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Sonographic Assessment of Normal Prostate Sizes Within Age Groups Among Benue People of Nigeria

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ABSTRACT

The aim of this study is to establish normal prostate sizes within age groups among Benue People of Middle Belt region of Nigeria using transabdominal pelvic sonography. The prostate length, anteroposterior and transverse diameters were measured in 158 subjects at Federal Medical Centre, Makurdi and Hospital of Immaculate Conception, Makurdi using transabdominal pelvic sonography. The subjects were aged 9 to 100 years (mean 27.65±17.55 years). Their height ranged from 93cm to 186cm (mean 169.20±24.61cm) and they weighed between 21 and 101kgs (mean 66.76±17.55kg). The mean prostate volume for 19 years and under, 20 29, 30 39, 40 49, 50 59, 60 69, 70 79, and 80 years and over are 8.78±5.24cm^3, 13.69 ±3.28cm^3, 15.09±7.77cm^3, 18.63±5.68cm^3, 19.04±5.59cm^3, 24.91±6.18cm^3, 34.41±30.73cm^3 and 32.45±16.30cm^3 respectively. The results show a strong relationship between prostate volume and age (r = 0.5). Prostate volume did not correlate well with height (r = 0.1) and weight (r = 0.1). The study established the baseline data for assessing the normality of prostate volume among Benue People of Nigeria.

Keywords: Prostate sizes, Ultrasound, Prolate ellipse.

The prostate is the largest accessory gland of the male reproductive system. It is approximately 3cm long. It is walnut shaped and has a base closely related to the neck of the urinary bladder and an apex that is in contact with the superior aspect of the urethral sphincter and deep perineal muscles (Moore and Dalley, 1999). Because of the close relationship of the organ with the neck of urinary bladder and prostatic urethra, the size becomes a very critical factor to consider when investigating patients with suspected bladder outlet obstruction.

The prostate is involved in a couple of pathological processes, namely, benign prostatic hypertrophy and carcinoma which lead to increase in its dimensions and volume. Thus, the prostate has been a subject of considerable research interest especially with regards to its volume. Prostate volume is assessed by a number of procedures including digital rectal examination (DRE), conventional contrast radiology, computed tomography, magnetic resonance imaging and ultrasound. Ultrasound is currently the preferred mode because it is fast and easy to carry out and does not involve ionizing radiation. It is also the cheapest of the procedures except DRE.

There is paucity of information regarding normal sonographic prostate volume in the middle belt region of Nigeria. This study is, therefore, aimed at providing a nomogram to serve as a baseline data for assessing the normality of the prostate volume within categorized age groups in Benue State, Nigeria. Anyanwu et al., (2004) had established such a nomogram for Southeast Nigerians but there may be ethnic variations.

MATERIALS AND METHOD

Scope

This was a two-year prospective study carried out in the radiodiagnostic departments of two hospitals in Makurdi, Benue State, Nigeria. The hospitals are Federal Medical Centre and Hospital of Immaculate Conception. The study lasted from April, 2004 to March, 2006.

Subject Selection

The following criteria were used for subject selection.

1. No clinical evidence of prostatic enlargement
2. No clinical evidence of other prostatic pathologies
3. Normal urinary steam
4. Non- obese subjects.
5. Benue State indigenes.

Sample Size Determination

A convenience sample size of 158 subjects aged between 9 and 100 years (Mean 27.65±17.55 years) was chosen. The subjects were between 93 and 186cm tall (Mean 169.20 ±24.61cm) and weighed between 21 and 101 kilograms (Mean 66.76±17.55kg).

Subject Preparation

The subjects' consent was obtained prior to the study. The subjects after recruitment into the study were instructed to drink 1 litre of clean water or juice 45 minutes before sonography was carried out. This was to have adequately filled urinary bladder through which the prostate could be visualized sonographically.

Equipment Used

The ultrasound equipment used were EHOSKAN 10 ultrasound machine with 3.5MHz and 5.0MHz mechanical sector transducers, Siemens LX ultrasound machine with 3.5MHz linear transducer and Toshiba SSA 250 sonolayer machine with 3.75MHz curve linear transducer. A Hana simple bathroom scale graduated at one kilogram intervals and capable of weighing up to 120 Kilograms was used to weigh the subjects. A metre tape was used to measure heights of the subjects.

Data Collection and Measurement

Sonography was carried out according to the transabdominal technique described by Casey and Sanders (1991). The transabdominal technique is used for estimation of size and radiotherapy planning. The transducer is angled inferiorly under the symphysis pubis. Transverse sections are obtained at angulations of about 15^0 caudad with the bladder full. The longest longitudinal image is obtained. This may require application of suprapubic pressure. The length, anteroposterior and transverse diameters of the prostate were measured on a frozen image. The weight and height of the subjects were also measured. Care was always taken to adjust the weighing scale to the zero mark between measurements to ensure correctness of measurements. One sonographer carried out all these measurements for each subject to avoid interobserver error.

The prostate volumes were calculated from the determined dimensions using the formula for prolate ellipse (Length x AP diameter x Transverse diameter x 0.52) as described by Casey and Sanders (1991).

RESULTS

The data collected in the course of the study were categorized according to age on one hand and height and weight of the subjects on the other. Analysis was done on computer using Microsoft Excel Package. Correlation analysis was done according to the Pearson's method described by Owen and Jones(1977).The age and prostate size distribution as presented in table 1 shows there was a steady increase in prostate dimensions and volumes with age.

The largest prostate volume occurred at between 70 and 79 years. The volume at this age is 34.41±30.73cm^3.The standard deviation recorded for the volume was highest at this point, being 30.73cm3. This means that there is wide variation in prostate volume at this age. The mean prostate dimensions recorded for this age group were 3.67±1.08cm, 3.61±0.79cm and 4.36±1.19cm for the length, AP and transverse diameters respectively. The smallest prostate volume occurred in subjects that are 19 years and under. Their mean prostate volume is 8.78±5.24cm3. Their mean prostate dimensions are 2.41±0.74cm, 2.13±0.60cm and 2.88 0.74cm for the length, AP and transverse diameters respectively.

The prostate volume shows a significant positive correlation (r = 0.5) with age. This means that apart from pathological enlargement, prostate volume depends on the age of the subject.

TABLE 1: Distribution of Prostate Dimensions and volumes according to Age.

PROSTATE SIZE					
Age (years)	Frequency	Length (cm)	AP Diameter (cm)	(Cm) Transverse Diameter	Volume (Cm^3).
19 and under	22	2.41 ± 0.66 (1.3 – 4.1)	2.13 ± 0.60 (1.1 – 2.7)	2.88 ± 0.74 (1.7 – 3.6)	8.78 ± 5.24 (1.41 – 17.06)
20 – 29	31	2.79 ± 0.31 (2.3 – 3.7)	2.62 ± 0.35 (1.9 – 3.6)	3.58 ± 0.35 (3.0 – 4.3)	13.69 ± 3.28 (8.48 – 23.79)
30 – 39	33	2.79 ± 0.31 (2.1 – 5.2)	2.63 ± 0.50 (1.9 – 3.6)	3.58 ± 0.35 (3.0 – 4.3)	13.69 ± 3.28 (8.48 – 23.79)
40 – 49	18	3.30 ± 0.37 (2.2 – 3.6)	2.95 ± 0.46 (1.6 – 3.8)	3.91 ± 0.48 (3.0 – 4.9)	18.69 ± 3.28 (8.48 – 23.78)
50 – 59	22	3.07 ± 0.32 (2.2 – 3.7)	2.90 ± 0.48 (2.0 – 4.0)	S4.07 ± 0.44 (3.1 – 4.8)	19.04 ± 5.59 (9.62 – 32.32)
60 – 69	16	3.41 ± 0.48 (2.8 – 6.6)	3.31 ± 0.31 (2.3 – 4.8)	4.20 ± 0.47 (2.9 – 4.7)	24.91 ± 6.18 (14.78 – 36.22)
70 – 79	10	3.67 ± 1.08 (2.8 – 6.6)	3.61 ± 0.79 (2.3 – 4.8)	4.36 ± 1.19 (3.1 – 7.2)	34.41 ± 30.73 (12.73 – 118.61)
80 and over	6	3.82 ± 0.53 (3.2 – 4.6)	3.30 ± 0.65 (2.3 – 3.9)	4.60 ± 1.01 (3.5 – 5.9)	32.45 ± 16.30 (12.63 – 55.04)
TOTAL	158				
Correlation Coefficient (r)		0.5	0.6	0.6	0.5

TABLE 2: Distribution of Prostate Dimensions and volumes according to Height and Weight.

Age (cm)	No of subject	Length (cm)	AP (cm)	(Cm) Transverse Diameter	Volume (Cm^3).
19 – 116	22	1.7	1.1	1.7	1.65
117 – 140	3	1.77 ± 0.45	1.37 ± 0.25	1.97 ± 0.12	2.53 ± 0.97
141 – 164	25	3.13 ± 0.61	2.94 ± 0.65	3.81 ± 0.92	20.26 ± 12.04
165 – 188	129	3.03 ± 0.56	2.85 ± 0.54	3.85 ± 0.56	18.21 ± 11.29
TOTAL	158				
Correlation Coefficient (r)		0.2	0.2	0.3	0.1
WEIGHT (KG)					
21 – 41	6	2.00 ± 0.52	1.63 ± 0.67	2.23 ± 0.65	4.75 ± 5.04
42 – 62	26	3.17 ± 0.63	2.89 ± 0.56	3.96 ± 0.83	20.51 ± 11.52
63 – 83	116	3.03 ± 0.56	2.89 ± 0.54	3.87 ± 0.56	18.69 ± 11.71
84 – 104	10	2.95 ± 0.34	2.56 ± 0.68	3.38 ± 0.46	13.52 ± 4.98
TOTAL	158				
Correlation Coefficient (r)		0.2	0.3	0.2	0.1

The distribution of prostate dimensions and volumes according to subject height on one hand and weight on the other as shown in table 2 did not yield a useful pattern. Correlation of prostate volume with both subject height and weight was low ($r = 0.1$).

DISCUSSION

Assessing the Prostate volume is the main criterion in evaluating the prostate gland for pathological enlargement. Witjes et. al., (1997) observed that estimation of total prostate volume by transrectal ultrasound (TRUS) was a reasonable way to obtain information required about prostate size but this technique is invasive. In assessing the prostate volume subject's age should be taken into consideration. This is because prostate dimensions and volume vary according to age. Anyanwu et. al., (2000) established a strong relationship between prostate size and age in Southeast Nigerians.

This study showed a steady increase in prostate dimensions and volume with age. The mean prostate volumes in the 19 years and under, 20- 29, 30-39, 40-49, 50-59, 60-69, 70-79 and 80 years and over age groups were 8.78 ± 5.24 cm^3, 13.69 ± 3.28 cm^3, 15.09 ± 7.77 cm^3, 18.63 ± 5.68 cm^3, 19.04 ± 5.59 cm^3, 24.91 ± 6.18 cm^3, 34.41 ± 30.73 cm^3, and 32.45 ± 16.30 cm^3. These values significantly differ from the previously established nomogram by Anyanwu et al, (2004). They are also not in agreement with the normal prostate volume of 20cm3 or less given by Casey and Sanders (1991) calculated from prolate ellipsoid formula (dimensional method). This may be related to the method adopted in measuring prostate dimensions and or ethnic variations. Also Casey and Sanders (1991) did not categorize prostate volumes according to age of subjects.

This study showed a wide variation in prostate volume in the older subjects as shown in Table 1. This is presumably because the prostate after the fifth decade of life either undergoes benign hypertrophy or progressive atrophy. In view of the risk of prostatic hypertrophy in old age, patients that are over 50 years should have their prostate volume determined when presenting for ultrasound investigation. Attah et. al.,(2000) are of the opinion that by the age of 80 years everyone is affected by benign prostatic hypertrophy.

Before ultrasound became the preferred mode of assessing prostate size, conventional radiology was the mainstay. It shows enlarged prostate as indented bladder base on contrast film investigations. Digital rectal examination is also one of the clinical investigations to assess prostate size. It is often the first line procedure and is complementary to the imaging procedures. It is qualitative as the prostate size cannot be quantitatively determined.

In determining prostate volume by ultrasound, two methods are used prolate ellipsoid technique (dimensional method) and step planimetry. The dimensional method is more commonly deployed but it is not as accurate as step planimetric volumetry. In carrying out planimetric prostate volumetry the 3D prostate shape is divided into thin sections. The areas of these sections are multiplied by distances between them. The volume is then calculated by summation of all the contribution from the cross sections. Aarnink et al., (1995) working on the accuracy of planimetric prostate volumetry in clinical practice recommended a step size of 4mm as a good compromise between investigation time and accuracy. Also, Nathan et. al., (1996) in a study to determine why prostate volumes and dimensions determined by TRUS were inaccurate found that using the dimensional method the prostate volumes was smaller than when step planimetry was used. The craniocaudal, anteropostenor and transverse diameters were underestimated by 13%, 2% and 7% respectively. In conclusion, they confirmed that to estimate accurately the volume of the prostate using prolate ellipsoid formula the current methodology of using maximum prostate dimensions needs to be changed. Human error in the clinic was a negligible factor (2%) with good correlation between the dimensions and volumes obtained in the clinic and those from computer enhanced images ($r = 0.94$).

CONCLUSION

This study by transabdominal pelvic sonography has established a nomogram of prostate sizes across various age groups among Benue People of Middle Belt of Nigeria.

We are aware that step planimetric volumetry is more accurate than the dimensional method we used. Planimetric volumetry method is hitherto not in use in our locality and we recommend the use of this nomogram with dimensional method only.

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