Sudan University of Science and Technology

College of Graduate Studies

Measurement of Prostatic Gland Size in North Kurdfan State Using Ultrasound

قياس حجم غدة البروستاتا في ولاية شمال

كردفان باستخدام الموجات فوق الصوتية

Thesis Submitted for Partial Fulfillment of M.sc Degree in Medical Diagnostic Ultrasound

:By

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2016

الاية

قال تعالي:

((قالوا سبحانك لا علم لنا الا ما علمتنا انك انت العليم

الحكيم))

صدق الله العظيم

سورة البقره

الايه 32

Abstract

This is a descriptive study, carried out in order to know the normal measurements (volume and diameters) of prostate gland in North Kurdfan 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. Trans-abdominal 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± 4.7ml

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 indeces by 0.09 ml/year, 0.11
ml/kg, and 0.3 ml/kg/m^2 respectively.

Moreover the study reveals that the normal prostate
has mid-grey level echogenicity, and homogenious in
texture.

ملخص البحث

اجريت هذة الدراسة الوصفية من اجل معرفة الحجم الطبيعي لغدة البروستاتا وكذلك

قياس الطول والعرض والارتفاع لهذة الغدة لدي الرجال البالغين بولاية شمال كردفان.

اجريت هذة الدراسة بمستشفي الابيض التعليمي , ومستشفي الشرطة , وكذلك

بمركزي القلعة وود الياس الصحيين , في الفتره من ابريل الي اغسطس 2016م. تم

اخذ عدد 92 حاله عشوائيا , من عمر 18 سنة فما فوق , بعد التاكد من عدم معاناتهم

من اي اعراض متعلقة بامراض البروستاتا. وتم فحصهم بالموجات فوق الصوتيه علي

منطقة العانه, وبهذه الطريقه تم اخذ الابعاد القياسية لغدة البروستاتا وكذلك حجمها.

وجدت الدراسة ان متوسط الابعاد لهذه الغده هوللطول 2.73سم والعرض 3.53سم

اما الارتفاع 2.98سم , وان متوسط حجم هذه الغده طبقا لهذه الابعاد هو 15.27±

4.7سم مكعب.

واثبتت الدراسة كذلك ان حجم غدة البروستاتا يزيد بزياده بعض العوامل المتعلقه

بالشخص كالعمر والوزن ووزن الجسم الكلي للاشخاص بنسب متفاوته 0.09مل لكل

سنه , و 0.11مل لكل كيلوجرام , و 0.3مل لكل كيلوجرام\مربع الطول.

واثبتت الدراسه ايضا ان غده البروستاتا الطبيعيه متجانسه وبدرجة متوسطة

الرماديه.

DEDICATION

**To the soul of my father and mother
To my lovely wife**

To my sweet heart kids (M, and M)

To my brothers Tariq, Nor-Eldin, and Osama

To my colleagues

To the staff of M.sc degree of US in Sudan university

To the all workers, tea makers, library staffs, volunteers, and anyone in this colledage for their cooperation and help.

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To my god for giving me a health to complete this thesis and still giving me more and more.

To our staff of M.sc degree for their efforts all through the duration of study.

Special thanks and gratefulness to my supervisor Dr. Asmaa Ibrahim Ahmed Alamin for her advices and guidance.

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List of abbreviations

AJCC...................American Joint Committee on Cancer

AUA................... American Urological Association

BPH...................Benign prostatic hyperplasia

CP/CPP.............. Chronic prostatitis/ chronic pelvic pain syndrome.

CZ .... Central zone

DRE....................Digital per rectum examination

EDOs....................Ejaculatory duct obstructions

HIV.................... Human immunodeficiency virus

IPCN.................International Prostatitis Collaborative Network.

LUTS................. Lower urinary tract symptoms

MHz...................Mega-hertz

NIDDK...............National Institute of Diabetes and Digestive and Kidney Diseases.

NIH...................National Institutes of Health

NKS.................... North Kurd fan State

NSAIDs..............Non-steroidal anti-inflammatory drugs.

PSA...................Prostate specific antigen.

PZ.....................Peripheral zone.

TAUS................ Tarns-abdominal ultrasound.

TNM....................Tumor-Node-Metastasis.

TRUS.................Trans-rectal ultrasound.

TUUS.................Trans-urethral ultrasound.

TURED................Transurethral resection of ejaculatory ducts.

US.....................Ultrasound.

Chapter one

Chapter one

Introduction

1-1: **Introduction**:

The prostate is a compound tubule-alveolar exocrine gland of the male reproductive system in most mammals. It differs considerably among species anatomically, chemically, and physiologically (Jarble, 2008).

In humans the prostate is an unpaired accessory

structure of a male reproductive system that surrounds the urethra (prostatic urethra) in the pelvic cavity (Drake, 2005). It's shaped as an upside-down truncated cone with the base of the gland above related to the urinary bladder, and an apex inferiorly, and four walls, anterior wall, posterior wall, and two inferiolateral walls (Ryan, et.al, 2007).

Structure of the prostate (see page.6) is described traditionally as having five lobes anterior, posterior, median, and two lateral lobes. But more usefully the gland is described based on its internal architecture as having three glandular zones (peripheral, central, and transition) with the non-glandular isthmus anteriorly (Ryan, et.al, 2007).

The normal size of the gland varies according to so many recourses: while it's 20gm in young, more than 40gm is Benign prostatic hypertrophy (Rumack, et.al, 2011), or the mean weight is 11gm ranging from (7-16)gm (Jarble, 2008), it's in some books up to 25gm (Hofer et.al 1999) etc.... More over as the prostate volume is calculated with the "oblate spheroid" formula: volume = $0.5236 \times (W \times AP \times L)$, where W; is the maximal transverse width (right to left), AP; is the anteroposterior plane (anterior midline to rectal surface), and L; is the length (maximal head to foot) (Rumack, et.al, 2011). Again there is also variations in the values of these above mentioned three dimensions; while in some recourses these dimensions were 3.5 x4.5 x 3.5 (Block, 2004), or 4 x 3 x 2 (Sinnatamby, 2004), they were 3 x 3 x 5 in others (Hofer et.al 1999) etc....Prostate volume can be converted to prostatic weight because the specific gravity of the prostate tissue is about 1, thus 1cc (1ml) is equivalent to

.(1gm (Rumach, et.al, 2011

Estimation of prostatic gland size can be carried out clinically by doing digital per-rectal examination (DRE), or by trans-rectal US (TRUS), both of which are harmful techniques, and many patients get empresses from it, and may refuse them, moreover trans-urethral US (TUUS) is a useful technique but it's invasive and not widely used. So this study will help to respect trans-abdominal US (TAUS) as more practical, more acceptable and accurate

technique. As well as it will helps to put a reference values

.for normal dimensions and volumes of the prostate in NKS

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

The prostate volume measurement is frequently used
to diagnose the abnormalities of the gland. But, as
mentioned earlier in this chapter the normal size of the
gland itself might reveals variations in overlap regions, in
addition to that the gland volume is affected by so many
factors (age, weight, hormones etc…)**.** Therefore we are in
need for estimation of prostate size based on patient's

.characteristic so as to be as local reference

:**Objectives** :1-3

:**General objective** :1-3-1

The main purpose of this study is to identify the
normal measurement of the prostatic gland in North

.Kurdfan State peoples

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

- To establish standard measurements of the prostate gland in normal adults by trans-abdominal ultrasound.

- To identify the relation between the prostate size and individual's age.

- To correlate measurements of the gland with height, weight, and body mass index of the patient.

- To identify texture and echo-pattern of normal prostate size.

- To test the effect of patient's age, height, weight, and marital status collectively on the prostate gland size.

4-1: overview of the study:

This study is concerned with the normal measures of the prostate gland by using trans-abdominal ultrasound, accordingly it falls into five chapters: chapter one is an introduction which includes: brief anatomy, the problem, the objectives of study and the overview. Chapter two includes: detailed background about the anatomy, and sonogram of the gland as well as the literature review. Chapter three deals with the material and methods used to conduct this study. Chapter four illustrates the results using figures and tables. And finally chapter five presents discussion, conclusion, and recommendations of the study followed by references and appendices.

Chapter

two

Chapter two

Literature review

:Prostate anatomy :2-1

:Prostate development :2-1-1

The prostate gland develops as (30-40) individual complex glands, which grow from the urethral epithelium into the surrounding wall of the urethra. Collectively, these glands enlarge the wall of the urethra into what known as the prostate (Drake, 2005). The pelvic part of the endodermic urogenital sinus gives rise to lateral epithelial buds which become the prostatic acini of the peripheral zone. Dorsal out growths from above the level of entry of the mesonephric ducts from the acini of the central zone. The fibromuscular stroma develops from the surrounding mesenchyme (Sinnatamby, 2004).

:Shape and location :2-1-2

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 (Bulter, 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 the 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

:Structure of prostate :2-1-3

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 is
composed mainly of fibro-muscular fibers, and contains
little if any glandular tissue, a posterior lobe which is
posterior to the urethra and inferior to the insertion of the
ejaculatory ducts, a median lope between the urethra and
the ejaculatory ducts, 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 (Fig.2-1) with the non-glandular isthmus anteriorly (Ryan,et.al,2007) so as the following: the central zone comprises approximately 25% of glandular tissue, resistant to diseases, and it's a midline wedge at the base of the prostate between the peripheral and transitional zones, the peripheral 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, consists of two small glandular areas adjacent to the proximal urethral sphincter, 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

Histologically, the prostate is a compound tubuloalveolar organ, which, in one plane of section,

presents small to fairly large glandular spaces lined by epithelium. Characteristically, the glands are lined by two layers of cells: a basal layer of low cuboidal epithelium covered by a layer of columnar secretory cells. In many areas, there are small papillary inbuddings of the epithelium. These glands all have a distinct basement membrane and are separated by an abundant fibromuscular stroma (Vinay.et.al, 2005).

The prostate is contained within a sheath or false capsule derived from pelvic fascia. This sheath is composed of smooth muscle, skeletal muscle, and loose connective tissue, penetrated by numerous vessels and nerves (Ryan, et.al, 2007).

4-1-2: 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 its posterior wall is a longitudinal ridge called the urethral crest, on each side of these ridges is a groove called the prostatic sinus, the prostatic glands open into these grooves. On the summit of urethral crest is a depression, the prostatic utricle, which is an analog of the uterus and vagina in females. On the edge of the mouth of the utricle

are the openings of the two ejaculatory ducts (Snell,

.(1995
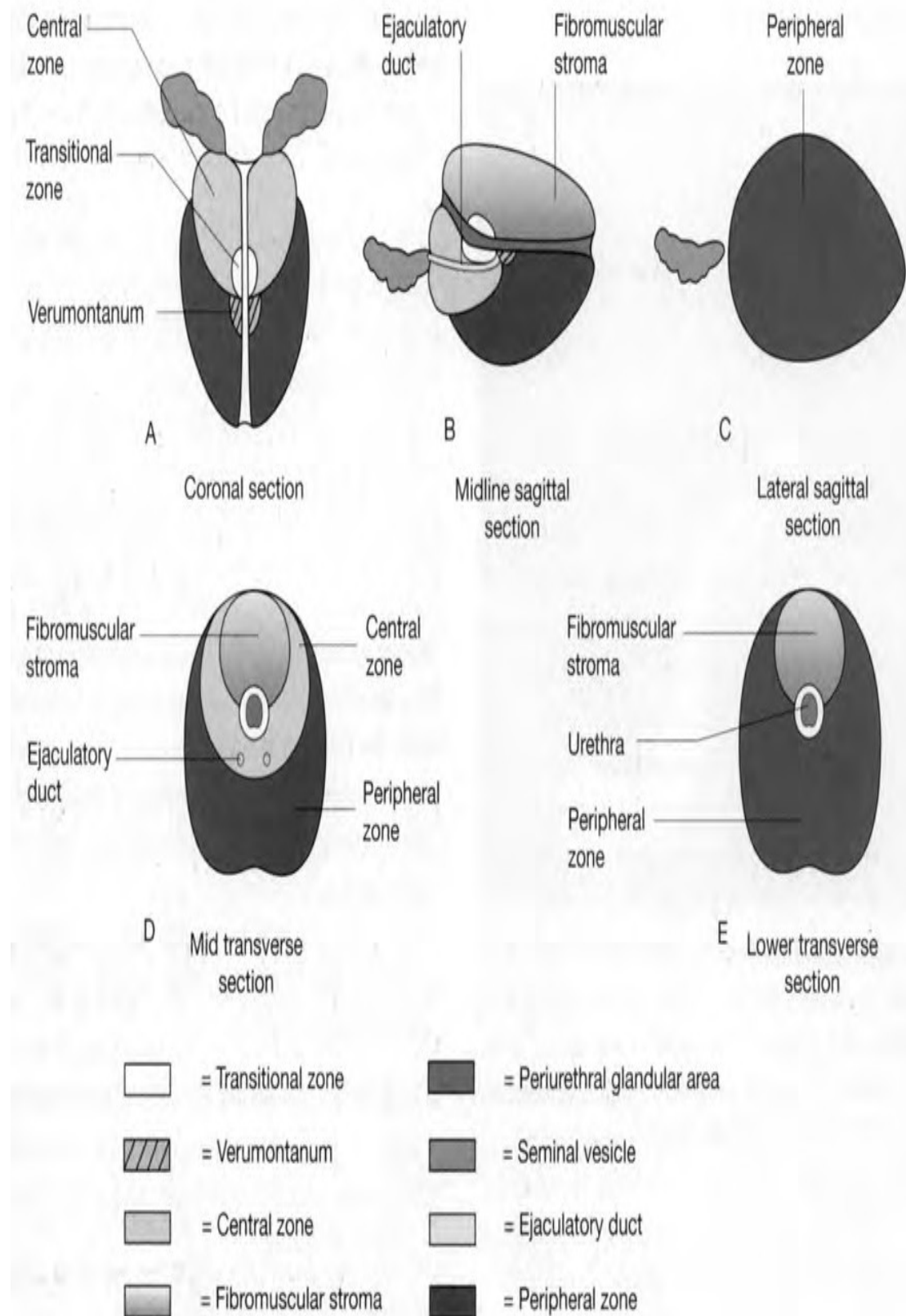
Fig (2-1): shows zonal anatomy of the prostate (Ryan, et.al, 2007).

Periurethral glands: 2-1-5:

Comprise1% of glandular tissue, also it's the tissue that lines the prostatic urethra (OVEL, 2014).

Verumontanum: 2-1-6:

It's the region where the ejaculatory ducts enter the urethra (Fig. 2-2), and divides the urethra into proximal and distal segments (OVEL, 2014).

Seminal vesicles: 2-1-7:

These are paired anatomical structures (Fig. 2-2), 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, 2014).
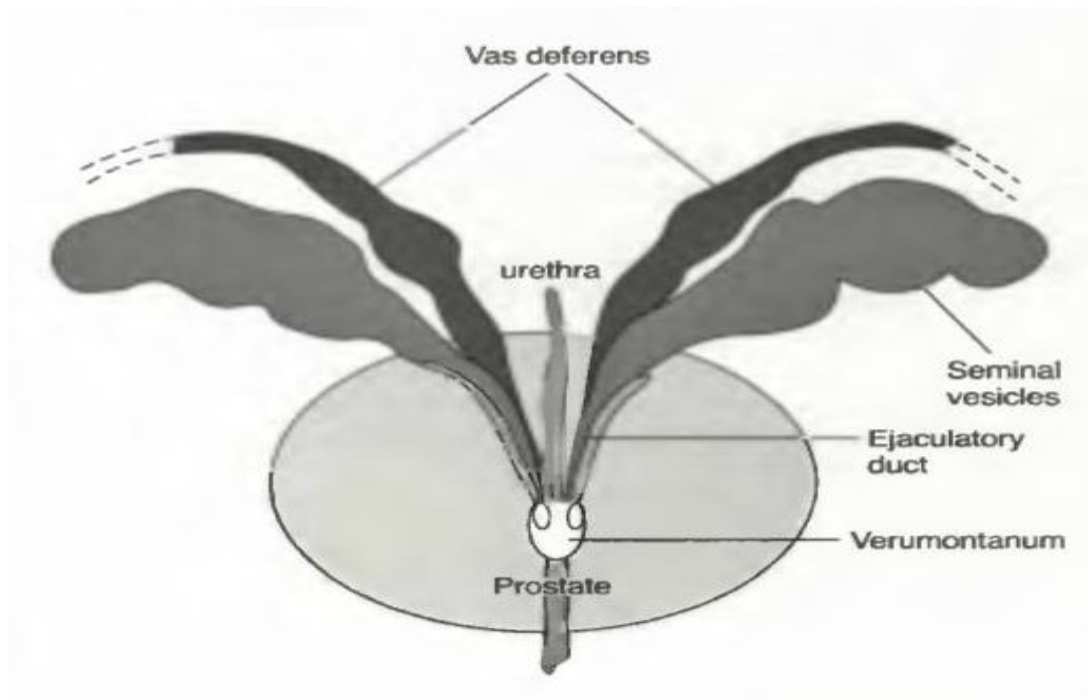
Fig (2-2): shows the seminal vesicles and vas deferens both end into ejaculatory duct that ends in Verumontanum .((SANDERS and WINTER, 2007

:Function of the prostate :2-1-8

The function of the prostate is the production of a

thin, milky fluid containing citric acid and acid phosphatase. The smooth muscle in the capsule and stroma contract, and the secretion from the many glands is squeezed into the prostatic urethra. The prostatic secretion is alkaline and helps to neutralize the acidity in the vagina (Snell, 1995). Moreover the prostatic secretion

constitutes between 13% and 30% of the volume of

.(semen (Penny, 2011

:Blood supply of the prostate :2-1-9

:Prostaticovesical arteries :2-1-9-1

Arise from the internal iliac arteries. Branches

include the prostatic and inferior vesical arteries

.((OVEL, 2014

:Capsular arteries :2-1-9-2

They supplies two third of the blood going into

.(the prostate (OVEL, 2014

:Urethral artery :2-1-9-3

They supplies one third of the blood going into

.(the prostate (OVEL, 2014

:Venous drainage :2-1-9-4

Via the periprostatic plexus to the internal iliac

veins and also to the vertebral venous plexus
(prostatic cancer spread to the vertebrae) (Bulter,

.(et.al, 2013

:Lymphatic drainage of the prostate :2-1-10

The lymphatic drainage is to the internal iliac, and

(obturator lymph nodes (Bulter, et.al, 2013).

:Nerve supply :2-1-11

The nerve supply of the prostate is from parasympathetic nerve fibers from pelvic splanchnic

(nerves (S2-S4) (Ryan, et.al, 2007).

:Prostate sonogram :2-2

Now a day's prostate sonography is a frequently used

imaging modality to detect its abnormalties. From this point of view here are some informations about the normal appearance, different sonographic techniques, in addition

to prostate biobsy.

:Normal appearance :2-2-1

In relation to the normal sonographic appearance the prostate gland has a homogeneous structure demonstrating a median-level echo pattern (Fig. 2-3). The peripheral zone (PZ) appears uniform in texture and slightly more echo-genic than the central zone (CZ). A hyper-echoic band (surgical capsule) separates the PZ from CZ. The seminal vesicles appear as hypo-echoic structures superior to the prostate gland. The

verumontanum appears hyper-echoic compared with the parenchyma (OVEL, 2014). Patients may have benign calcification and simple-appearing cysts within the

prostate as well (Penny, 2011).
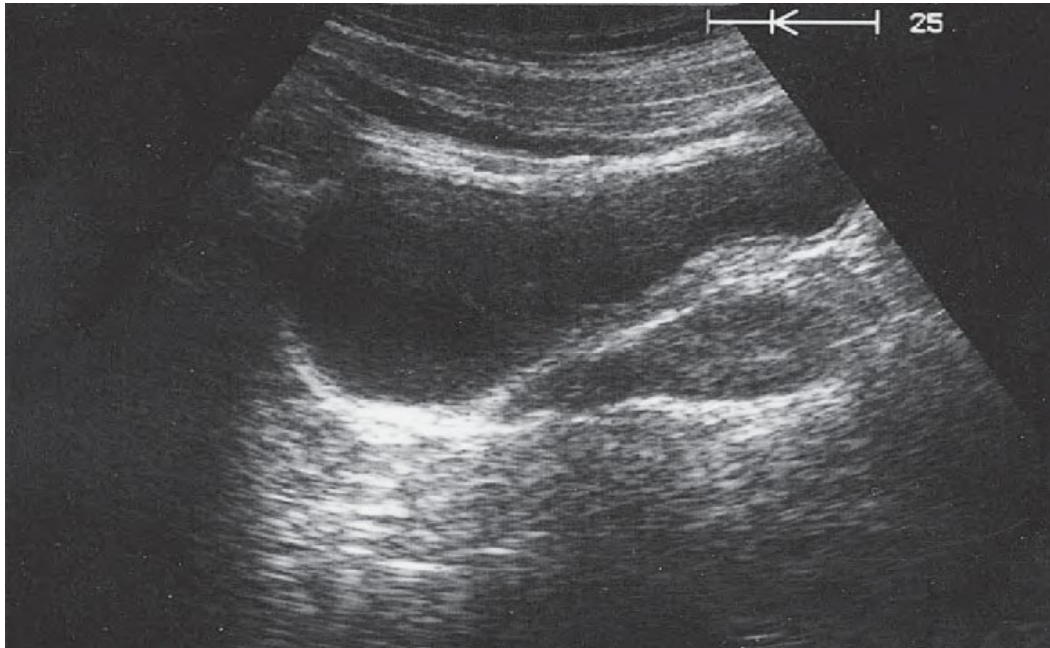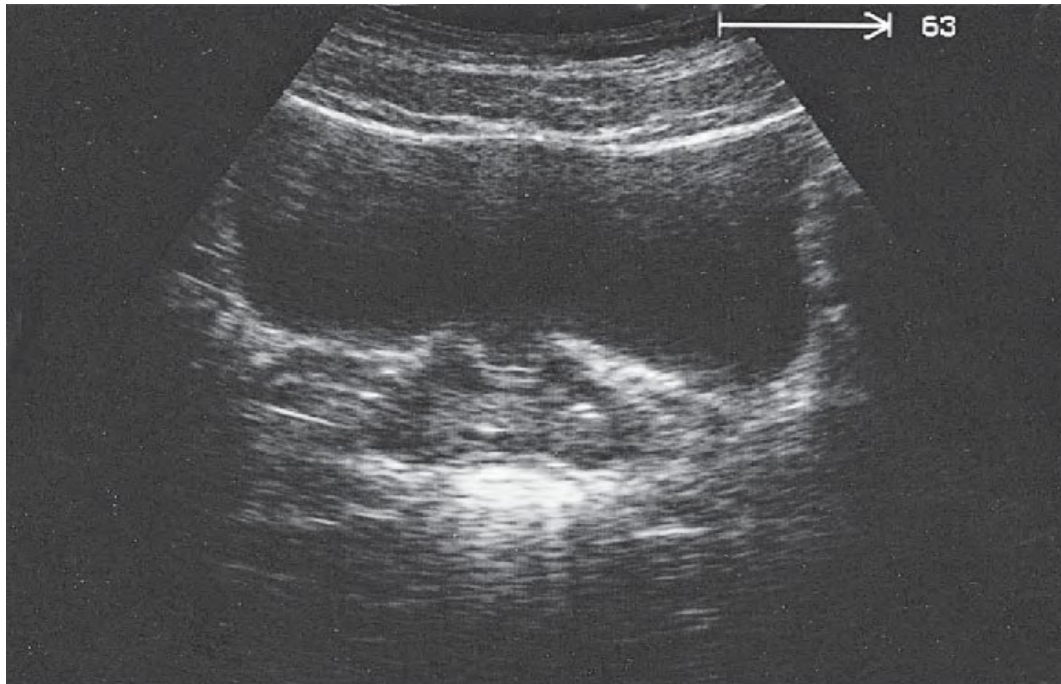
Fig. (2-3): TAUS, longitudinal plane (above), and transverse plane (below), shows; normal prostate sonographic

appearance (Block, 2004).

2-2-2: Ultrasound techniques:

2-2-2-1: Trans-abdominal approach:

Done by using a 3.5 to 5-MHz transducers and a full

bladder, the prostate may be identified by angling slightly inferior. Longitudinal and transverse images and measurements may be obtained; however a thorough evaluation of the prostate tissue is not possible. This

approach allows post-void residual within the bladder to

 (length x width x   be determined by the equation

height x 0.523) (SANDERS and WINTER, 2007), see

.technique used on page. 21

:Trans-perineal approach :2-2-2-2

A perineal approach can be used scanning between

the legs posterior to the scrotum**,** but this is not an ideal way to evaluate the prostate by US. Both transverse and longitudinal images can be obtained and the prostate volume can be calculated; however internal architecture may not be well appreciated. This approach can be used for biopsy if the patient has surgically removed rectum

.((SANDERS and WINTER, 2007

:Trans-rectal approach :2-2-2-3

The most accepted scanning approach when

evaluating the prostate. It's done by using 5-9-MHz endocavitary transducers. It's convenient, not invasive, and good image quality. Preparation; needed adequate defication, bladder filling with up to 100cc , condom or protective sheath, careful probe water filling, and the patient should be placed in a left lateral decubitus position

.(with the knees bent (SANDERS and WINTER, 2007

:Trans-urethral approach :2-2-2-4

Require local anesthesia for intra-urethral insertion

with rotation. There is good visualization of capsule and intra-capsular spreading tumor. Not appropriate method because of no delineation of periurethral region and more

.(or less invasive (Lee, and Young, 2011

:Ultrasound and prostate biopsy :2-2-3

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 (Fig. 2-4) is more common and less painful put 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
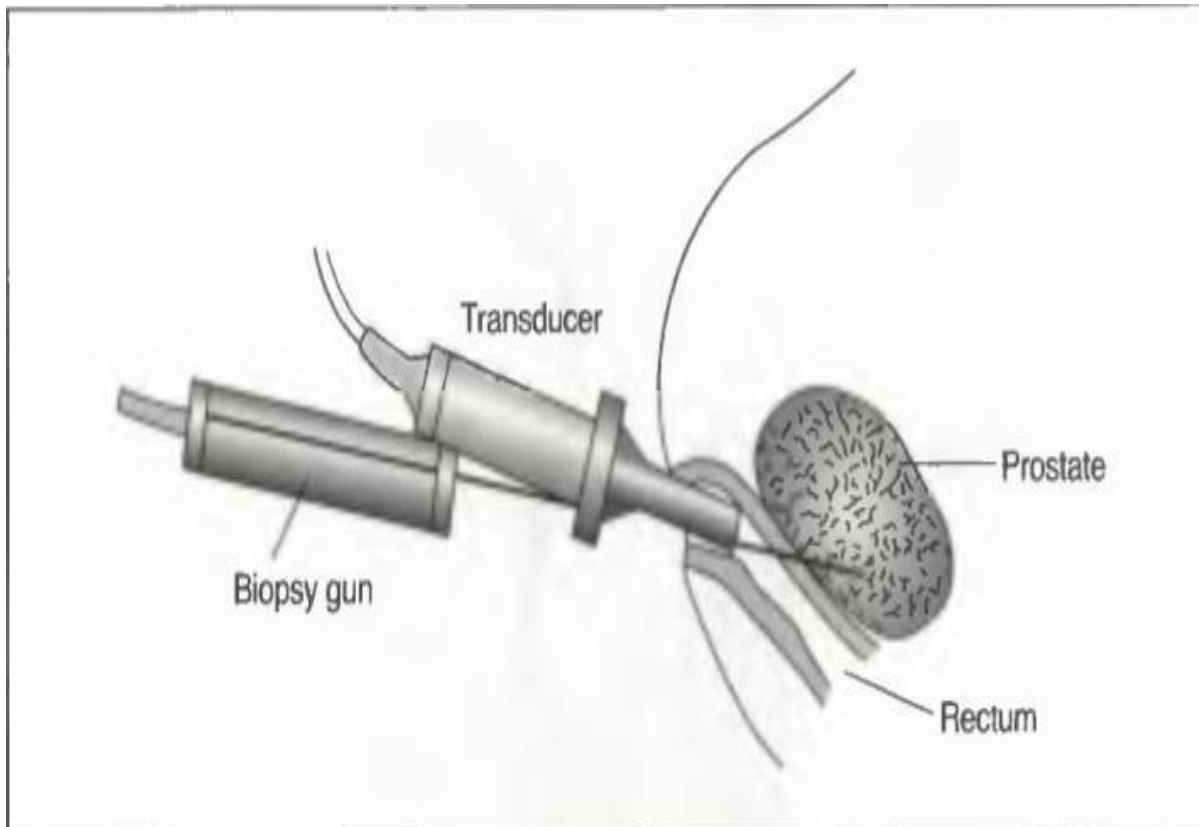
Fig. (2-4): shows trans-rectal biopsy procedure (SANDERS
and WINTER, 2007).

After either procedure, blood pressure and pulse are

taken because hemorrhage is a possible complication.

Infection on a delayed basis may occur after a trans-rectal

biopsy, but is uncommon. It is expected that blood may be

seen within the stool, urine, or sperm after the procedure,

for up to 24 hours. Severe bleeding is extremely rare

((SANDERS and WINTER, 2007).

2-3: Previous studies:

This study is conducted to evaluate the prostate

weight in Sudanese using ultrasound. The study was

carried out in Sinja hospital, in the period from February

2012 –to December 2013. It includes 62 cases aged above 25years, who were randomly selected from patients visit Sinja hospital for prostate ultrasound. The results of this study show that; the prostate weight increased linearly with the patient age by 0.5gm/year. As well as the prostate weight in respect to patient's weight, and height increased linearly by 0.08gm/kg, and 0.09gm/cm respectively. Also patients with normal prostate weight showed normal echogenicity, and homogeneous texture. More over 78% of single patients has normal prostate weight, while 22% of married patients show normal

 .(weights (Elshihawe, 2013

Another study which was conducted by Yahiya Hassan was 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. A 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 trans-abdominal ultrasound. The study was carried out in three hospitals: Bahri hospital, Police hospital, and Alzaiem Alazhari ultrasound clinic, at duration from (June, 2010 –to march, 2011). The study includes 100 cases aged from (50-to 89) years, with different complains. The results of this study shows that the accuracy of ultrasound in prostate measurements and diagnoses 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 results stated that there is significant proportional relation between patient's age and prostate size, and that there is an inverse relation between the patient's height and the size of the prostate

.((Anwar, 2010

Moreover, we have this thesis which was also carried out in order to asses' prostate volume measurement using trans-abdominal ultrasound scanning. In this study, 10 subjects from age of 20 years old to 25years old were selected to undergo trans-abdominal scans. The subjects were randomly selected with different heights and weights. The subjects were the students whom do not have any bad habits like smoking and drinking. The subject's weights, 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. Moreover for the same height increment, the prostate volume was controlled by the weight of the subjects. And finally as this thesis concentrates on body mass indexes, the results find out that the volume of the prostate increases in relation to

.(increase in body size (Skudai, Malaysia, 2012

Chapter three

Chapter three

Materials & Methods

3-1: **Materials:**

3-1-1: **Subjects:**

This is a descriptive study, carried out in order to state the normal measurements of prostate gland in North Kurdfan State. This study was conducted in Elopied city, the capital of (NKS). It was carried out in Elopied teaching hospital, Police hospital, in addition to Elgla'a, and Wad-elyas health centers. This study was conducted in duration from April- to August 2016. The population of this study was an adult patient whom referred for abdominal US scans in Eloped city, who were not suffering from any symptoms related to prostate diseases. The sample size of this study was consisted of 92 cases, and they were randomly selected. Any adult patient from (NKS), who referred for abdominal US scans during the duration of the study (April- to August, 2016) was included. Patients who were not resident in (NKS), pediatric age groups, patients who find to have prostatic diseases symptoms, or who are known cases, or detected to have prostatic pathology during US scan, and patients refused to be a candidate of study were all excluded from this study.

:**Machines used** :3-1-2

Ultrasound machines: Shimadzu 2200, Japan (2003-2008), Medison Accuvix-XG Korea, (2010-2014), and SonoAce R7, Korea, (2010-2014), all of which has major machine three probes, with full US department facilities, and coupling jell. Also we use a personal computer, Toshiba, Satellite, c660, made in china, 2009.   Moreover measurement equipments for heights, and weights of the patient's were used.

:**Methods** :3-2

:**Technique used** :3-2-1

It was by (TAUS), which was done through the

following steps: The patient needs optimal bladder filling if not, more than 40 ounces should be taken by the patient, note that over distended bladder can push the pelvic organs out of view, so you may need to request the patient to void partially (Gilani, 2001). The patient put supine in position, with the legs extended; no breathing technique is recommended (breathing gently) (Gilani,

(2001.

Begin with the transducer perpendicular at the body, just superior to the syphysis pubis and angle inferiorly. The

prostate is visualized here. Once the long axis of the prostate is located, angle the transducer inferiorly to scan apex of the prostate until come beyond it. Return to midline just superior to symphysis, with the transducer angled inferiorly-less than before- to locate the long axis of the prostate. When locating the long axis of the prostate, slowly move the transducer towards the patient's right, scan laterally through the prostate until you are just beyond it, going on with the right lateral scan through the pelvic side wall. Return to the midline superior to symphysis with inferior transducer angulations; locate the long axis of prostate. When locating the long axis of the prostate, slowly move the transducer towards the patient's left, scan laterally through the prostate until you are just beyond it. Continue to scan left lateral through the pelvic

side wall until beyond it (Gilani, 2001).

Still in sagittal plane, locate the long axis of the prostate; rotate the transducer 90 degree into the transverse seaming plane. Begin with the transducer angle inferiorly, at the midline of the body, just superior to the symphysis pubis. Angle the transducer back into the pelvis; look first for the apex of the prostate. Then scan superiorly through the prostate until you are beyond the

base of it (Gilani, 2001).

2-2-3: **Measurements:**

46

The prostate width and height were taken in a

transverse plane, by measuring the maximum right to left

diameter and the maximum antero-posterior diameter

respectively, while the prostate depth is from a sagittal

one, by taking the maximum crainio-caudal diameter. The

volume of prostate is calculated by the US machine

automatically after measuring the above mentioned three

dimensions. The prostate echogenicity, and texture were

.observed all through the scan

:Data collection method :3-2-3

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

index, 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 height, width, depth, 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

:Data analysis :3-2-4

The data was analyzed using Statistical Packaged for Social Studies (SPSS). Using frequency tables, bar graphs, and pie charts, to inter present the variables used in the data collected. Also a correlation tests, scatter, and line plots to find out the definite relationships between the

.prostate volumes and the other variables under study

:Data storage :3-2-5

Data was stored in personal computer, and data

.sheets were kept safely and responsibly

:Ethical Issues :3-2-6

Verbal permissions were taken from the patients

before doing scans, and they were informed about the

study, and accept it. Also the patients get sure that their

details will not be exposed. Before that verbal permissions were also taken from the head mangers of the hospitals,

.and health centers where the study is conducted

Chapter four

Chapter four

Results

About 92 cases having neither complain nor
pathology related to prostate were selected for this study.
The results of this study are presented into tables and

:figures so as the following
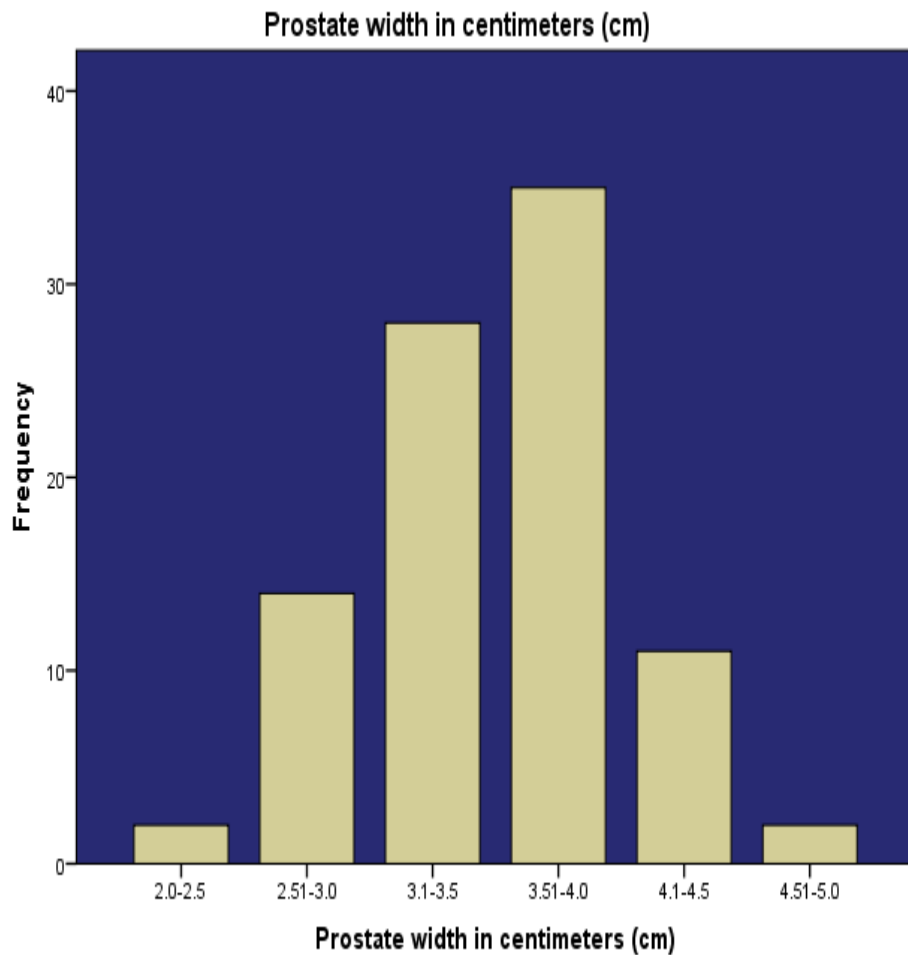
Prostate width in centimeters (cm)

Figure (4-1A): shows bar graph displaying frequency distribution
.of   prostate width

Figure (4-1B): shows bar graph displaying frequency distribution of
.prostate height
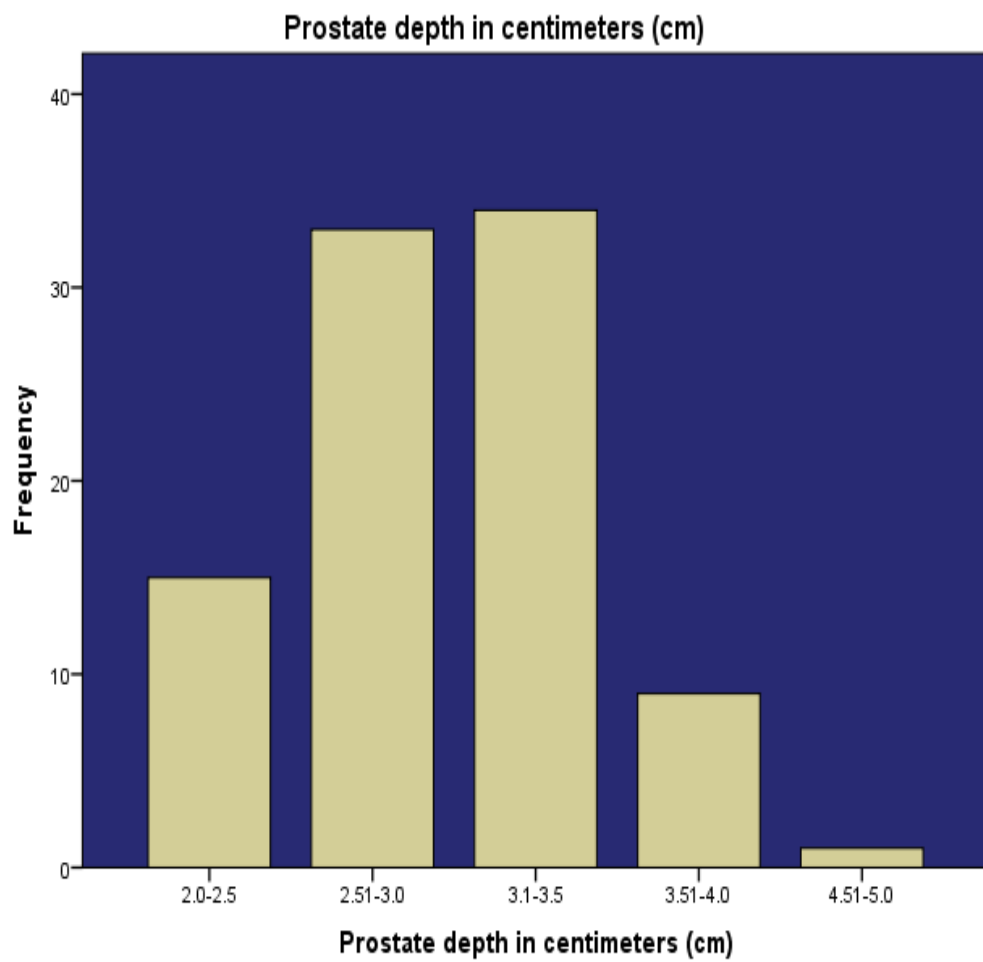
Figure (4-1C): shows bar graph displaying frequency distribution of prostate depth.

Figure (4-2): line plot shows the linear relationship between patient's age and prostate volumes.

Table (4-1) Model coefficients test expressing the positive linear relationship between the patient's age and prostate volume:

Sig		Unstandardized Coefficients		
.	t	Std. Error	B	Model
000.	8.357	1.342	11.214	(Constant)
002.	3.226	028.	090.	Patient's age in Years

53
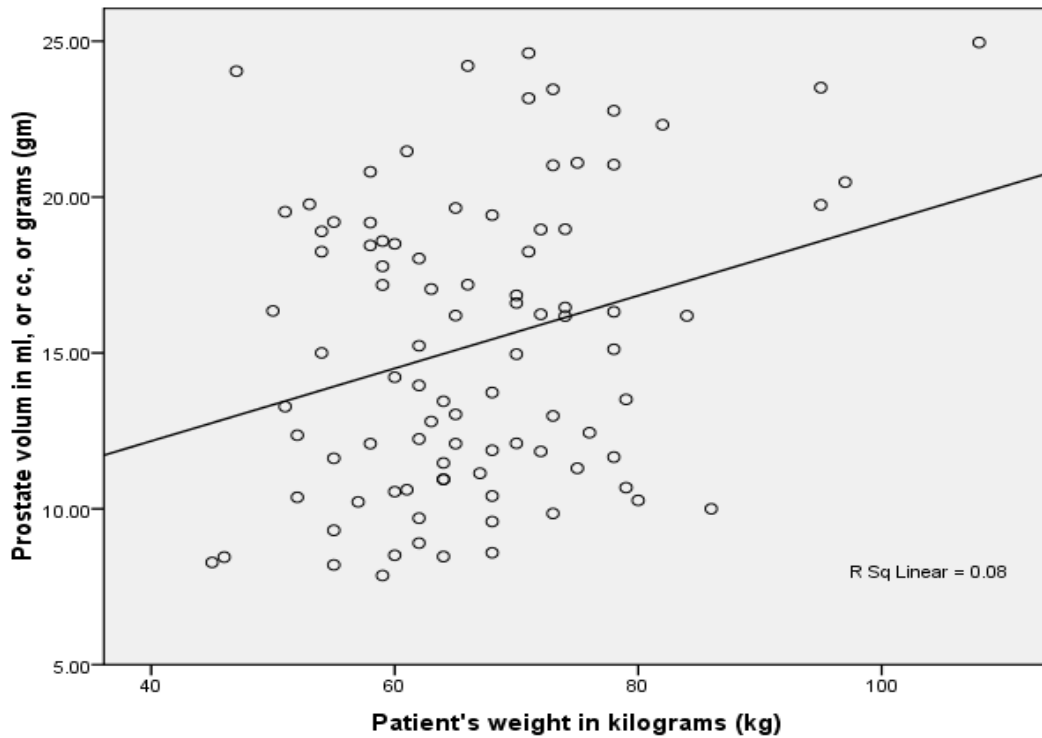
Figure (4-3): shows scatter plot expressing the linear relationship between
.the patient's weight and prostate volume

Table (4-2) Model coefficients test expressing the positive linear
:relationship between the patient's weight and prostate volume

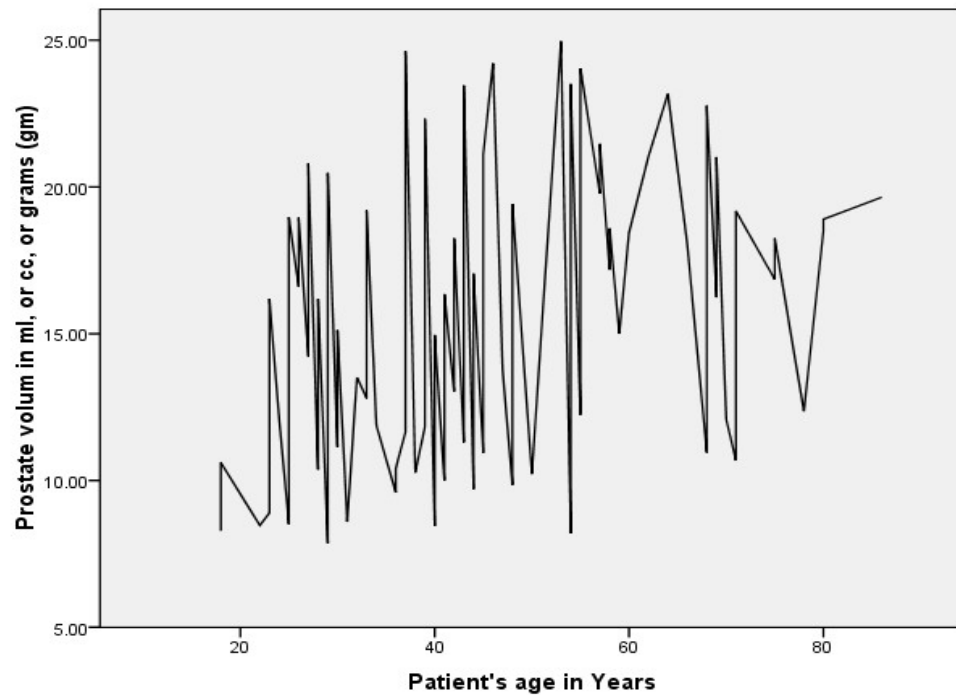| .Sig | t | Unstandardized Coefficients | | Model |
		Std. Error	B	
009.	2.66	2.82	7.51	(Constant)
006.	2.79	042.	117.	Patient's weight in (kilograms (kg
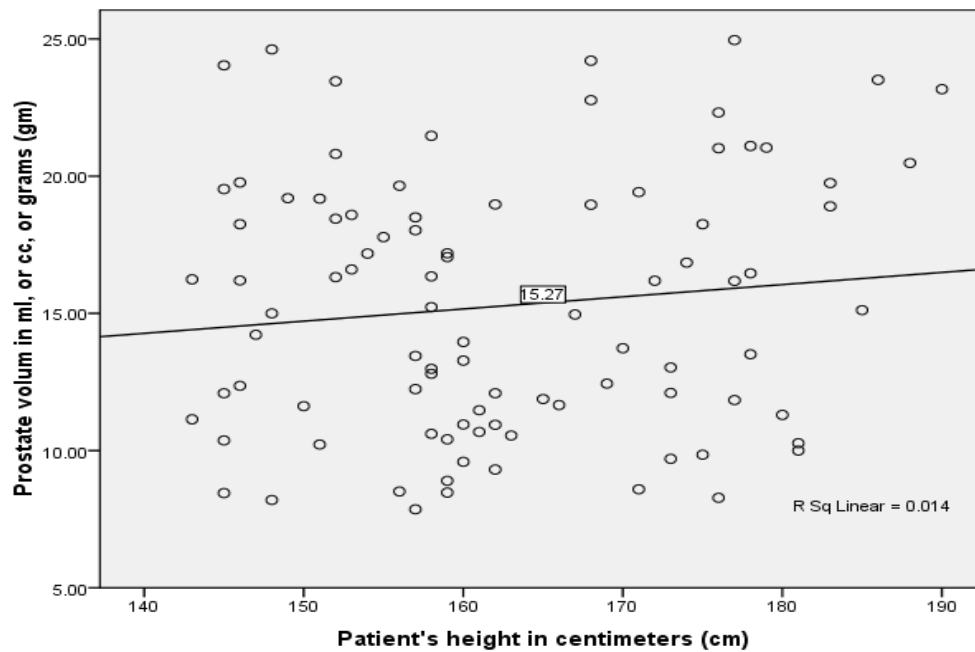
Figure (4-4): shows scatter plot expressing the linear relationship between
the patient's height and prostate volume.

Table (4-3) Model coefficients test expressing the positive linear
relationship between the patient's height and prostate volume:

| .Sig | t | Unstandardized Coefficients | | Model |
		Std. Error	B	
220.	1.24	6.518	8.057	(Constant)
270.	1.11	040.	044.	Patient's height in centimeters (cm)
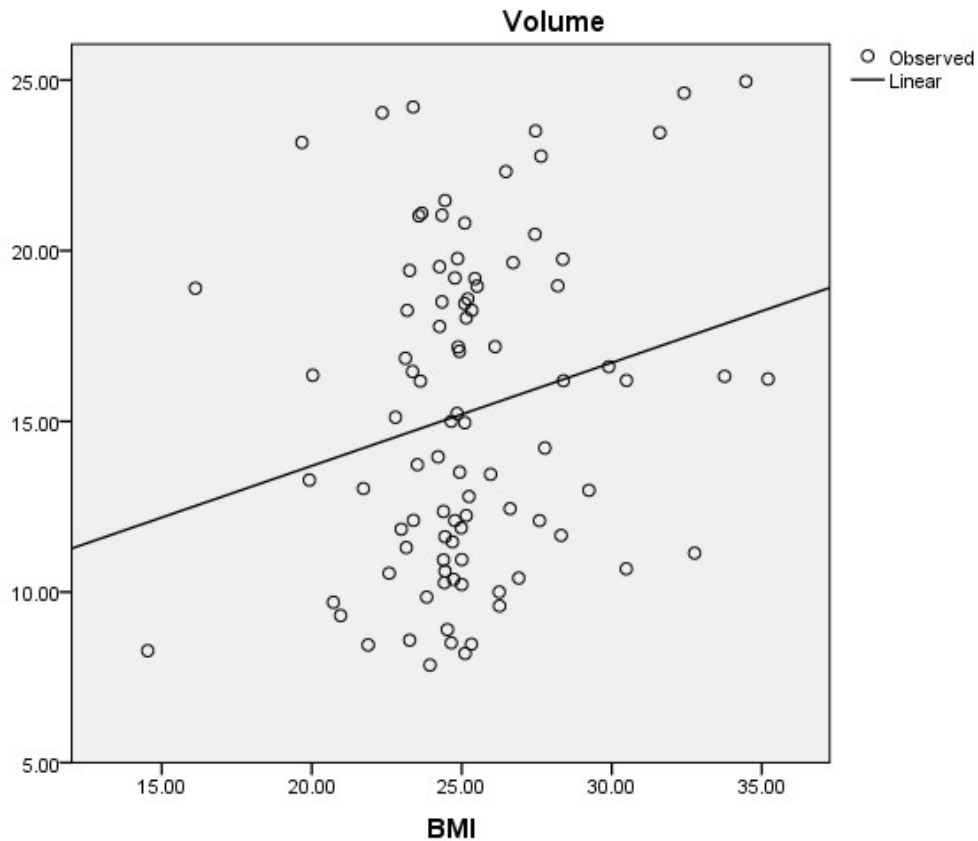
Figure (4-5): shows scatter plot expressing the linear relationship between
.the patient's body mass (kg/m²) index and prostate volume

Table (4-4) Model coefficients test expressing the positive linear
:relationship between the patient's body mass index and prostate volume

| .Sig | t | Unstandardized Coefficients | | Model |
		Std. Error	B	
041.	2.07	3.700	7.669	(Constant) 1
041.	2.07	145.	301.	Body Mass Index

Table (4-5): shows distributions of two groups (Marred and Single) with
:their means and standered deviations calculated

Std. Deviation	Mean	N	Marital status
4.66278	15.5280	79	Married
4.79826	13.7285	13	Single

:Table (4-6): t-test for Equality of Means of two groups

t-test for Equality of Means							
Confidence 95% Interval of the Difference		Std.Error Differenc e	Mean Difference	Sig. (2-(tailed	df	t	
Upper	Lower						
4.58	98.-	1.40	1.8	2.	90	1.28	Prostate volume

Table (4-7): shows Model Summary expressing the effect of age,
:BMI, and marital status collectively on the prostate volume

Adjusted R Square	R Square	R	Model

:Table (4-8): shows the frequency distribution of prostate Echogenicity

Percent	Frequency	Prostate echogenicity
83.7	77	Normal echogenicity (mid-grey)
5.4	5	Hypo-echoic
10.9	10	Hyper-echoic
100.0	92	Total
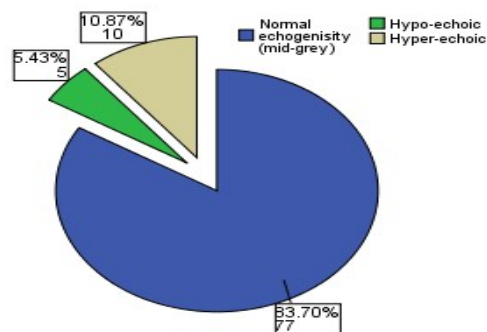
Figure (4-6): show that most (83.7%) of participants were Normal echogenicity (mid-grey) prostate, (10.9%) Hyper-echoic .while (5.4%) of them appeared Hypo-echoic

:Table (4-9): shows the frequency distribution of prostate texture

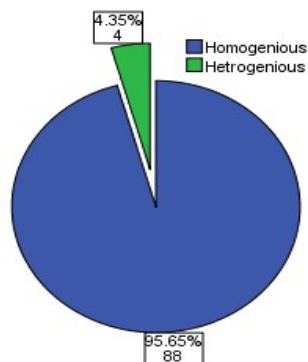| Percent	Frequency	Prostate texture
95.7	88	Homogeneous
4.3	4	Heterogeneous
100.0	92	Total

Figure (4-7) show that most (95.7%) of participants were Homogeneous prostate texture, while (4.3%) of them were heterogeneous.

Chapter five

Chapter five

Discussion, conclusion, and

recommendations

Discussion :5-1

As mentioned earlier, the main purpose of this thesis

is to identify the normal measurements of the prostate

gland (volume, and dimensions) in NKS peoples using

trans-abdominal ultrasound, and to state these

measurements in relation to their individual

characteristics. So about 92 patients were selected

randomly, who have no any complains related to prostate

:pathology. The results of this thesis find out the following

The prostate transverse, AP and longitudinal

diameters were measured and displayed in Fig. (4-1A, B,

C), and their 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± 4.7ml

this mean ranges from (7.86- 24.96) ml. These results

.agree with (Abdallah, 2015) study, see previous studies

Also the results confirmed that there is positive linear

relationship between the age of patients and their prostate volumes fig. (4-2), that's to say when patient's age increases by 1year the prostate volume also increases by 0.09 ml, see table (4-1). This linear relationship can be stated in the formula: prostate volume (PV) = 0.09 x Age of patient + 11.21. 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. (4-3), that's to say an increase in body weight by 1kg there should be an increase in prostate volume by 0.11 ml, see table (4-2). This linear relationship can be expressed in the formula: prostate volume (PV) = 0.11 x weight of patient + 7.51. 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. (4-4), and also it's a positive one. That's to say an increase in body height by 1cm there should be an increase in prostate volume by 0.04 ml, see table (4-3). When this correlation is tested:

the coefficients table (4-3) provides that ("Sig." = 0.270 > 0.05) which indicates that there no statistically significant correlation between the patients height and prostate volume. And that this positive relationship occurs by chance. But when comparing this result with those found in the previous studies (page. No 16 - 18), we can accept this positive relationship, based on two out of four thesis confirming it (Elshihawe, 2013 and Skudai, Malaysia, 2012), and one of them said that there is negative relationship (Anwar, 2010), and the last one do not mention .(any correlation (Abdallah, 2015

Regarding to the body mass index (BMI) and prostate volume, the (BMI) were calculated to all patients by the equation: weight/height squire and we find out that there is a positive linear relationship Fig. (4-5), that's to say an increase in the BMI by 1kg/m^2 there should be an increase in prostate volume by 0.3 ml, see table (4-4). This linear relationship can be expressed in the formula: prostate volume (PV) = 0.3 x BMI of patient + 7.67. This positive relationship is also expected because higher BMI simply means heavy weights. This result

.agrees with (Skudai, Malaysia, 2012) study

Relating to the effect of marital status on the prostate volume, we find that see table (4-5), the married

patients were 79 persons, and the single ones were 13 persons, and that the mean prostate volumes for both were 15.53± 4.67, and 13.73± 4.8 respectively. And that the difference in means between them is 1.8. We use T-test to test the difference in means between these two mean groups and the results tell us that there is no significantly different because the values in the "Sig. (2-tailed)" Colum see table (4-6) is 0.2 which is more than 0.05. So, we can conclude that marital status has no effect

.in the prostate volume among this population

As the humans were not age alone or weight or so,

we try to find the effect of the all above mentioned variables (age, BMI, and marital status) collectively on the prostate volume. And we find out that see table (4-7) they are all affect in prostate volume by 14.7%. That means there is another 85% of variables not studied here such as the ethnic group, hormones levels, personal habits e.g., alcohol, and coffee intake, environmental factors and so

.on

Studding the echogenicity and texture of the prostate gland the results reveals that, Table (4-8), and Fig. (4-6) shows the echogenicity of the prostate and that 77 patients have normal echo's, 5 patients were hypo-echoic, and 10 of them hyper-echoic. And table (4-9), and Fig. (4-7) shows the texture of the prostate and that 88 patients have homogenious texture, and 4 patients have hetrogenious texture. So we can state that from the

results the normal prostate sonographic appearance is
mid-grey level echo's (83.7%), and at the same time

.(homogenious texture (95.7%

Statistical Methods: the use of comparative analytical method
using the SPSS statistical program based descriptive statistics and
comparative and relationship hypothesis tests (0.05 sig. level), to
demonstrate the differences in (Prostate volume) with respect to (age,
height, weight, marital and body mass index). The test was used for
(simple linear regression, binary logistic regression, t-tests and
correlations) to study the hypothesis which states there are significant
.differences in Prostate volume

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± 4.7ml

The study also concludes that, there was linear

increase in the prostate volume in relation to increase in

the patient's age, weight, height, and body mass indexes

by 0.09 ml/year, 0.11 ml/kg, 0.04 ml/cm, and 0.3 ml/kg/m^2

.respectively

Moreover the normal prostate volume has mid-grey

level echogenicity (83.7%), and homogenious in texture

.((95.7

Also, the study found out that the prostate volume

didn't affected by the marital status of the patients among

.these populations

Recommendations :5-3

- Trans-abdominal ultrasound is a respectful approach, and should be used confidently in the measurements and evaluation of the prostate gland size and

.pathologies among Sudanese

- 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

- As mentioned in the discussion, there is another 85% of factors that might affect the prostate volume were not included here. There for other researches were

.recommended to cover these factors

- Also I think that we are in need for assessing the normal prostate measurements in the other different states in our country. So as to have our own local

values, hence we are here in Sudan have different

.environments and very vary habits

- I notice that some sonologists measure the all three parameters of the prostate (transverse, AP, and length) from one plane, which may produces un accurate volume. Therefore it's better to follow

  .standered protocols to improve our techniques

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Appendices

:Appendix-A

Text	Echo	Prostate volume	Prostate depth	Prostate width	Prostate height	MS	Weight	Height	Age

:Appendix-B

Sudan University of Science and technology

College of Graduated studies

M.Sc of Diagnostic ultrasound

Measurement of normal Prostatic gland in

Sudanese people

Data Collection sheet

.……/.…../….. :Date

: Patient data .1

• Patient's ID:

…..……………………………………………….

• years…………………………………….: Patient's age.

• Patient's marital status:…………..………………….…

• cm…………………………………….: Patient's height.

• kg…………………………………….: Patient's weight.

:Sonographic findings .2

• cm……………………………………. Prostatic length.

• cm…………………………………….:Prostatic width.

• cm…………………………………….: Prostatic depth.

• gram………………………………….:Prostatic weight.

• Prostatic echogenicity……………….…………………..…

• Prostate texture………………………………………….