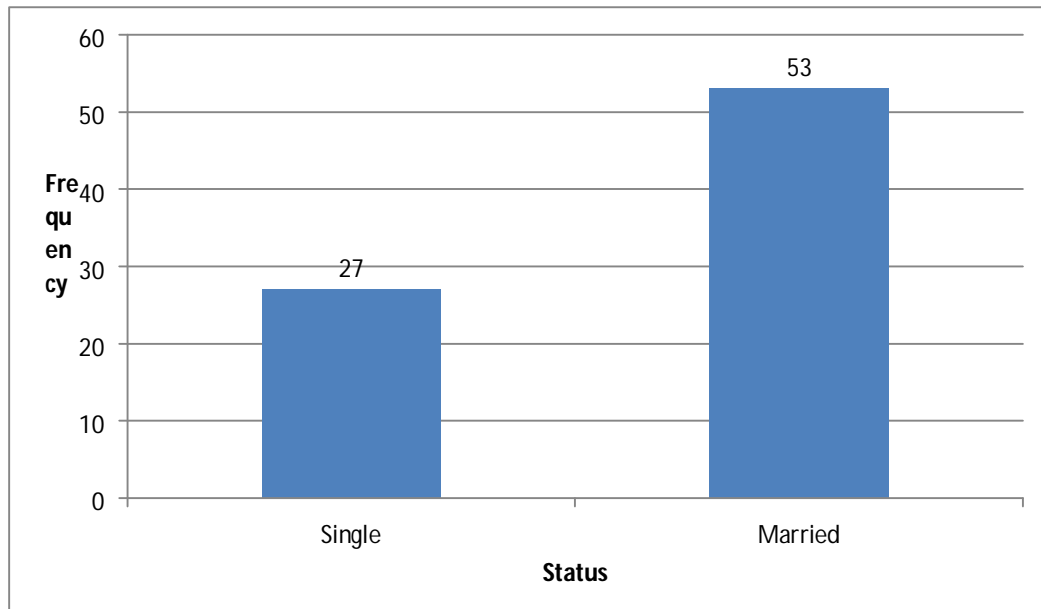


**Figures(4-1) Illustration of subject's age**



**Table( 4-2 ) shows the subject's marital status**

<b>Status</b>	<b>Frequency</b>	<b>Percentage</b>
Single	27	<b>33.8%</b>
Married	53	<b>66.3%</b>
Total	80	<b>100.0%</b>



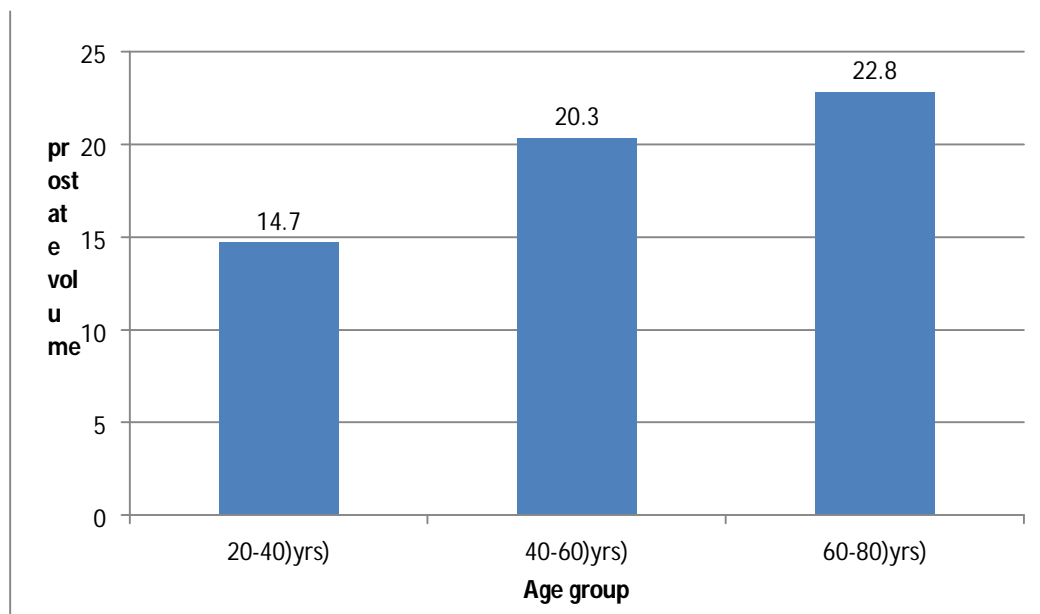
**Figure (4-2) Description of subject's marital status**

**Table(4-3) shows the minimum,maximum,mode,median,SD ,range and Mean value of prostate depth,width ,length and volume**

Prostate	Mean	Median	Mode	Std.	Minimum	Maximum	Range
				Deviation			
Volume	18.771500	16.700000	20.7000 <sup>a</sup>	6.7112998	8.8000	29.1000	26.8000
Depth	2.952125	2.895000	2.4000	0.4945467	2.0400	3.9800	1.9400
Width	3.748875	3.720000	3.3000 <sup>a</sup>	0.5573309	2.7000	5.3200	2.6200
Length	3.145875	3.215000	3.4000	0.4930471	2.0700	4.1000	2.0300

**Table(4-4) shows the prostate volume mean of age group**

Age Group	Mean of age	Mean of prostate volume
20-40)yrs(	27.5	14.7
40-60)yrs(	47.1	20.3
60-80)yrs(	68.5	22.8



**Figure (4-3) demonstrate the mean prostate volume of age group**

**Table (4-5) demonstrate the mean prostate volume of single and married patients**

<b>Marital status</b>	<b>Mean of prostate volume</b>
Single	14.9
Married	20.7

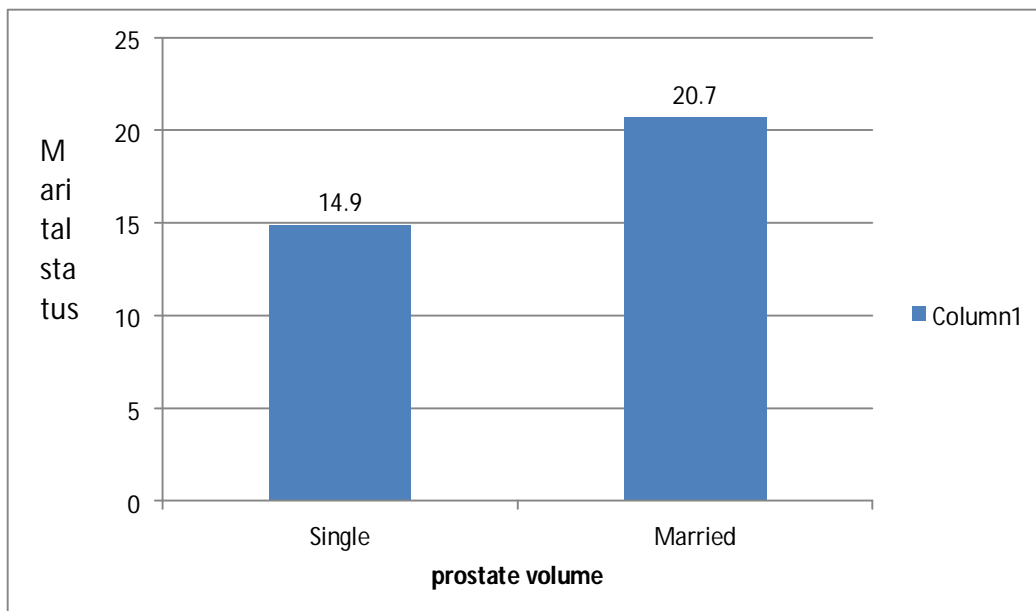


Fig (4-4) shows marital status distribution

**Table(4-6) express the positive relationship between the patient's age and prostate volume Correlations**

		Volume	Age
volume	Pearson Correlation	1	.489**
	Sig. (2-tailed)		.000
	N	80	80
Age	Pearson Correlation	.489**	1
	Sig. (2-tailed)	.000	
	N	80	80

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

**Model Description**

Model Name		MOD_1
Dependent Variable	1	Volume
Equation	1	Linear
Independent Variable		Age
Constant		Included
Variable Whose Values Label Observations in Plots		Unspecified

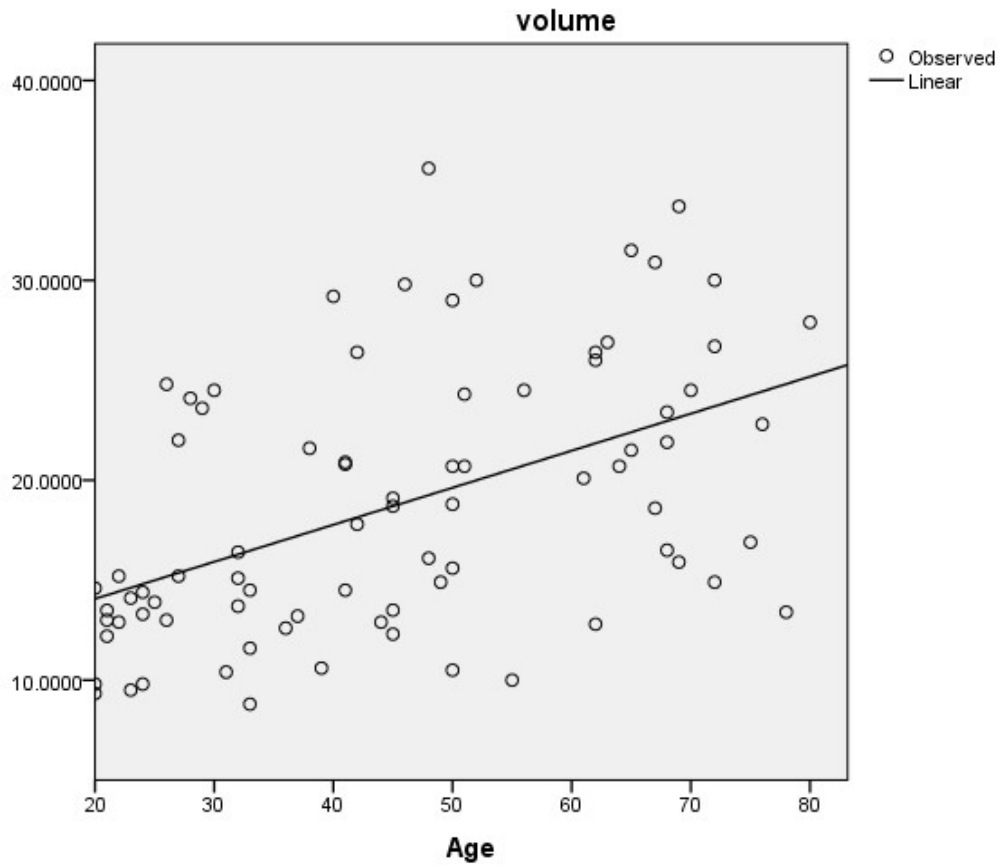
**Model Summary and Parameter Estimates** Dependent Variable: volume

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.239	24.456	1	78	.000	10.362	.185

The independent variable is Age.

From the above table a linear relationship equation between Age and prostate volume can be estimated as follows:  $PV=0.185A+10.362$ .....(1)

Whereas ; **PV**= Prostate volume **A**= age



**Figure(4-5) shows scatter plot expressing the linear relation between the patient's age and prostate volume**

### Correlations

Table(4-7) Model express the positive linear relationship between the patient's weight and prostate volume

		Volume	Weight
volume	Pearson Correlation	1	.466**
	Sig. (2-tailed)		.000
	N	80	80
Weight	Pearson Correlation	.466**	1
	Sig. (2-tailed)	.000	
	N	80	80

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

### Model Description

Model Name	MOD_1	
Dependent Variable	1	Volume
Equation	1	Linear
Independent Variable		Weight
Constant		Included
Variable Whose Values Label Observations in Plots		Unspecified

### Model Summary and Parameter Estimates

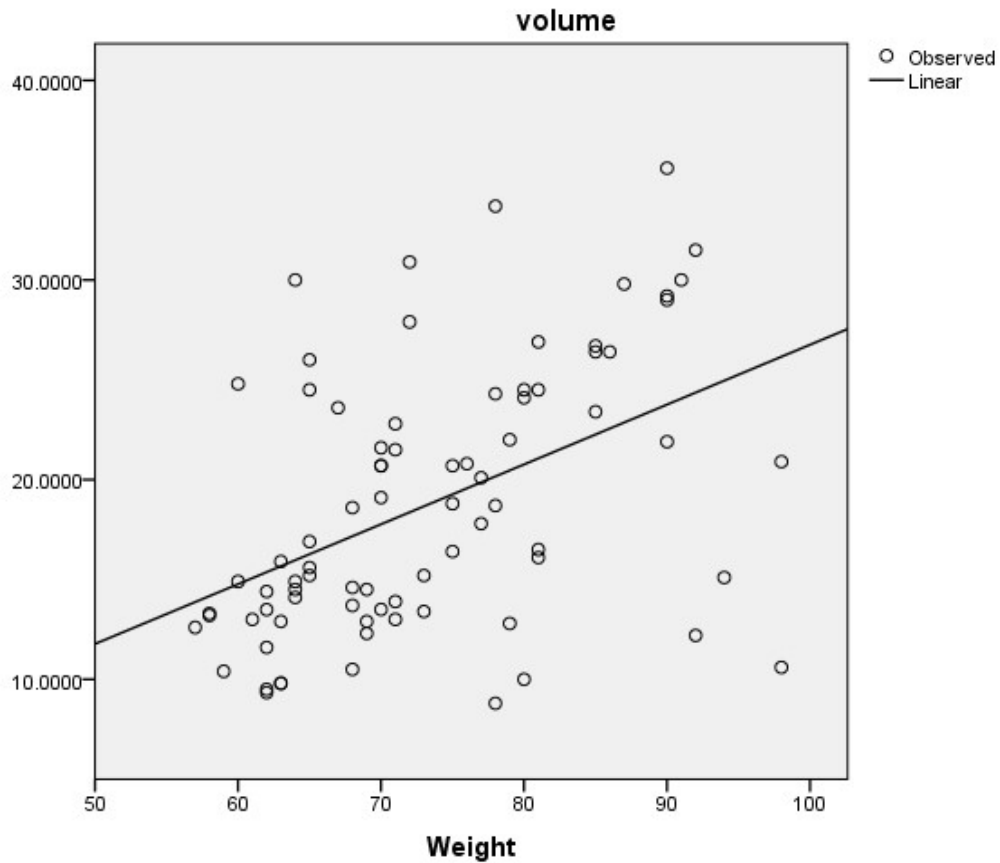
Dependent Variable: volume

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.217	21.594	1	78	.000	-3.213-	.300

The independent variable is Weight .

From the above table a linear relationship equation between Weight and prostate volume can be estimated as follows:  $PV=0.3w - 3.213$ .....(2)

Whereas ;  $PV=$  Prostate volume  $W=$  weight



**Figure (4-6) shows scatter plot expressing the linear relationship between the patient's weight and prostate volume**



### Correlations

Table(4-8) express the positive linear relationship between the patient's height and prostate volume

		volume	Height
volume	Pearson Correlation	1	.387**
	Sig. (2-tailed)		.000
	N	80	80
Height	Pearson Correlation	.387**	1
	Sig. (2-tailed)	.000	
	N	80	80

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

### Model Description

Model Name		MOD_2
Dependent Variable	1	Volume
Equation	1	Linear
Independent Variable		Height
Constant		Included
Variable Whose Values Label Observations in Plots		Unspecified

### Model Summary and Parameter Estimates

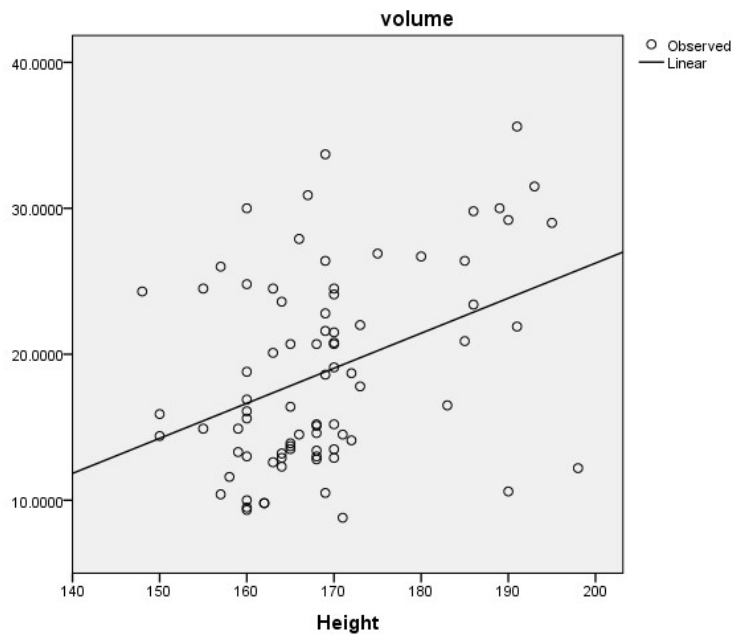
Dependent Variable: volume

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.150	13.735	1	78	.000	-21.778	.240

The independent variable is Height.

From the above table a linear relationship equation between Height and prostate volume can be estimated as follows:  $PV=0.24H - 21.778$ .\_\_\_\_\_ (3)

Whereas ;  $PV$ = Prostate volume  $H$ = Height



**Fig (4-7) shows scatter plot expressing the linear relationship between the patient's height and prostate volume**

### Correlations

Table(4-9) represent t test result shows the effect of marital status in prostate volume

		volume	Marital status
Volume	Pearson Correlation	1	-.401 <sup>**</sup>
	Sig. (2-tailed)		.000
	N	80	80
Marital status	Pearson Correlation		1
	Sig. (2-tailed)	.000	
	N	80	80

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

### Model Description

Model Name		MOD_3
Dependent Variable	1	Volume
Equation	1	Linear
Independent Variable		Marital status
Constant		Included
Variable Whose Values Label Observations in Plots		Unspecified

### Model Summary and Parameter Estimates

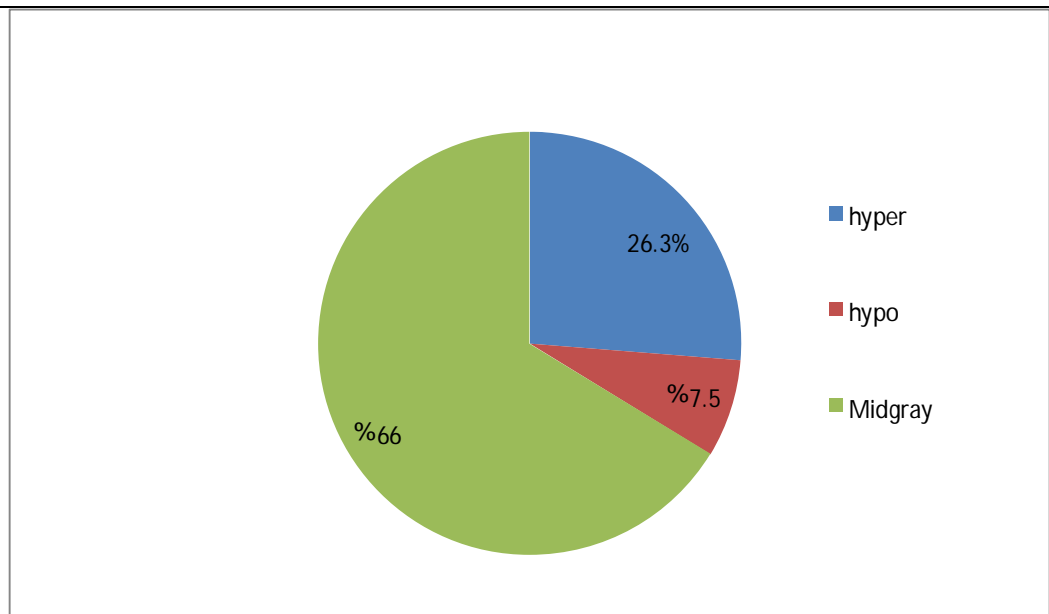
Dependent Variable: volume

Equation	Model Summary					Parameter Estimates	
	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.171	16.121	1	78	.000	9.067	5.837

The independent variable is Marital status.

**Table (4-10) shows the frequency distribution of prostate echogenicity**

Echogenicity	Frequency	Percent
Hyper	21	<b>26.3</b>
Hypo	6	<b>7.5</b>
Midgray	53	<b>66.3</b>
Total	80	<b>100.0</b>



**Figure(4-8) shows the distribution of prostate echogenicity**

**53 (66.3%) of participants were Normal echogenicity (midgray) prostate ,21(26.3% ) were Hyperechoic,while 6(7.5%) of them appeared Hypoechoic**

**Table(4-11) shows the frequency of distribution of prostate texture**

<b>Texure</b>	<b>Frequency</b>	<b>Percent</b>
Hetro	12	<b>15.0</b>
Homog	68	<b>85.0</b>
Total	80	<b>100.0</b>

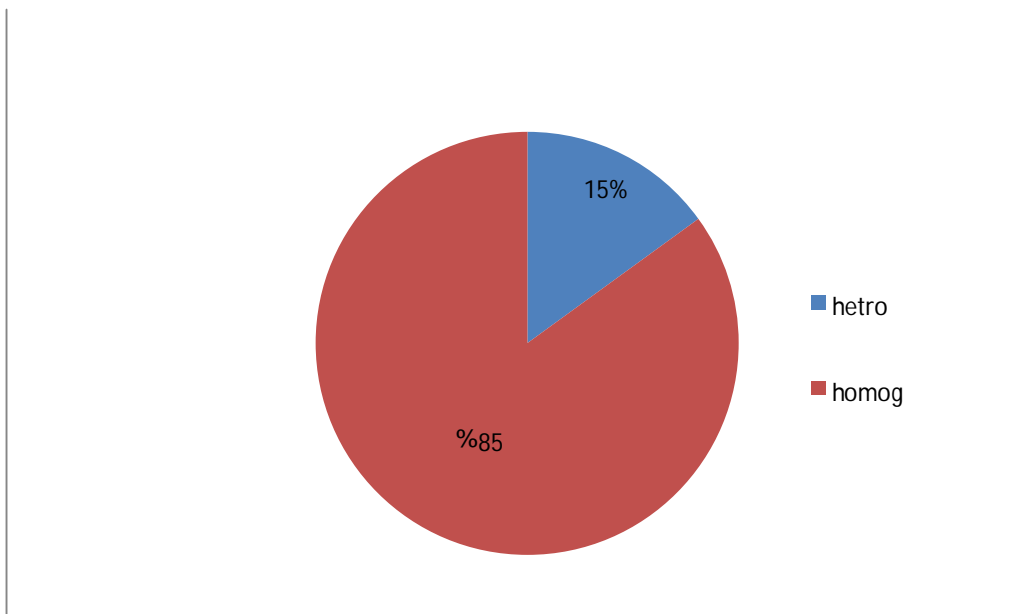


Figure (4-9) shows the distribution of prostate texture, expressing that most 68 (85%) of participants were homogenous, while 12 (15%) of them were heterogenous



# **Chapter five**

## **Discussion, conclusion, and Recommendations**

## Chapter five

### Discussion, conclusion, and recommendations

#### 5-1 Discussion :

The main purpose of this thesis was to identify the normal measurements of the prostate gland (volume, and dimensions) in adult sudanese males using trans-abdominal ultrasound, and to state these measurements in relation to their individual characteristics. So about 80 patients were selected randomly, who have no any complains related to prostate pathology. The results of this thesis found out the following :

The mean values of prostate depth,width and length were (2.9), (3.7) and (3.1) cm respectively, the mean prostate volume obtained from the above parameters was  $18.7 \pm 6.7$ ml this mean ranges from (8.8- 29.1) ml. These results agree with (Abdallah,2015),(Fudal, 2016) studies.

Regarding the age group (20-40y) ,(40-60) and (60-80) study found that mean prostate volumes were (14.7),(20.3) and (22.8) respectively table(4-4). Also the results confirmed that there is positive linear relationship between the age of patients and their prostate volumes fig. (4-5), expressed in table(46) by the following equation:

$$PV=0.185A+ 10.362. \text{-----}(1)$$

Whereas ; **PV**= Prostate volume **A**= age . This positive relationship is expected because aging is main risk for prostate enlargement BPH as mentioned. And this result agrees with all previous .studies

Moreover there is also another positive linear relationship between the prostate volume and patient's weight Fig. (4-6),this relation demonstrated in table(4-7) by thefollowing equation: **PV**=0.3w - 3.213. \_\_\_\_\_(2)



Whereas ; **PV**= Prostate volume **W**= weight

This positive relationship is also expected because an increase in patient weight increases fats concentration in the body, which were the main source of steroid hormones that influence the growth of the prostate gland. Also this result agrees with all previous studies .

Concerning to the relation between the height of the patient and the patient's prostate volume, there is also linear relationship Fig. (4-7), this relation presented in table(4-8) by the following equation:  $PV=0.24H - 21.778$ .\_\_\_\_\_ (3)

Whereas ; **PV**= Prostate volume **H**= Height

Relating to the effect of marital status on the prostate volume, we find that see table (4-2), the married patients were 53 persons, and the single ones were 27 persons, and that the mean prostate volumes for both were 20.7, and 14.9 respectively table(4-5). And that the difference in means between them is 5.8. We use T- test to test the difference in means between these two mean groups and the results tell us that there is significant difference see table (4-9) . So, we can conclude that marital status has an effect in the prostate volume among this population.,and the result found out the prostate volume increase more in married patients than in single ones,table ( 4-9)

Regaroin the echogenicity and texture of the prostate gland the results reveals that, Table (4-10), and Fig. (4-8)shows the echogenicity of 53patients (66%) have normal echo's, 6 patients (7.5%) were hypo-echoic, and 21 of them (26.3) were hyper-echoic. And table (4-11), and Fig. (4-9) shows the texture of 68 patients (85%)have homogenous texture, and 12 patients (15%) have hetrogenious texture. So we can state that from the results the most of participant's prostate was normal(midgray) in echogenicity ,and homogenous in texture.

## 5.2 Conclusion:

This study shows that using transabdominal approach is an easy simple way of prostate measurement. Hence this method can be used a standard screening method for imaging prostate. Therefore, transrectal scanning can be used only when necessary or when ambiguity is present during transbdominal scanning.

This study found out the following:

- The mean values of prostate depth,width and length were (2.9), (3.7) and (3.1) cm respectively.
- The mean prostate volume obtained from the above parameters was  $18.7 \pm 6.7$ ml
- ) study found that mean prostate volumes of the age group (20-40y) ,(40-60) and (60-80 were (14.7),(20.3) and (22.8) respectively .
- The mean prostate volume of single and married participants were 20.7, and 14.9 respectively

This study also found out that prostate volume increases linearly with subject's parameters like age, weight ,height and affected by marital status of patient, the study showed the prostate volume increase more in married patient than in single one.

### **5-3 Recommendations:**

From the results of this study the researcher recommended:

- Further studies needed to show the relationship between prostate volume and ethnicity by categorizing each subject to his ethnicity background to observe differences of prostate Volume between Sudanese population , for example western , northern , eastern and median population
- More specific researches of prostate volume for single males with their other factors like age,tribe,personal habits (alcohol, smoking, coffee intake, environmental factors.
- Also more specific researches of prostate volume for married males with related factors likes tribe,work, ,residence ,sexual activity,years of marriage, and number of children.
- Using TRUS and Doppler ultrasonography ,specialy in patient with enlarge d prostate volume to detect early stage of prostate cancer .
- Other researches needed for detection of prostate pathology by using ultrasound .
- In this study there were frequent ultrasonographic findings like calcifications from amyloseous bodies ,and periurethral cysts so, other researches needed to concentrate in prostate echogrnicity and texure
- In order to improve the image quality, the patients should be well prepared, and the ultrasound machines should be well adjusted to have better .resolution,and the sonologists should be appropriately trained and their results subjected to rigorous audit.

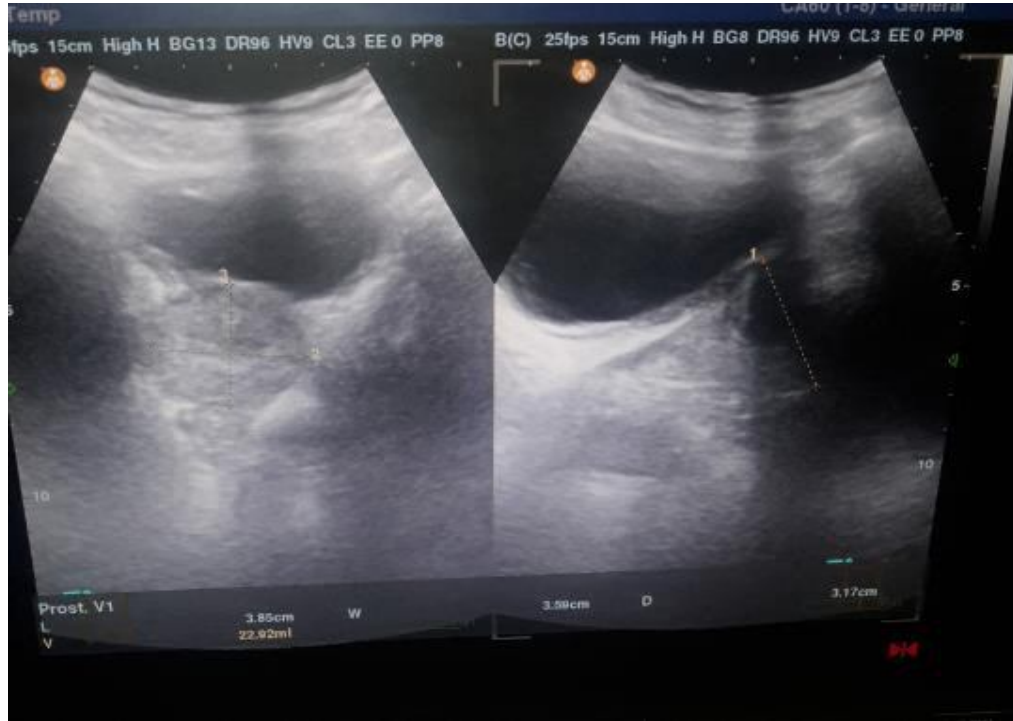
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## **Appendices**

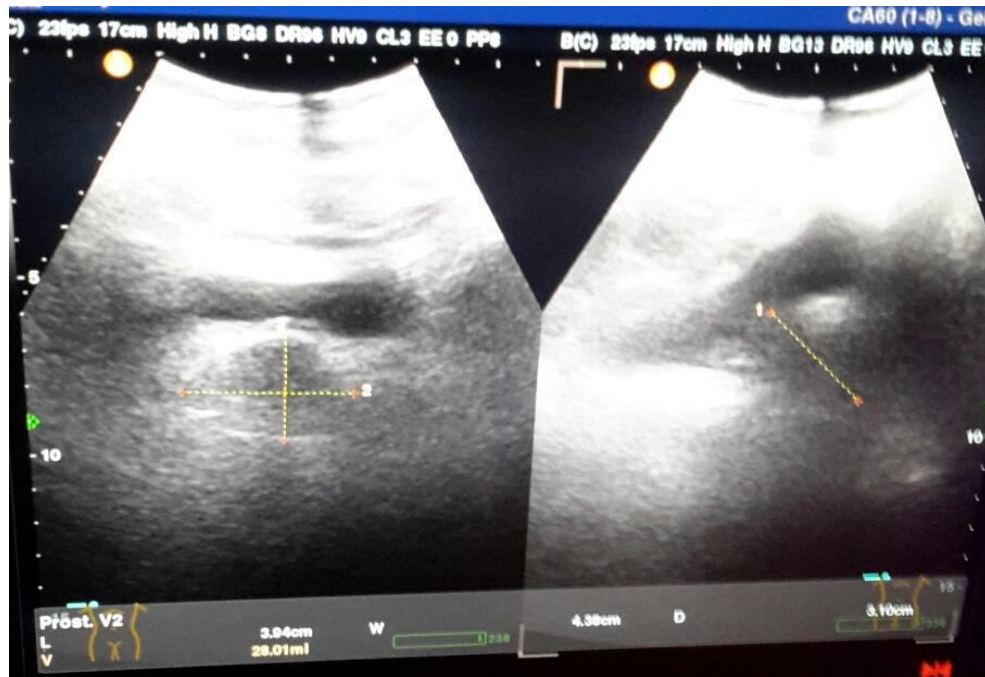


**Image (1) image for married patient,68year old,70Kg,160cm ,and 22.92ml prostate volume**

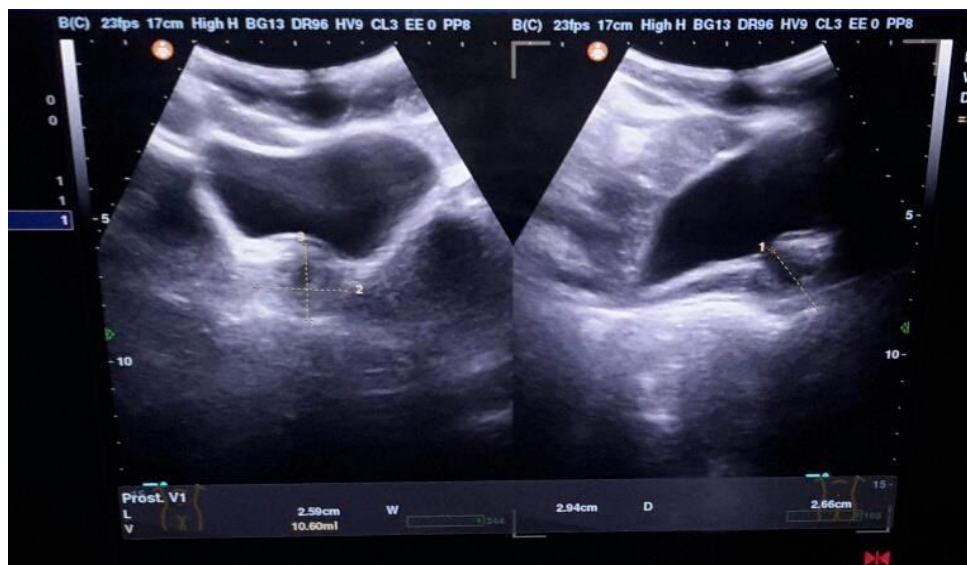


**Image (2) for single patient, 23 years old, 65 Kg,163 Cm, and 10.97 ml prostate volume**





**Image (3) image for married patient 72 year, 68Kg, 165Cm ,and 28.01ml prostate volume**



**Image (4) image for single patient,70Kg,183 Cm,and 10.6ml prosattae volume**





