

DETERMINATION OF NORMAL RANGE OF ULTRASONIC SIZES OF PROSTATE IN OUR LOCAL ENVIRONMENT

*Marchie T.T , MBBS, FWACS, FICS,
Diagnostic Urology Unit, Department Of Radiology,
University Of Benin Teaching Hospital, Benin*

*Onuora V.C , MBBS, FRCS, FWACS, FICS
Surgical Urology Unit, Department Of Surgery
University Of Benin Teaching Hospital, Benin*

*All correspondence to: Dr T.T Marchie
Department of Radiology
University of Benin Teaching Hospital, Benin*

ABSTRACT.

This study was carried out to determine the range of sizes of the prostate gland in adult males in our local environment using supra-pubic ultrasonography, and to provide acceptable range of normal prostate gland dimensions.

A prospective random selection of 74 asymptomatic adult males were recruited and measurements of the maximum length, height and width of their prostate gland were obtained and the volume calculated. Subjects were selected, if they had no complaints related to the urinary system or signs of urinary tract disease. The transverse, AP and Longitudinal diameters range from 26-54mm (\pm 6.9mm), 24-51mm (\pm 4.5mm) and 22-53 (\pm 6.5mm) respectively, the volume ranges for the above three parameters were 41.8mm, 30.9mm and 34mm.

The mean prostate volume obtained was 22.9cm. there results are discussed with data obtained modalities among Caucasians.

INTRODUCTION.

The prostate gland is made of glandular elements that are embedded in a fibromuscular stroma, and they surround the first part of the male urethra. The shape is like an inverted pyramid, of which the base is applied to the neck of the bladder and the apex is below abutting the fascia covering the upper surface of urogenital diaphragm. A rich plexus of veins encompasses the prostate gland between the true fibrous capsule of the gland and the lateral prostatic fascia; these are visible landmarks on sonographic images¹. The prostate gland is

anatomically divided into five lobes that consist of the following, anterior, posterior, middle and two lateral lobes. The other names of middle lobe are median and or prespermatic lobe. Four glandular zones each with their own duct system have replaced this concept. The zones are peripheral zone, transition zone and periurethral gland, these have similar histology, and are derived from urogenital sinus. The other is central zone, which is histologically distinct and is derived from mesonephric duct. The proximal part of the urethra transverses through the prostate gland at the midline closer to the anterior surface than to the posterior of the gland. The prostate gland has variable dimensions; in the adult cadaver; the average dimensions are about 3cm high, 4cm wide and 2.5 cm long. The weight is about 20gram¹. Other study by computer integrated medical intervention laboratory in the inter-net (http://mrcas.mpe.ntu.edu.sg/classroom/prostate_cancer.htm), suggested that pre-operative dimension of prostate are as follows length 29-59mm, mean value of 41mm, width 48-80mm, mean value of 52mm, and height of 33-60mm, mean value of 35mm. The volume is usually calculated with the formula $\text{height} \times \text{width} \times \text{length} \times \pi / 6$. Where π is a mathematical constant whose value equals to 3.14. Hence the approximate formula is $\text{height} \times \text{width} \times \text{length} \times \frac{1}{2}$. Nathan et-al² in a comparative assessment of prostate volume and dimensions by trans-rectal (TRUS) and trans-urethra (TUUS) sonography in symptomatic subjects (Caucasians) suggested the following; mean values with TRUS were as follows, length 40.1 8.7mm, height 27.7 7.6mm and transverse diameter of 47.4 6.8mm

and volume of 29.4 16.2cm³.

The mean values with TUUS were length 42.3 10.2mm, height 32.7 7.1mm, and transverse diameter of 42.1 7.1mm and volume of 32.6 19.3cm³(2). The prostate has undefined endocrine function and produce significant secretions from its glandular tissue. It is under the control of testicular androgenic hormone, of which the excess of the hormone can cause hyperactivity and hyperplasia with an increase in gland to stroma ratio. On the other hand, a low level of the hormone increases the growth of prostatic urticle and fibromuscular stroma of the middle lobe but atrophy of the glandular elements occur. The larger peripheral zone of the prostate is histologically made of the long branching prostatic elements, whose draining ducts curve backward to open into prostatic sinuses. This area of prostate gland is more prone to carcinoma and in sonogram usually appears hyper-echoic. The inner zone of the prostate is made of submucous gland and their draining duct opens into prostatic sinus and urticle. These sinuses and urticle open into the prostatic urethra. This zone is more prone to senile or hyperactive hypertrophy and in sonogram usually appear hypo-echoic¹. The prostate has two main functions, one of it is to control urination and the other is to help sexual activity. The muscles around the prostate help control the flow of urine during micturation. The glandular secretions² help the mobility of sperm in the urethra and make up a third of the seminal fluid. It is whitish in appearance on ejaculation.

This study is meant to standardize prostate gland dimensions in our local environment.^{3,4,5,6} This will bring to fore earliest suggestion of enlargement using our local dimensional references, which will call for adequate and further investigation. The prostate specific antigen (PSA) is a substance primarily produced by prostate gland, and is considered as a very reliable telltale sign in screening for prostate cancer. The acceptable normal range of psa should be equal or below 4ng/ml. But studies have shown that 70% of men with psa between

4ng/ml to 10ng/ml, did not have cancer and 20% of men who had cancer of prostate had psa level in the normal range. The requirement for the use of psa in determination of prostate cancer is to show comparative rising level of psa at different time and in addition assessing the size of prostate. Enlarged prostate do go with high level of psa but benign prostate hypertrophy do not show a rising titter (7,8,9,10). Trans-rectal digital palpation and use of basal filling defect in a contrast cystogram, in assessing prostate enlargement are still very much in practice in our environment. This process is limited in accuracy, especially in getting reproducible assessment of size and parenchymal nature of the prostate. The other modalities currently in use for assessment of the prostate glands are trans-rectal sonography, trans-urethra sonography, sonographic guided prostatic biopsy/ Doppler studies, computerized axial tomography and magnetic resonance imaging with spectroscopy^{11, 18}. However, these facilities are not readily assessable in the environment, hence the use of the suprapubic ultrasonography for the study. This modality is readily assessable and has been used previously in such assessment with comparable accuracy as transrectal sonography.^{3,4}

METHOD

A random selection of adult males above the age of 18years, who had no history of increase frequency of micturation, hesitancy, incontinence of urine, haematuria, poor stream of urine on micturation and no evidence of an enlarged prostate on digital palpation, were evaluated with gray scale two dimensional ultrasound or Bscan using either a medison sonoace or siemen machine in our local hospitals. The subject's consent was obtained after explaining the procedure and reason for the study. The technique consist of trans- supra-pubic scan through ultrasonic inert gel, in a moderately urine filled bladder which acts as acoustic window. The patient were examined in the supine position with an inert ultrasonic gel spread on the patient's supra-pubic skin. The gel acts as a

coupling substance to remove air gap, to allow an effective probe and skin contact. Properly visualized prostate glands in the patients for evaluation had the following characteristic, regular with well defined outline and slightly echoic hypo uniform parenchyma. The evaluations consist of measuring maximum height, length and width of the prostate gland. The ultrasonic machine automatically computes the volume of prostate gland. The scan probes used were 3.5Hz curvilinear real time array and or a sector probe. These were adequate for proper delineation of the prostate gland in all the dimensions. The data were analyzed with statistical procedure of social science (spss).

RESULTS

Statistical analysis of the data showed that among the 74 subjects evaluated, 49 of the men were married and 25 were single, giving percentage ratio of 66.2% and 33.8% (table 1).

On the subjects occupation Table 2 21.6% were farmers. Students constitute 18.9%; teachers 13.5%; artisans 12.2% and medical workers 12.2%. Table 3 shows the age distribution: 81% were within the age range 21-60 yrs. The highest percentage frequency of 21.6% were seen in age group 21-30yrs and 41-50yrs. Mean age was 43-34 yrs with standard deviation of 15.88yrs and median 42.5yrs as shown in table 4.

The transverse, AP and longitudinal diameters gave a range of 26-54mm (\pm 6.9mm), 24-51mm (\pm 4.5mm), 22-53mm (\pm 6.5mm) respectively. These ranges (Table 8) gave a volume range of 13.7-40.6cm³ (\pm 6.7cm³). The mean values of the transverse, AP and longitudinal diameters were 41.8mm, 30.9mm, and 34mm as shown in Table 9 mean prostatic volume for the study was 22.9cm³, there data are summarized in Table 10.

Discussion

This study is to determine the normal dimension and volume of prostate gland in the normal adult male in our environment. The authors of this study are aware of the advances in this area of study, but decided to conduct this study with two-dimensional or B ultrasound scan machine, basically due to limitation and unavailability or accessibility of the other required diagnostic machine in the locality. B scan machines with supra-pubic probes are commonly available and assessable to medical practitioners in the locality and these groups; are targeted in the study to improve their practice. This study was done, to form baseline reference values for local assessment of dimension of prostate gland among the adult male. During the past decade, there has been other non-invasive imaging procedures developed for proper evaluation of prostate gland and staging of prostate neoplasia, such as the following; multi-detector CT-scan with 3 dimensional reconstruction, MRI with multi-planar plane of scan view and MRI spectroscopy. In addition there is Trans-rectal sonography (TRUS) with 3 dimensional reconstructions, tissue typing and guided tissue biopsy.^{6, 18} The use of sonography in prostate gland assessment is the most cost effective means of evaluation, especially in this environment where cost is a limitation in patients' management. Thus, the effort to use gray scale supra-pubic B scans sonography in spite of known advances in this area, in assessment of prostatic dimensions. This is because it is readily available in the locality and has been proven to be adequate for dimensional measurement, hence can be used to complement the limitation in use of prostate specific antigen (psa) in assessing prostate neoplasia.^{3,4} In the methodology, the assessment took in to consideration the three-dimensional shape of the prostate gland by measuring the maximum length of prostate on the longitudinal scan plane and using the same plane as focal point, to get the maximum transverse scan plane of the prostate gland, in other to measure the maximum height and maximum diameter. The results of the data analysis using SPSS, has shown no remarkable contradiction,

when compared to other studies done elsewhere. There were no contributions of the subjects marital status, occupation, and age to the variation in the sizes and volume of the prostate gland among the seventy-four male evaluated. These were the average dimensions and the volume of the prostate gland, in the normal subjects studied.

The prostate gland has variable dimensions, in the adult cadaver; the average dimensions are about 3cm height, 4cm width and 2.5 cm length. The weight is about 20gram¹. Pre-operative dimension of prostate as follows were elicited in another study, length 29-59mm, mean value of 41mm, width 48-80mm, mean value of 52mm, and height of 33-60mm, mean value of 35mm²⁰. Nathan et-al³ in a comparative assessment of prostate volume and dimensions in symptomatic subjects by trans-rectal (TRUS) and trans-urethra (TUUS) sonography suggested mean value for TRUS as follows: length 40.1

8.7mm, height 27.7 7.6mm and transverse diameter of 47.4 6.8mm and volume of 29.4 16.2cm³. The mean values for TUUS were length 42.3 10.2mm, height 32.7 7.1mm, and transverse diameter of 42.1 7.1mm and volume of 32.6 19.3cm³.²³ Our local study in asymptomatic subjects suggested a slight lower dimension for normal when compare to above values mentioned obtained with different modalities of sonography, among the Caucasians. Hence our study have produced a good baseline dimensions and volumes of the prostate gland in our locality asymptomatic subjects. Using suprapubic sonography, which is commonly available in practice in many centers in our locality. We are suggesting these reference values as comparative parameters in assessment of patients with suspected prostate gland enlargement.

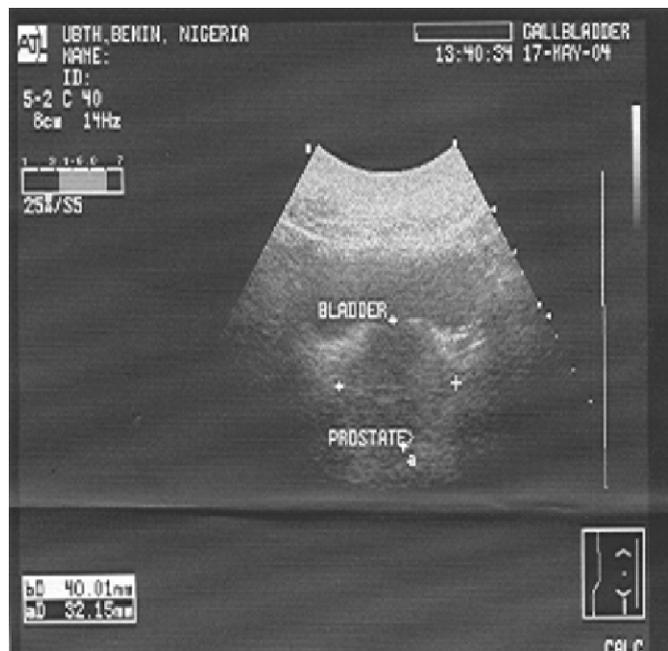
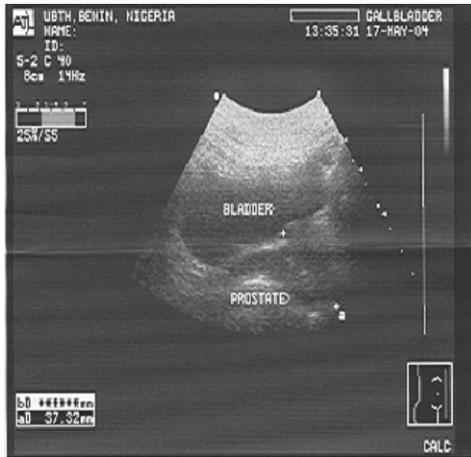


Fig. Prostate gland showing height (A-P diameter) =3.2mm and Width (Transverse diameter) =40.01mm



Prostate gland showing length
(longitudinal diameter) =37.32mm



Zoom image of prostate gland on
maximum transverse scan



Table 1
Marital Status

	Frequency	Percent	Valid percent	Cumulative
Married	49	66.2	66.2	percent
Single	25	33.8	33.8	66.2
Total	74	100	100	100

Table 2
Occupation

	Frequency	Percent	Valid percent	Cumulative
Not stated	3	4.1	4.1	percent
Trader / business	9	12.2	12.2	4.1
Farmer	16	21.6	21.6	16.2
Student	14	18.9	18.9	37.8
Media worker	1	1.4	1.4	56.8
Lecturer/ Teacher	10	13.5	13.5	58.1
Artisans	2	2.7	2.7	71.6
Medical/doctor/worker	9	12.2	12.2	74.3
Civil servant	9	12.2	12.2	86.5
Driver	1	1.4	1.4	98.6
Total	74	100	100	100.0

Table 3
Age range of respondents

	Frequency	Percent	Valid percent	Cumulative percent
Not stated	1	1.4	1.4	1.4
< 20years	2	2.7	2.7	4.1
21-30years	16	21.6	21.6	25.7
31-40years	13	17.6	17.6	43.2
41-50years	16	21.6	21.6	64.9
51-60years	15	20.3	20.3	85.1
61-70years	9	12.2	12.2	97.3
Above 70years	2	2.7	2.7	97.3
Total	74	100	100	100

Table 4
Mean/ Standard Deviation / Median of respondents' age

Sex	Mean (yrs)	Std Deviation (yrs)	Median (yrs)	Variance
1.00	43.3378	15.8773	42.5000	252.090
Total	43.3378	15.8773	42.5000	252.090

Table 5
Longitudinal Diameter (length)

mm	Frequency	Percent	Valid percent	Cumulative
22.00	2	2.7	2.7	percent
23.00	3	4.1	4.1	2.7
26.00	10	13.5	13.5	6.8
27.00	1	1.4	1.4	20.3
28.00	3	4.1	4.1	21.6
30.00	3	4.1	4.1	25.7
32.00	3	4.1	4.1	29.7
33.00	9	12.2	12.2	33.8
34.00	6	8.1	8.1	45.9
35.00	9	12.2	12.2	54.1
37.00	2	2.7	2.7	66.2
39.00	7	9.5	9.5	68.9
40.00	6	8.1	8.1	78.4
41.00	3	4.1	4.1	86.5
42.00	3	4.1	4.1	90.5
45.00	2	2.7	2.7	94.6
49.00	1	1.4	1.4	97.3
53.00	1	1.4	1.4	98.6
Total	74	100.0	100.0	100.0

Table 6
Transverse Diameter (width)

mm	Frequency	Percent	Valid percent	Cumulative percent
26.00	3	4.1	4.1	4.1
29.00	3	4.1	4.1	8.1
31.00	3	4.1	4.1	12.2
36.00	6	8.1	8.1	20.3
38.00	3	4.1	4.1	24.3
39.00	5	6.8	6.8	31.1
41.00	15	20.3	20.3	51.4
42.00	5	6.8	6.8	58.1
43.00	3	4.1	4.1	62.2
44.00	3	4.1	4.1	66.2
45.00	7	9.5	9.5	75.7
47.00	2	2.7	2.7	78.4
48.00	5	6.8	6.8	85.1
49.00	3	4.1	4.1	89.2
51.00	2	2.7	2.7	91.9
54.00	6	8.1	8.1	100.0
Total	74	100.0	100.0	

Table 7
Anterior-posterior Diameter (height)

mm	Frequency	Percent	Valid percent	Cumulative percent
24.00	6	8.1	8.1	8.1
25.00	1	1.4	1.4	9.5
26.00	10	13.5	13.5	23.0
27.00	3	4.1	4.1	27.0
28.00	3	4.1	4.1	31.1
30.00	9	12.2	12.2	43.2
31.00	9	12.2	12.2	55.4
32.00	9	12.2	12.2	67.6
33.00	3	4.1	4.1	71.6
34.00	7	9.5	9.5	81.1
35.00	10	13.5	13.5	94.6
36.00	1	1.4	1.4	95.9
39.00	2	2.7	2.7	98.6
51.00	1	1.4	1.4	100.0
Total	74	100.0	100.0	

Table 8
Volume

cm ³	Frequency	Percent	Valid percent	Cumulative percent
13.70	3	4.1	4.1	4.1
14.60	3	4.1	4.1	8.1
15.10	3	4.1	4.1	12.2
15.40	6	8.1	8.1	20.3
18.00	3	4.1	4.1	24.3
18.20	2	2.7	2.7	27.0
18.70	1	1.4	1.4	28.4
19.20	3	4.1	4.1	32.4
19.50	3	4.1	4.1	36.5
21.40	10	13.5	13.5	50.0
22.60	3	4.1	4.1	54.1
22.70	3	4.1	4.1	58.1
23.40	3	4.1	4.1	62.2
23.50	4	5.4	5.4	67.6
23.60	2	2.7	2.7	70.3
26.60	3	4.1	4.1	74.3
27.00	3	4.1	4.1	78.4
27.70	2	2.7	2.7	81.1
28.80	3	4.1	4.1	85.1
29.70	1	1.4	1.4	86.5
31.60	2	2.7	2.7	89.2
33.30	3	4.1	4.1	93.2
36.00	1	1.4	1.4	94.6
38.50	2	2.7	2.7	97.3
39.60	1	1.4	1.4	98.6
40.60	1	1.4	1.4	100.0
Total	74	100.0	100.0	

Table 9
Mean/ STD Deviation/ Median of prostate gland dimensions

Sex	Transverse diameter (mm)	Anterior-posterior diameter (mm)	Longitudinal diameter (mm)	Volume cm ³
1.0 Mean	41.7703	30.8514	33.9730	22.9419
Std. Deviation	6.8637	4.4712	6.5186	6.6526
Median	41.0000	31.0000	34.0000	22.0000
Variance	47.111	19.991	42.492	44.257

Table 10

Parameters	Transverse diameter (width) mm	Anterior posterior diameter (height) mm	Longitudinal diameter (length) mm	Volume cm ³
Range	26-54	24-51	22-53	13.7-40.6
Mean	41.8	30.9	34	22.9
Std deviation	6.9	4.5	6.5	6.7
Median	41	31	34	22.0
Variance	47.111	19.991	42.492	44.257

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