GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL 14, NO. 2, 2008: 213 - 215
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CORRELATIONS BETWEEN TOTAL PROSTATE VOLUME AND ANTHROPOMETRIC VARIABLES IN NORMAL SUBJECTS

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(Received 15, June 2007; Revision Accepted 11, February 2008)

ABSTRACT

To investigate the relationship between total prostate volume and age; total prostate volume and body mass index; and total prostate volume and body surface area. This can be useful in assessing the normality of prostate size. The length, anteroposterior and transverse diameters of the prostate gland were measured in 158 normal subjects by transabdominal pelvic sonography. The prostate volumes were calculated using the formula for prolate ellipse. The ages, and heights and weights of the subjects were recorded and both body mass index and body surface area calculated. Pearson's product moment correlation was used to establish relationship between variables. Statistical tests were two-tailed with $P < 0.01$ to indicate statistical significance. There was a significant positive linear correlation between total prostate volume an age ($r=0.638$; $p= 0.000$). The correlation between total prostate volume and body mass index was not significant ($r=0.155$; $p = 0.52$). The correlation between total prostate volume and body surface area was also not significant ($r=0.143$; $p= 0.72$). No useful trend was established between total prostate volume and body mass index and body surface area. Total prostate volume correlates significantly with age. Age can therefore be used as a predictor of prostate volume prior to pelvic ultrasonography. Total prostate volume does not correlate significantly with body mass index and body surface area.

KEYWORDS: Prostate; Ultrasound; Prostate volume; Body mass index; Body surface area.

INTRODUCTION

At the base of the urinary bladder and surrounding the neck is a small gland; the prostate. The urethra traverses the prostate gland as it exits the bladder. Anatomically, the prostate gland is made up of five lobes namely; the posterior lobe, anterior lobe, two lateral lobes and median lobe (Moore and Dalley; 1999). In imaging the prostate by ultrasound, the organ is not depicted in terms of lobes but by zonal anatomy thus; the peripheral zone, central zone and transition zone. Studies by McNeal (1968), McNeal (1972), McNeal (1981) and McNeal (1981) have shown the morphologic appearance of adult prostate gland to consist of two well-delineated regions within the prostate rather than lobes.

The close relationship of the prostate to the bladder outlet makes it important when it is pathologically enlarged as in benign prostatic hypertrophy and cancer of the prostate. Enlargement of prostate causes bladder outlet obstruction. Total prostate volume increases with age but when the enlargement becomes excessive symptoms arise. Anyanwu et al. (2000) established a strong linear relationship between prostrate size and age among southeast Nigerians. Eze et al. (2006) also reported a fairly strong linear relationship between prostate volume and age ($r=0.5$) among the people of Benue, Nigeria. Prostate volume however did not correlate strongly with height ($r=0.1$) and weight ($r=0.1$). Eze et al. (2006) reported the following prostate volumes: $8.78 \pm 5.24 cm^3$ for 19 years and under, $13.69 \pm 3.28 cm^3$ for 20 – 29 years, $15.09 \pm 7.77 cm^3$ for 30 – 39 years, $18.69 \pm 3.28 cm^3$ for 40-49 years, $19.04 \pm 5.9 cm^3$ for 50-59 years, $24.91 \pm 6.18 cm^3$ for 60 – 69 years, 34. 41 ± 30.73 for 70 – 79 years and $32.45 \pm 16.30 cm^3$ for 80 years and over.

The estimation of body surface area is based on a formula derived by Du Bois and Du Bois (1916). The formula was derived by trial and error when the authors examined nine individuals of various ages, shapes and sizes and measured their body surface areas directly with moulds. In our study, we used the Du Bois formula to calculate the body surface area of our subjects.

The aim of this study is to investigate the relationship between prostate volume and age, body mass index and body surface area. To the best of our knowledge no previous study on prostate volume has included body mass index and body surface area and their relationship with prostate volume. The result of the study will help clinicians in assessing the normality of prostate sizes with regard to these anthropometric variables.

MATERIALS AND METHODS

SCOPE OF THE STUDY: This was a two-year prospective study carried out in the radio-diagnostic 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 pathological prostatic enlargement.
2. No clinical evidence of other prostatic pathologies
3. Normal urinary stream
4. Non-obese subjects.

SAMPLE SIZE DETERMINATION: A convenient sample size of 158 subjects with characteristics as shown in table 1 was chosen.

SUBJECT PREPARATION: All the subjects indicated willingness to participate in the study and gave informed consent before being recruited. 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

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machine with 3.5MHz linear transducer and Toshiba SSA 250 Sonolayer machine with 3.75MHz curvilinear 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 the heights of the subjects.

DATA COLLECTION AND MEASUREMENT

Transabdominal pelvic sonography was carried out on each subject according to the 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 degrees toward the feet 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 frozen images. The prostate volumes were estimated from the determined dimensions using the formula for prolate ellipse;

$$P.E = 0.52 (L \times D_{AP} \times D_T) \quad \ldots\ldots 1$$

Where PE is the prolate ellipse volume, L the prostate length, D_{AP} the prostate AP diameter and D_T the prostate transverse diameter as described by Casey and Sanders (1991).

The weight and height of the subjects were measured. Care was always taken to adjust the weighting scale to the zero mark between measurements to ensure correctness of measurement. The body mass index (BMI) was computed for each subject while the body surface area was determined according to the formula given in Du Bois and Du Bois (1916);

$$BSA = (W^{0.425} \times H^{0.725}) 0.007184 \quad \ldots\ldots 2$$

Where W is weight in kilograms and H is height in centimeters.

One sonographer (C.C) carried out all these measurements for each subject to avoid inter-observer variations. Five measurements were made for each dimension and the average taken.

DATA ANALYSIS

Data collected were analysed on computer using Microsoft Excel and SPSS.11 packages. Correlation analysis was done according to the Pearson's method as described by Owen and Jones (1977) using SPSS.11. Values are expressed as mean±standard deviation. $P < 0.01$ indicated statistical significance.

RESULTS

The means total prostate volume (TPV) of the subjects was 17.89± 11.19cm3 (range 1.41cm^3-118.61cm^3). The mean body mass index (BMI) was 23.80±2.86kg/mg^2 (range 15.22kg/m^2 –36.03kg/m^2) while the mean body surface area (BSA) was 1.78 ± 0.19cm^2 (range 0.76cm^2-2.20cm^2).

The total prostate volume showed a significant positive correlation with age; (r=0.638; p = 0.000). The body mass index and body surface area did not show significant correlation with total prostate volume; (r=0.155; p = 0.52) and 1. (r=0.143; p=0.72).

Figure 1 is a graph of age against total prostate volume. This shows a general linear upward trend of total prostate volume with increasing age.

Table 1 is the mean values of anthropometric variables of the subjects.

Table 1: Values of Anthropometric variables of the subjects

	Age (years)	Height (cm)	Weight (kg)	BMI (kg/m^2)	BSA (cm^2)
Range	9....100	93....186	21....101	15.22....36.03	0.7569....2.2005
Mean	27.654	169.20	66.76	23.89	1.7777708
Standard deviation	17.55	24.61	11.23	2.86	0.18791

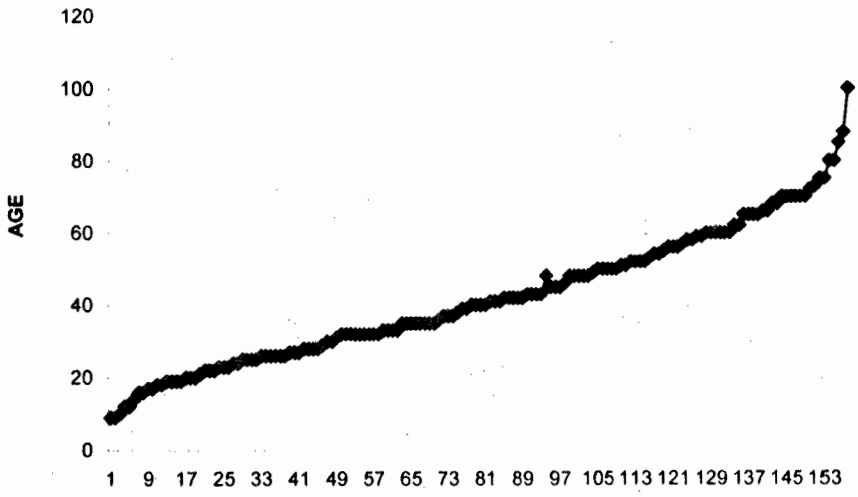

Figure 1: A graph of age against total prostate volume.

DISCUSSION

The result of this study shows a strong linear relationship between prostate volume and age. This relationship should be put to clinical advantage. Elderly men presenting for ultrasound investigation of other organs should have their prostate volume determined. This would enable the referring clinician to initiate a conservative management procedure and preclude surgery before the onset of symptoms should the prostate volume be above the value for his age. This is largely because by the age of 80 years everyone is affected by benign prostatic hypertrophy (Attah et al 2000). This linear relationship between prostate volume and age may be breached on rare instances when the prostate enlarges pathologically in childhood. Essiet et al (2003) reported the case of an eight-year old child with rhabdomyosarcoma of the prostate gland presenting as urinary retention.

The uniqueness of this study is that is introduced new concepts, namely body mass index and body surface area in evaluation of prostate volume in normal subjects. These two parameters have not been reported in relation to the prostate.

Prostate volume does not correlate with body mass index and body surface area. This is in agreement with the study by Eze et al (2006) which reported that prostate volume did not show strong correlation with height and weight of subjects. The obvious implication of this result is that in investigating patients for prostate size, age should be the primary consideration. There were some obvious shortcomings in our study. In determining the prostate volume we used ellipsoid approximation (dimensional method) instead of the more accurate planimetric volumetry. Our estimated prostate volumes may therefore be questioned. However, since the dimensional method is used locally, the result of this study can find application pending the acquisition of planimetric data for the local population. Also, measuring the height and weight of our subjects with metre tape and simple bathroom weighting scale is not an accurate way of making these measurements. A *seca* scale would have been more appropriate. Some of our subjects were illiterate and did not know their exact age. We resorted to estimation based on how old they thought they were at a certain historical time such as the Nigeria/Biafra Civil War.

This study is purely feasibility in purpose and is not to be regarded as a clinical benchmark because of the small sample size. We suggest a repeat study with a much larger sample and planimetric volumetry for prostate volume determination to ascertain the accuracy of our findings.

CONCLUSION

Total prostate volume has a strong significant linear relationship with age. Body mass index and body surface area do not correlate significantly with total prostate volume. Age can therefore be used to predict prostate volume prior to ultrasound.

REFERENCES

Anyamwu, G. E, Akpuaka, F. C, Anibeze, C. I. P and Mgbo, S . 2000. Relationship of measured prostate diameters with age in southeast Nigerians. Journal of Experimental and clinical Anatomy. 1: 34-35.

Attah, B.O., (Ed) 2000. Human pathology: A complete text for Africa. Ibadan: Ibadan University press. Pp. 524-535.

Casey, J and Sanders, R. C., 1991. Rule out prostate carcinoma; benign prostatic hypertrophy. In: Sanders RC (Ed). Clinical sonography. 3rd Edition. Boston: Little Brown and Co. Pp333-324

Du Bois, D and Du Bois, E. F., 1996. A formula to estimate the approximate surface are if height and weight be known. Arch Intern Med. 17:863-871

Essiet, A, Irekpita, E. E and Nkposong, E. O., 2003. Rhabdomyosacoma of the prostate gland presenting as urinary retention in a child- a case report. Niger Med J. 44(4): 99-100.

Eze, C. U, Ohagwu, C. C, Okaro, A. O and Nwobi, I. C., 2006. Sonographic assessment of normal prostate sizes within age groups among Benue people of Nigeria. Journal of Clinical and Experimental Anatomy. 5(2): 13-17.

McNeal, J. E., 1968. Regional morphology and pathology of the prostate. AM J Clin Pathol. 49:347

McNeal, J. E. 1972. The prostate and prostatic urethra: morphologic synthesis. J urol. 107:1008

McNeal, J. E., 1981. Normal and pathologic anatomy of the prostate. Urology 17:11.

McNeal, J. E., 1981. The zonal anatomy of the prostate 2:35

Moore, K. L and Dalley A. F., 1999. Clinically oriented anatomy. 4th Edition. Baltimore: Lippincott Williams and Wilkins P. 369.

Owen, F and Jones R., 1977. Statistics. Landon: Polytech Publishers. Pp. 367- 407