ULTRASOUND MEASUREMENT OF THE ABDOMINAL AORTIC DIAMETER IN A NORMOTENSIVE AND HYPERTENSIVE ADULT NIGERIAN POPULATION IN ENUGU

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ABSTRACT

Background: Hypertension has direct effect on abdominal aortic diameter. Some of its manifestations are aortic aneurysm and dissection.

Aims- To compare the AAD among adult normotensive and hypertensive subjects as well as correlating with age, sex and blood pressure.

Materials and methods: Participants will be randomly selected from hypertensives attending Cardiology Clinic, in University of Nigeria teaching hospital (UNTH) Enugu, Nigeria. Controls will be apparently healthy normotensive volunteers. Participants' demographics, weight, height and blood pressure will be documented. Ultrasound measurements of infrarenal AAD will be taken at 2 cm below the origin of the superior mesenteric artery. Data will be statistically analyzed and a p-value of ≤ 0.05 will be considered significant.

Results: 300 participants: comprising of 150 normotensives and 150 hypertensives were studied. The mean values for AAD in normotensive males and females were 16.66 ± 2.04

mm and 15.36 ± 1.97 mm respectively. Whereas the values for hypertensives, changed to 18.89 ± 2.64 mm and 16.57 ± 2.54 mm respectively. The AAD showed a positive correlation with systolic blood pressure ($r^2 = 0.317$, $P \leq 0.001$) but not with diastolic blood pressure.

Conclusion: Abdominal aortic diameter was significantly larger among hypertensives than normotensives. The diameter increased with age in both normotensive and hypertensive subjects.

***Key words*: Hypertensives, normotensives, abdominal aortic diameter, ultrasound.**

INTRODUCTION

Normal cross-sectional abdominal aortic luminal diameter of adults range from 3 cm proximally to about 1 cm at the site of bifurcation (see figure 1).[1] Mild increase in these values corresponds to aortic ectasia. But it is referred to as aneurismal when such diameter is greater than 3 cm at a level that is inferior to renal arteries.[2]

The middle layer of abdominal aorta is called tunica media and its primary structural elements are elastin and collagen.[3] These components regulate aortic hemodynamic events.[3] Alteration of these hemodynamic events are responsible for the phenomenon of injuries and repairs in the media of a normal abdominal aorta..[4] These changes are more pronounced in the abdominal aorta than other arteries.[3] Worst offending factor is hypertension as it increases the mechanical stress of billions of cyclic contractions and expansions of heart cycle. The aftermath is increased fragmentation of elastin and consequent aortic ectasia. Hence, in hypertension the aorta tend to dilate to accommodate the increased fluid volume.[3,5] Consequently, increased blood pressure is commonly cited as a risk factor for abdominal aortic aneurysms.[3,6-9] The definition of hypertension is systolic blood pressure of 140 mmHg and above or diastolic blood pressure of 90 mmHg and above or both.

The choice of ultrasonography in this study is favored by its low cost, high accuracy, non-invasiveness and Doppler potentials. Its value is seen to correlate with computed tomography (CT).[2] Ninety to ninety five percent of abdominal aortic aneurysms are known to occur at infrarenal aorta; therefore this study is restricted to infrarenal AAD in adult normotensive and hypertensive subjects.[2]

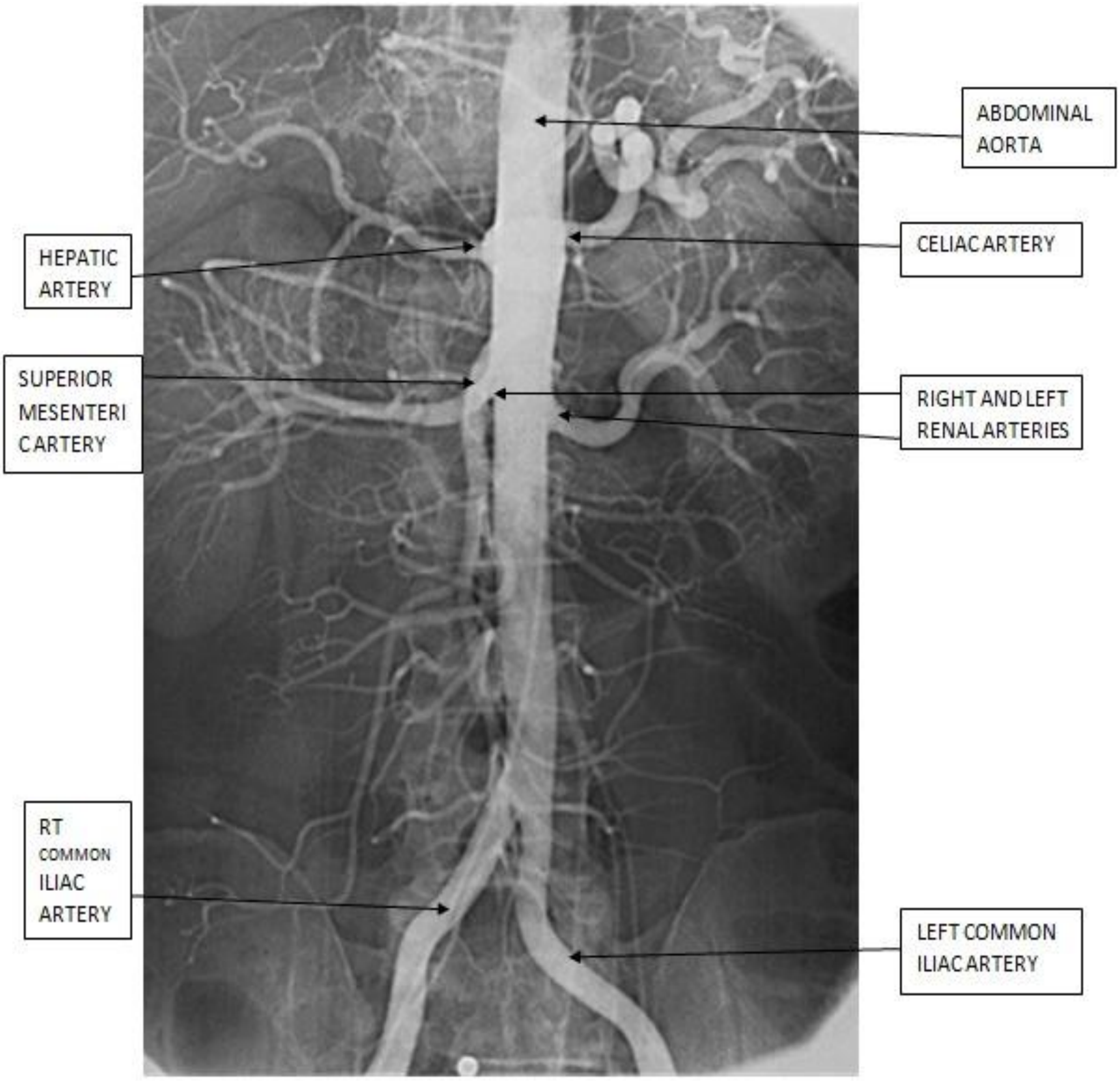

Fig. 1- Conventional aortic arteriogram showing the abdominal aorta, the superior mesenteric artery (SMA), and its major branches.[10]

Aims and objectives

- To compare the infrarenel AAD in normotensives and hypertensives.

- To correlate AAD (in normotensives and hypertensives) with diastolic and systolic blood pressures.

Materials And Methods

The subset of participants with hypertension will be selected from patients attending Cardiology Clinic at University of Nigeria (UNTH) Enugu. Controls (normotensives) will be selected from patients' relations and hospital staff. Selection across age groups will be selected by simple random sampling. Study period is six months.. Heights and weights will be measured on ELGIL Height/Weight scale in light clothing and devoid of shoes.

The blood pressure of each subject will be measured thrice in a sitting position using Accusson's mercury sphygmomanometer after five minutes interval of rest. The mean of the three sitting blood pressure measurements will be recorded. The duration of hypertension and antihypertensive medications will be recorded. No laboratory investigation will be conducted.

In terms of ultrasound scanning technique, each subject will be examined supine using 3.5MHz curvilinear probe on a Hitachi EUB-525 Doppler Ultrasound machine by the researchers. The transducer will be placed on the epigastrium and moved longitudinally to visualize the full length of abdominal aorta.

The superior mesenteric artery will be identified and traced to its origin from the aorta on the longitudinal view, Figure 2. The image with the widest diameter in the longitudinal plane will be frozen in systole and the play back function will be used to identify the best view.

The inner to inner technique of measurement used by Huseyin et al.[13] will be adopted for this study. The anteroposterior (AP) diameter will be measured from the inner margin of the anterior aortic wall to the inner margin of the posterior aortic wall (ITI).

The site of measurement will be at 2 cm below the origin of the SMA, on the static longitudinal image using electronic calipers, Figures 2 and 3. This allows correct measurement and placement of the calipers perpendicular to the long axis of the vessel.[17]

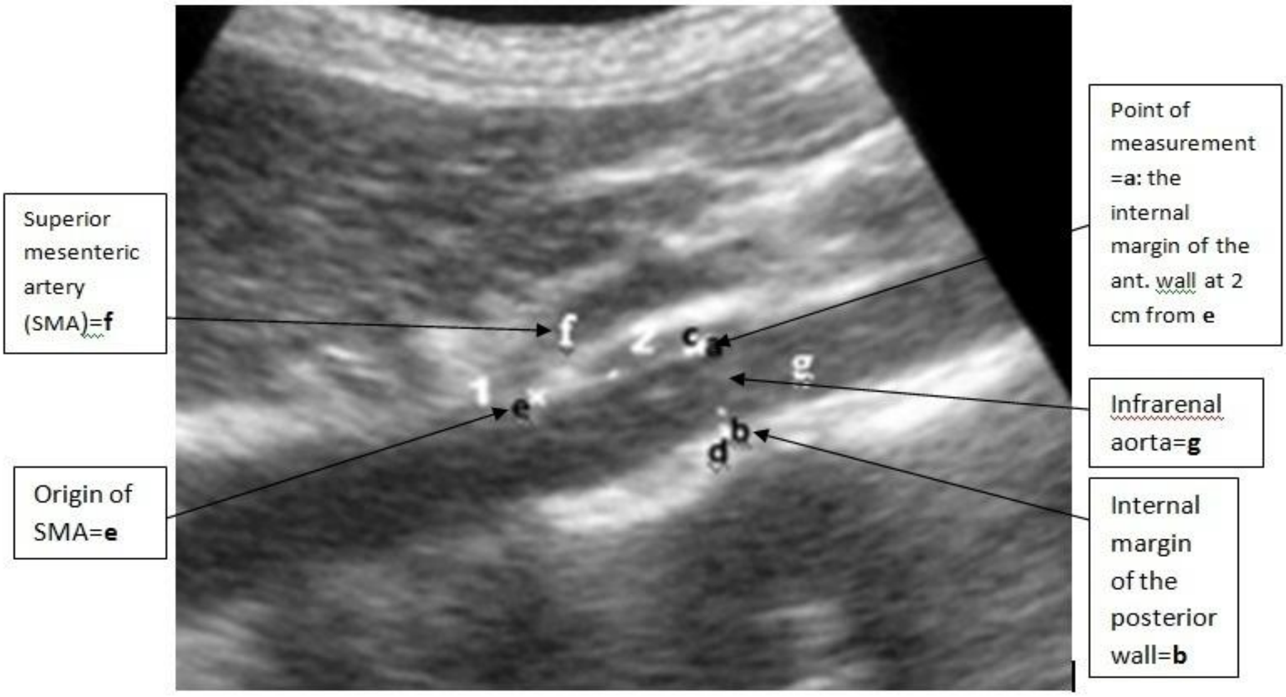

Fig. 2: 2D grayscale ultrasound longitudinal image of the abdominal aorta showing the pattern of measurement. a = point of measurement of AAD (inner margin of the anterior wall),b = Inner margin of the posterior wall, c = outer margin of anterior wall, d = outer margin of posterior wall, e = origin of superior mesenteric artery, f = superior mesenteric artery, g = infrarenal aorta.

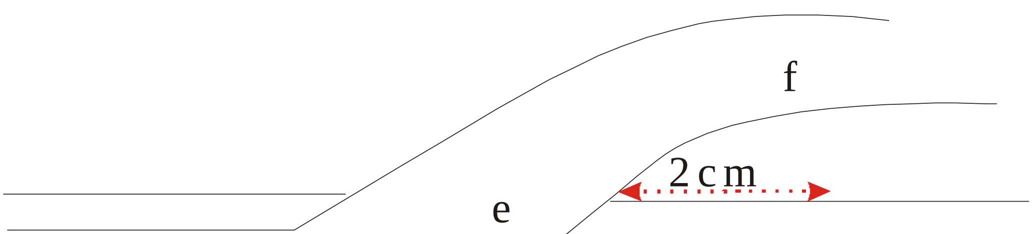

Fig. 3: Line diagram to demonstrate the pattern of measurement of the infrarenal aorta, longitudinal section. a = point of measurement of AAD (inner margin of the anterior wall), b = inner margin of the posterior wall, e = origin of superior mesenteric artery, f = superior mesenteric artery, g = infrarenal aorta

RESULTS

A total of 300 participants were studied. There were 136 (45.3%) males and 164 (54.7%) females giving a male to female ratio of 1:1.4.

Their ages ranged from 20 – 99 years, see Table 1.

Table 1: Demographic Data

Variable		Frequency (N)	Percentage (%)	Frequency (N)	Percentage (%)
		Normotensive		**Hypertensive**	
Age(yr)	20-29	12	8.00	8	5.33
	30-39	21	14.00	11	7.33
	40-49	27	18.00	32	21.33
	50-59	38	25.33	38	25.33
	60-69	23	15.33	24	16.00
	70-79	17	11.33	21	14.00
	80-89	10	6.67	12	8.00
	90-99	2	1.33	2	1.33
Sex	Male	66	44.00	70	46.67
	Female	84	56.00	80	53.33

The normotensive group, had a mean AAD of 15.70 ± 2.0mm while the hypertensive group had mean AAD of 17.72 ± 2.8mm (see table 2)..

The hypertensives had significantly higher AAD than the normotensives, $p < 0.001$, Table 2.

In both sexes, hypertensives had higher AAD than the normotensives, $p < 0.001$.

Table 2: The mean AAD in normotensive and hypertensive males and females

Category	Total No	Males		Females			Total
		No.	AAD	No.	AAD	P	
Normotensives	150	66	16.66 ± 2.04	84	15.36 ± 1.97	0.001	15.70±2.03
Hypertensives	150	70	18.89 ± 2.64	80	16.57 ± 2.54	0.001	17.72±2.83

The mean values of AAD in both normotensives and hypertensives, at different diastolic and systolic blood pressures, are shown in Figures 4 and 5.

Abdominal aortic diameter increased with SBP but not with DBP. (see figures 6 &7).

The SBP, unlike DBP had significant positive correlation with AAD as shown in Table 3.

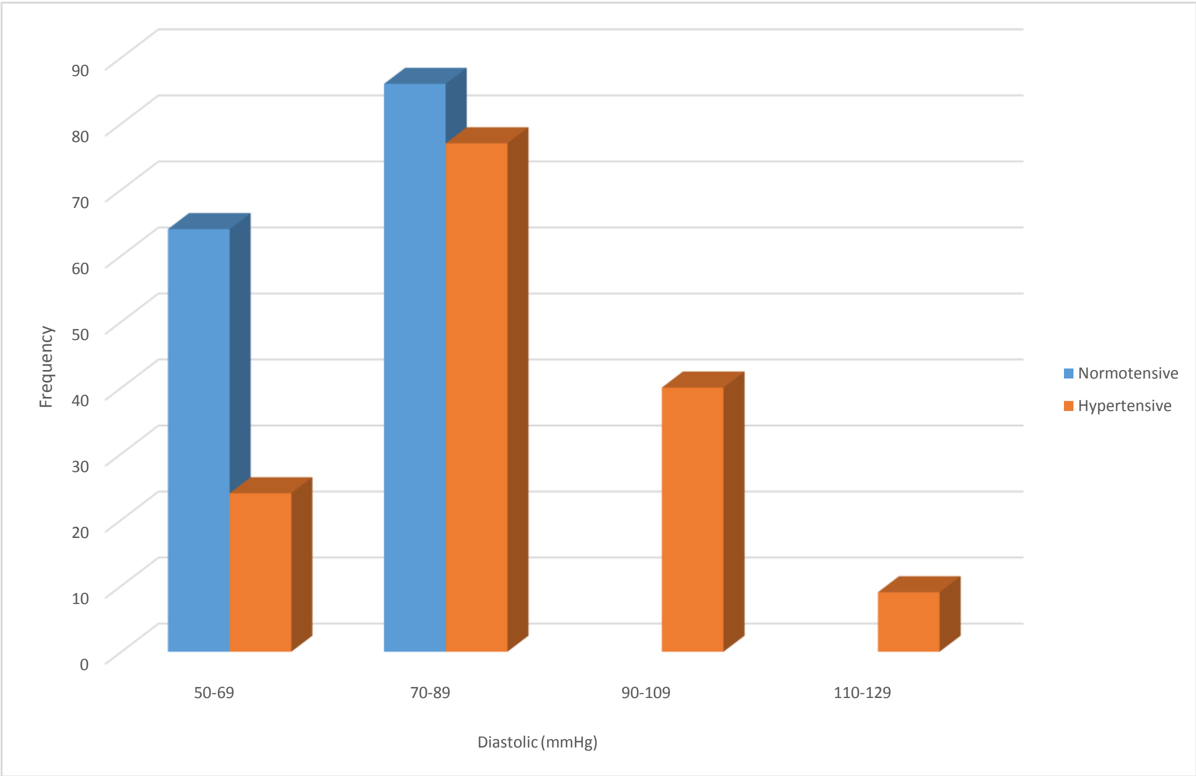

Fig. 4: Frequency distribution of participants by diastolic blood pressure

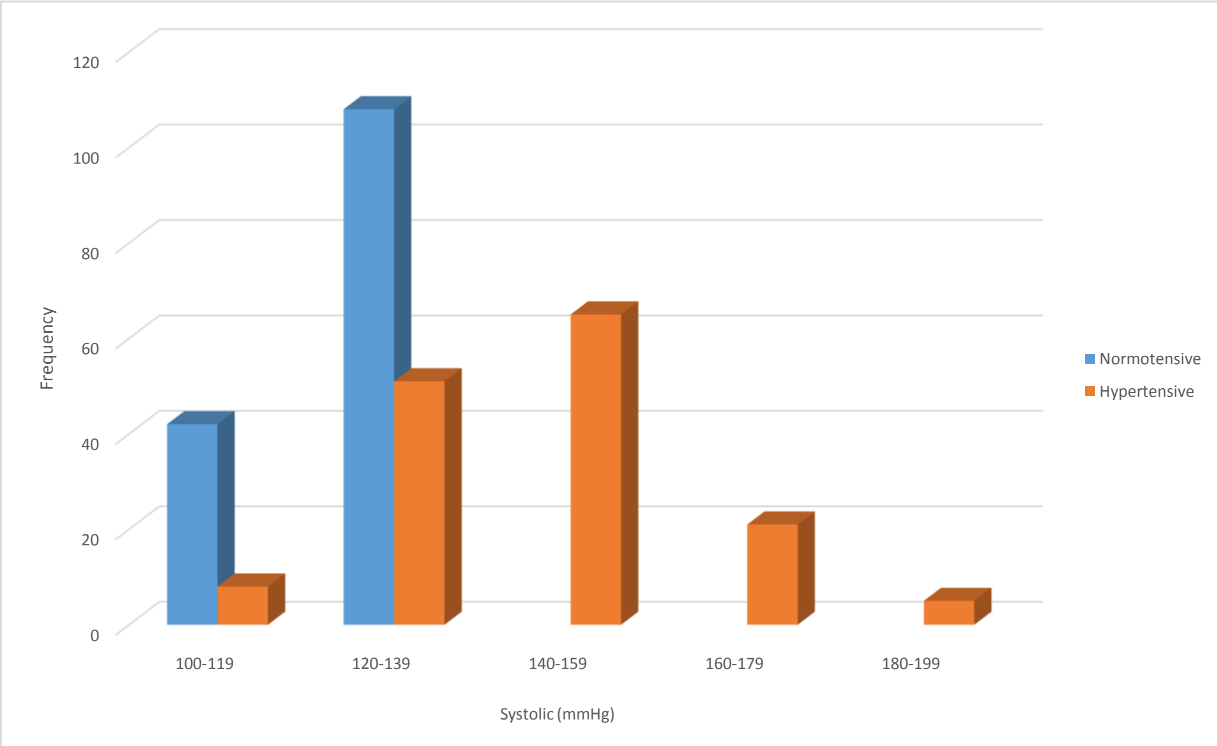

Fig. 5: Frequency distribution of participants by systolic blood pressure

Table 3: Correlation of AAD with SBP and DBP

Normotensives			
	r	**r^2(%)**	**P**
SBP	0.317	10	0.000
DBP	0.121	1	0.192
Hypertensives			
SBP	0.195	4	0.032
DBP	0.097	1	0.290

r = 'Pearson's correlation coefficient'. r^2(%) = 'coefficient of determination

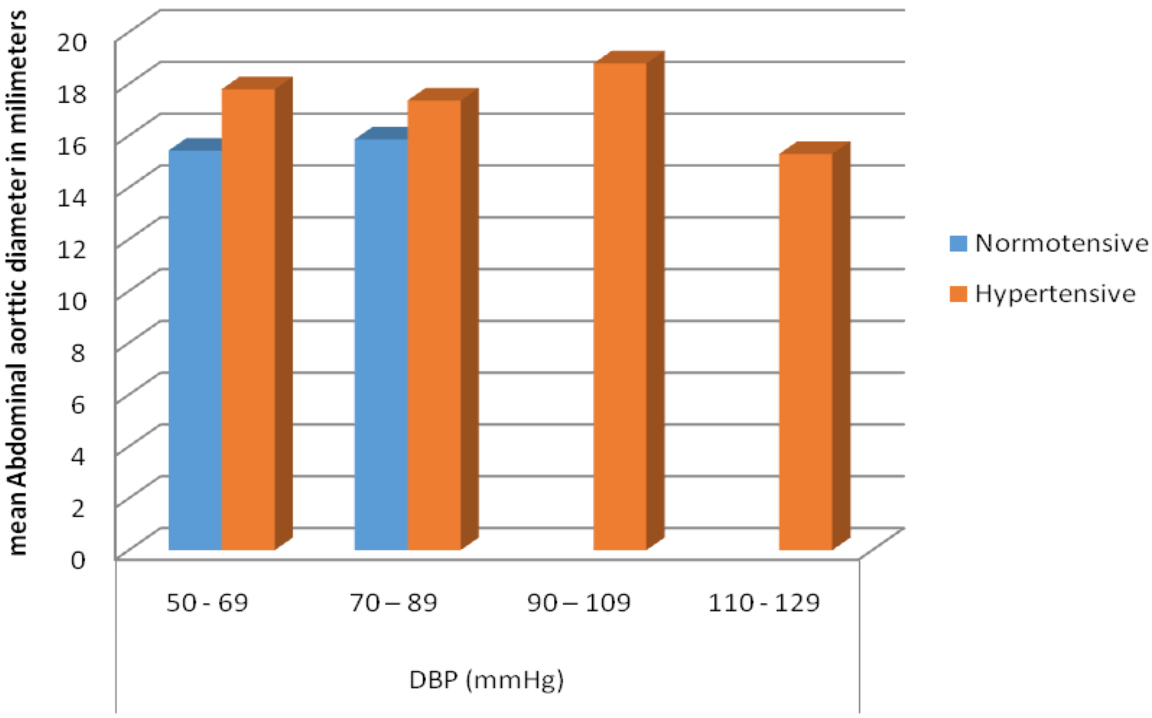

Fig. 6: Abdominal aortic diameter of normotensives and hypertensives by diastolic blood pressure

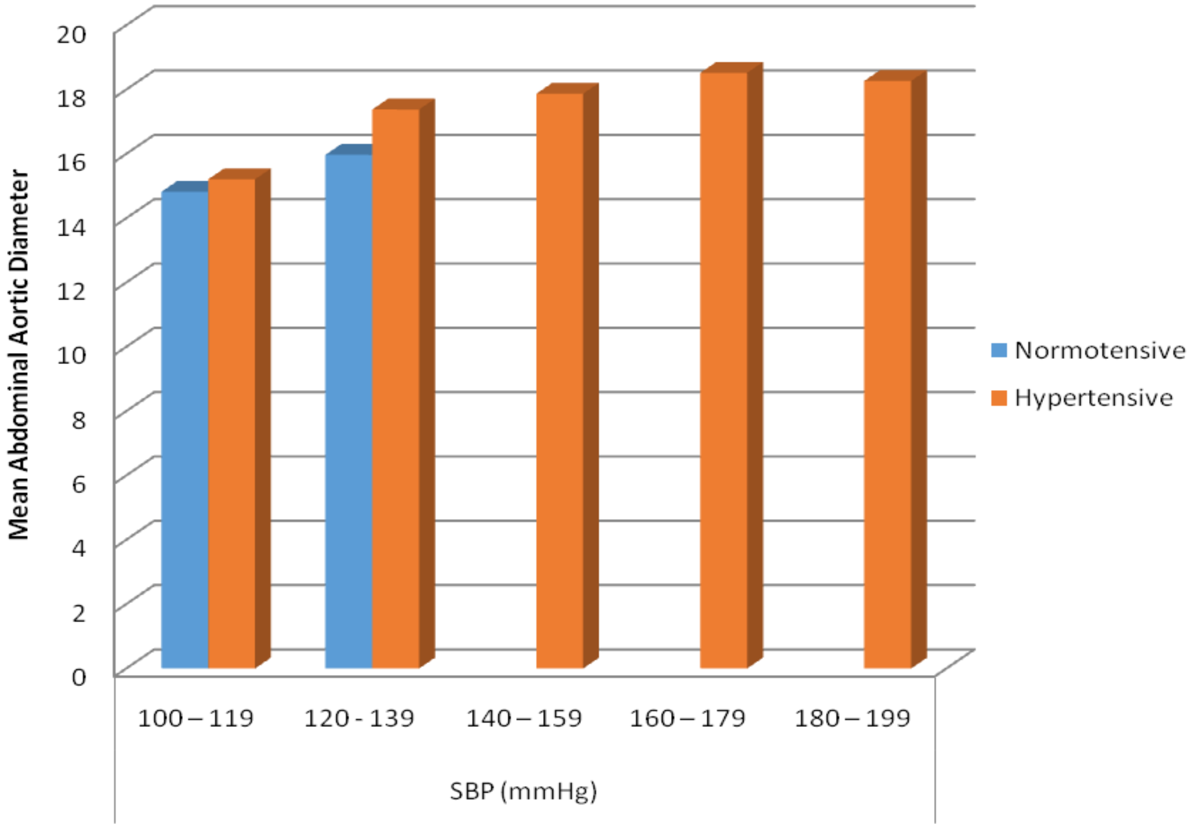

Fig. 7: Abdominal aortic diameter of normotensives and hypertensives by systolic blood pressure

Discussion

In this study, there is female population in both normotensivess and hypertensives (See tables 1). This may be because more females were available and willing to participate while their male counterparts required more explanations to be convinced. Most of the uncooperative subjects were also males.

The hypertensives had higher blood pressures than the normotensives. However; more than 39% of the hypertensives in this study had normal blood pressure at the time of measurement. The high frequency of normal blood pressure among the hypertensives in this study may be due to good blood pressure control at the cardiology clinic.

Median age was observed to be higher among normotensives in this study. This may be related to a higher life expectancy among normotensives who have smaller aortic diameter than their hypertensive counterparts. It has been documented that increased AAD in hypertensives is also a marker for death from other cardiovascular causes.[13]

The mean values of AAD among normotensive adult participants in this study is 16.66 ± 2.04 mm for males and 15.36 ± 1.97 mm for females (See table 2). This is consistent with the findings of Udemezue et al.[6] in Enugu, Nigeria. They reported a mean AAD of 15.7 mm for adult males and 14.9 mm for females. Since Udemezue et al.[2] conducted their study on the same population, this similarity in values of AAD is expected.

In this study, higher AAD was observed among hypertensives in both sexes (See table 2). This is in agreement with many other studies. [10,14-19] The difference in the mean AAD between the normotensives and hypertensives in this study varies between the sexes: 2.23 mm for males and 1.21mm for females. It is higher in males. This shows that the effect of hypertension on AAD in this study is more pronounced in males than in females which corroborates the findings of Markku et al.[17] The greater effect of hypertension on aortic diameter and the higher prevalence of hypertension in males, indicate greater risk of abdominal aortic aneurysms in males. This may be why abdominal aortic aneurysm is commoner in males than in females.[3]

The Whitehall study by Stranchan[20] reported a positive correlation of AAD with the diastolic blood pressure (DBP) rather than with the systolic blood pressure in hypertensives. In contrast, this study showed a positive correlation with systolic blood pressure (SBP) and not with diastolic blood pressure (DBP) [See figures 4,5, 6 & 7]. This corroborates the report of a multivariate analysis by Ryo et al. [21-23]. Correlation of AAD with the SBP and not the DBP is associated with increased shear stress. [23,24] Although these changes occur with aging, they are accelerated in hypertension. [23.24,25]. A number of other authors had shown that AAD increases with blood pressure, even in non hypertensives.[6,8,16,20,26-,29] These factors are hypothesis for further studies in our population.

The inner to inner (ITI) technique was used to measure the infrarenal AAD in this study and the values reported are lower than those reported by Markku et al.[17] and Singh et al.[18] who used the outer to outer (OTO) technique of measurement. This is because the internal and external wall diameter would give discrepancies of up to 5-6mm.[19] The difference in values of AAD between the studies may be due to technique.

The significance of the study includes the establishment that AAD increases with blood pressure especially systolic blood pressure, thus warranting the need of better blood pressure control. Besides, we have established a local normogram of AAD among normotensive and hypertensives as this information appears scanty in our locality.

Most of the limitations of this study were based on techniques. For example, failure to acquire high resolution images were due to bowel gas. This was reduced when the participants sips water slowly with a straw, while more pressure was applied to the probe.

Another limitation is intra-observer errors which were minimized by recording only the mean of three AAD measurements of the infrarenal aorta, while inter-observer error was eliminated by ensuring that all measurements were taken by the researchers only.

Conclusion

Abdominal aortic diameter (AAD) is larger among hypertensives than normotensives. The effect of hypertension on AAD is more pronounced in males than in females. There is a positive correlation of AAD with systolic blood pressure in our environment.

Recommendations

It is recommended that all hypertensives above the age of 60 should be screened for occult abdominal aortic aneurysm and the AAD obtained should be compared with age-matched local reference values. Early detection will reduce mortality from ruptured abdominal aortic aneurysm.

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