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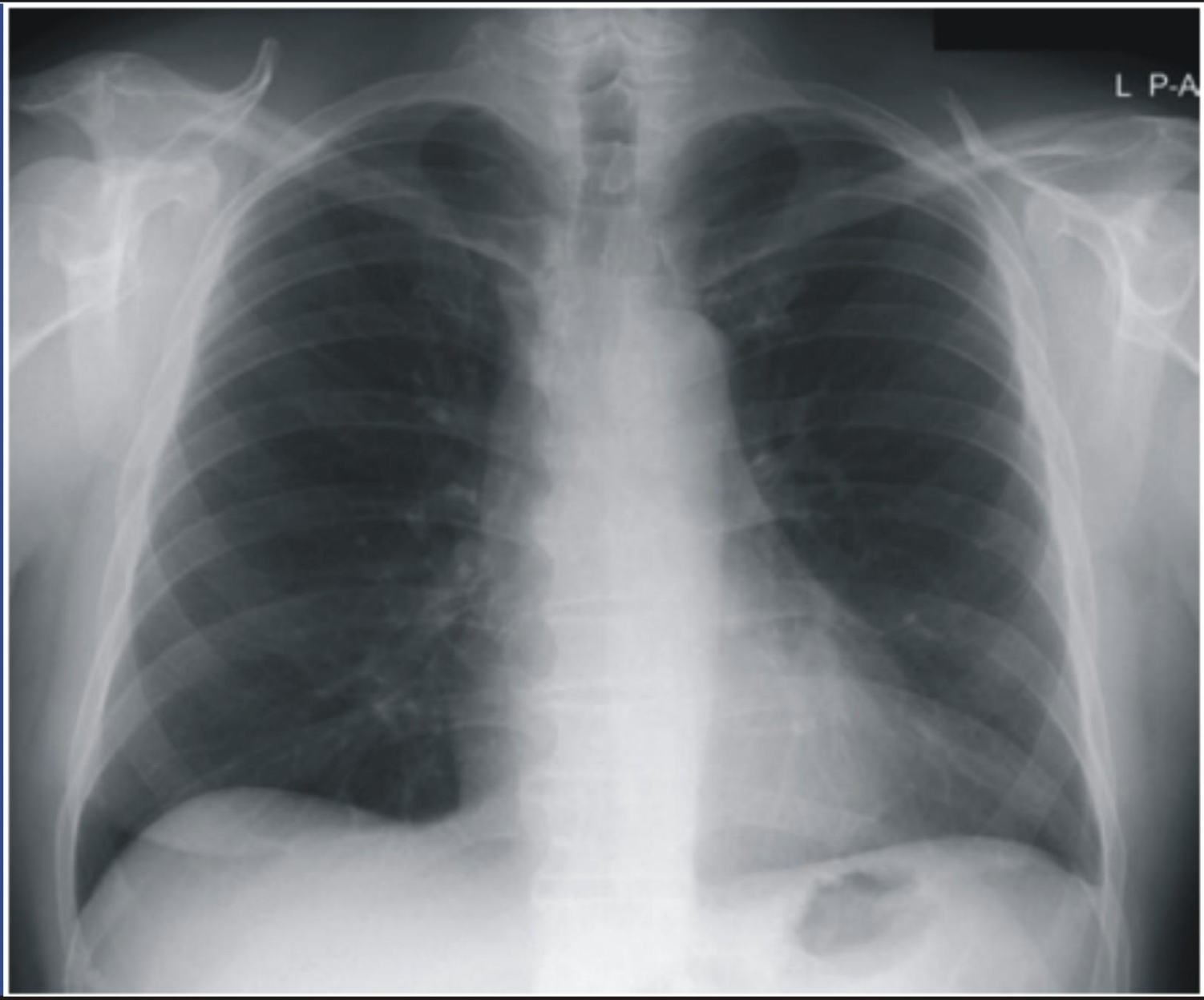

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Sonographic Determination of Normative Values of Infra-Renal Aortic Diameter in a Negroid Population in Nigeria

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ABSTRACT

Objective: To establish normal values of infra-renal aortic diameter and to determine its relationship with anthropometric variables.

Methods: A prospective and cross sectional clinical study involving 742 subjects (369 males and 373 females) aged 18 to 45 years which was carried out in Nigeria in 2012. Subjects were scanned supine and at rest. Measurements were taken from freezed longitudinal images using an exterior landmark of lumbar regions and an interior landmark of aortic bifurcation. The average of two values was recorded as the infra-renal aortic diameter. Statistical Package for the Social Sciences v16.0 was used for data analyses. The probability value adopted for statistical significance was $p < 0.05$.

Results: The mean infra-renal aortic diameter for male and female subjects was 15.0mm ± 1.8mm and 13.5 ± 2.0mm respectively. There was a statistically significant difference between both means ($p = 0.000$). Pearson correlation showed significant correlations between infra-renal aortic diameter and waist circumference ($r = 0.493$), weight ($r = 0.465$), BSA ($r = 0.432$), BMI ($r = 0.403$), height ($r = 0.238$) and age ($r = - 0.033$).

Conclusion: A normogram for infra-renal aortic diameter is generated. The study would be relevant in the determination of abdominal aortic dilatation in young adults. It might also find usefulness in pre-transplantation assessment of the vessel and screening of siblings of patient who have infra-renal aortic aneurysm.

Keywords: Ultrasound, Infra-renal aortic diameter (IAD), sonographer

Introduction

The normal diameter of the abdominal aorta varies with age, sex, weight and body surface area and decreases progressively from its entry into the abdominal cavity to the iliac bifurcation [1]. Infra-renal aortic diameter (IAD) is essential for clinical evaluation of infra-renal aortic aneurysm, abdominal aortic aneurysm (AAA) and aortic enlargement [2].

The anteroposterior (AP) diameter of the aorta measures 2.3cm in young males and 1.9cm in females. This diameter decreases as it courses inferiorly. Consequently, the AP measurement varies from one segment of the aorta to another and it depends on age, gender and the presence or absence of disease [3]. In elderly men, the IAD is between 1.5 and 2.4cm [4]. However, the IAD only takes on clinical significance once it exceeds 3cm, a level at which the propensity for further dilatation and subsequent rupture is high [2]. In order to determine the relevance of these dilatations, information concerning the normal infra-renal aorta and its diameter in relation to age, sex, and body size is essential [5].

Different imaging modalities exist for the assessment of the aorta such as Angiography, Computed Tomography [6] and Magnetic Resonance Imaging [7]**.** However, aside the risk of ionizing radiation, angiography is invasive and it is difficult to find healthy volunteers. Computed tomography (CT) involves ionizing radiation and it is expensive. Magnetic resonance imaging has no apparent radiation risk however, it is expensive.

Ultrasound however, is non-invasive, not expensive and gives reproducible results [8]. These characteristic allow serial testing before any decision to proceed with an invasive procedure is made. Also, the variability of ultrasound measurement of IAD between and within observers are similar and are acceptable for clinical decision-making [9]**.** Sonographically, the normal aorta has an anechoic lumen with echogenic walls [3]**.**

Racial variations have been noticed in the measurement of normal infra-renal aorta and the expected values are not well defined. Therefore, the aim of this study is to establish a normogram for infra-renal aortic diameter in young Nigerian adult population.

People and Methods

A prospective and cross sectional clinical study involving 742 subjects (369 males and 373 females) aged 18 to 45 years which was carried out in Enugu, Nigeria. The work was carried out between June to November, 2012. Ethical approval was obtained from the foremost tertiary hospital in the town and subjects gave informed, signed consent. Formula was used to determine sample size and subjects were recruited through convenience sampling. Excluded from the study were subjects on anti-hypertensive and anti-diabetic therapy, body mass index ≥ 30 kg/m^2, history of renal diseases, and subjects with ultrasound evidence of AAA $\geq$ 3.0cm, intra-abdominal mass and pregnant women.

A Mindray DP-1100 ultrasound machine manufactured by Shenzhen Biomedical electronics in 2004 with a 3.5MHZ sector transducer was used. Height (cm) and weight (kg) were measured using height and weight scales, respectively. Body surface area (m^2) was calculated by the method of Dubois[10**]** as 0.007184 x height (cm) $^{0.725}$ x weight (kg) $^{0.425}$.

Subjects were scanned supine and at rest. Measurements were taken from freezed longitudinal images using an exterior landmark of lumbar regions and the interior landmark was between the origin of the renal arteries and the aortic bifurcation, about 3cm to the bifurcation in the adults (Sonesson et al., 1994). The measurement was from outer wall to outer wall (Zwiebel, 1992). The average of two values was recorded as the infra-renal aortic diameter. Statistical Package for the Social Sciences v16.0 was used for data analyses. The probability value adopted for statistical significance was $p < 0.05$.

Results

742 volunteers made up of 369 males (49.73%) and 373 females (50.27%) with a mean age of 30.0 ± 8.0 years were involved. The mean values of other anthropometric variables derived for both gender were 82.6 ± 10.4 cm (waist circumference), 1.7 ± 0.1m (height), 68.8 ± 10.1kg (weight), 24.5 ± 3.2 kg/m^2 (BMI), 1.8 ± 0.2 m^2 (BSA) and 14.3 ± 2.1mm (IAD) respectively. These are summarized in tables 1-3.

Discussion

Men with abdominal aortic aneurysm and those with aortic diameters measuring 25-29 mm have an increased risk of mortality and subsequent hospital admissions compared with men with an aorta diameter of ≤ 24 mm [11]. This work was to determine the infra-renal aortic diameter in both gender in our locality. The observed mean infra-renal aortic diameter in this study for male and female subjects is 15.0 ± 1.8mm and 13.5 ± 2.0mm respectively.

This was comparable to the 15.7mm and 14.9mm for male and female subjects derived by a previous work [12]. Other corroborating works found ranges that varied from 14.6mm ± 2.0 mm to 23.5 ± 5.4mm [5, 13, 14]. Dissimilarity was however, found in a work which assessed a wider age range and it was noted that men aged 70 years and above had an IAD above 3.1cm [15]. The geriatric age is probably responsible for this increased IAD diameter.

Table 1: Gender and age group distribution of subjects

Age group	Male	Female	Total	Percentage
18-20	40	40	80	10.8
21-23	50	50	100	13.5
24-26	50	50	100	13.5
27-29	40	40	80	10.8
30-32	30	30	60	8.1
33-35	35	40	75	10.1
36-38	40	40	80	10.8
39-41	42	41	83	11.2
42-45	42	42	84	11.3
Total	369	373	742	100

Table 2:Dispersion and central tendencies of measured variables

Parameters	Range	Male	Female	Mean
Age (years)	18 - 45	30.9 ± 8.1	30.8 ± 8.0	30.8 ± 8.0
WC (cm)	59 - 113	84.5 ± 9.6	80.7 ± 1.1	82.6 ± 10.4
Height (m)	1.41–1.88	1.7 ± 0.1	1.6 ± 0.06	1.7 ± 0.1
Weight (kg)	40 - 97	72.5 ± 10.0	65.2 ± 1.0	68.8 ± 10.1
BMI (kg/m^2)	16.87–35.16	24.4 ± 3.0	24.6 ± 3.3	24.5 ± 3.2
BSA (m^2)	1.26–2.17	1.9 ± 0.1	1.7 ± 0.2	1.8 ± 0.2
IAD (mm)	10-19	15.0 ± 1.8	13.5 ± 2.0	14.3 ± 2.1

Table 4: Relationship between IAD and anthropometric parameters

Parameter	r	p
WC	0.493	0.000
Weight	0.465	0.000
BSA	0.432	0.000
BMI	0.403	0.000
Height	0.238	0.000
Age	-0.033	0.371

It has been suggested that aortic diameter at any level is a function of age, gender, and BSA [1]. The gender difference in our study was 1.5mm. Also, a statistically significant difference was noted between both gender and between IAD and age in both gender ($p = 0.000$). This agrees with some previous works [11, 16]. This increase was found to be more pronounced in men and women [17]. However, Sonesson [5] and Udemezue [12] found no effect of gender on IAD after adjustment for body size.

A positive, mild and statistically-significant relationship was observed between infra-renal aortic diameter and waist circumference ($r = 0.493$), weight ($r = 0.465$), BSA ($r = 0.432$) and BMI ($r = 0.403$). The relationship with height ($r = 0.238$) was weak but statistically significant while there was no relationship between IAD and age ($r = -0.033$, $P < 0.371$). Our findings are in agreement with previous works [4, 16, 18]. The highest correlation was however, found in IAD with BSA [16].

Conclusion

Infrarenal aortic diameter (IAD) is essential for clinical evaluation of infrarenal aortic aneurysm and aortic enlargement especially in cases of abdominal aortic aneurysm (AAA).

A normogram is established which can be of great help for pre-transplantation assessment of the vessel and screening of siblings of patients with infrarenal aortic aneurysm. The study would also be relevant in the determination of abdominal aortic dilatation in young adult.

Recommendation

We recommend that this study be carried out within our age range in other localities and on geriatrics within our locality in the country.

Limitation of study

In some subjects, IAD was difficult to assess due to increase in abdominal gas and abdominal adipose tissue.

Table 3: Measured infrarenal aortic diameter according to age groups

Age group	18-20	21-23	24-26	27-29	30-32	33-35	36-38	39-41	42-45	Mean
Male IAD (mm)	12.5 ± 1.2	14.3 ± 1.4	14.2 ± 1.6	14.8 ± 1.7	15.6 ± 1.7	15.4 ± 1.3	15.8 ± 1.3	16.4 ± 1.3	16.5 ± 1.2	15.0 ± 1.8
Female IAD (mm)	12.0 ± 1.6	12.3 ± 1.6	12.3 ± 1.4	13.1 ± 1.8	14.1 ± 1.9	14.3 ± 2.1	14.2 ± 1.5	14.2 ± 1.6	15.6 ± 1.2	13.5 ± 2.0

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