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Full Length Research Paper

Severity of coronary atherosclerosis in hypertensive: A postmortem study

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The development of coronary atherosclerosis and ischaemic heart disease had been attributed to risk factors that include but not limited to hypertension. These factors were determined without reference to data from autopsy studies. It is likely that there is no significant difference on the grades of coronary atherosclerosis in hypertensive's when compared with the non-hypertensive's. The aim of this study, therefore, is to test this hypothesis by assessing the impact of hypertension on the grades of atherosclerosis. A prospective postmortem study carried out from 1st of June, 2012 to 31st of May 2013. Consecutive sampling technique was employed to recruit the study population. At post-mortem, the coronary artery of each subject was graded on the basis of the percentage of cross-sectional area stenosis. The data obtained was analyzed with the SPSS version 20. There were 142 cases in this study with a male preponderance. Their mean age was 49.86 years. The grades of coronary atherosclerosis increases with age. The grades of coronary atherosclerosis in hypertensive's were more severe when compared with the non-hypertensive's (p=0.0001). The odds of a hypertensive developing grade III coronary atherosclerosis relative to a grade I lesion was 17.655 higher. The grades of coronary atherosclerosis is related to the presence of hypertension, thus we reject the null hypothesis.

Key words: Hypertensive's, non-hypertensive's, risk factors, grades of coronary atherosclerosis.

INTRODUCTION

Atherosclerosis is depicted by intimal lesions or atherosclerotic plaques that protrude into vessel lumens Mitchell et al., 2015 . It is responsible for the increased morbidity-mortality in comparison to any other disorder in the western world where it accounts for about 50% of all deaths (Mitchell et al., 2015; Miller, 2018). Epidemiological data associated with atherosclerosis mortality characteristically echo deaths caused by heart disease (Mitchell, 2015). This is because coronary artery disease (CAD) is a noteworthy indicator of atherosclerosis (Mitchell et al., 2015).

The prevalence and severity of atherosclerosis and ischaemic heart disease (IHD) among individuals and groups are related to either modifiable or non-modifiable risks factors (Mitchell et al., 2015). These factors were brought to the attention of medics worldwide by a number

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Table 1. Sex and age distribution of the study population.

Parameter	Male	Female	Age range (years)	Mean age (years)	Standard deviation (±)
Hypertensive's	54	17	40-79	61.47	11.47
Non-hypertensive's	51	20	18-72	38.30	13.00
Study Population	105	37	18-97	49.86	16.87

of prospective studies in well-defined populations, the Framingham Heart Study and Atherosclerosis Risk in Communities Study are noteworthy in this regard (Andersson et al., 2019; The Atherosclerosis Risk in Communities [ARIC I], 1989; Tsao and Vasan, 2015). Coronary artery disease and by extension IHD had been documented to be relatively rare in Nigerians and other Africans in comparison to Caucasians and African Americans (Williams, 1971; Williams et al., 1975). Gillum (1982) however reported that CAD was a leading cause of death in black Americans despite the widely held belief that CAD is not common in blacks. The role of risk factors cannot be ignored in this observation (Mitchell, 2015; Williams et al., 1975).

Hypertension is a modifiable risk factor in the development of atherosclerosis (Mitchell, 2015). There is however paucity of data at postmortem on its role in the development of atherosclerosis in our own environment in particular and Nigeria in general. It is likely that there is no significant difference on the grades/severity of coronary atherosclerosis in hypertensive and non-hypertensive. The aim of this study, therefore, is to test this hypothesis by assessing the impact of hypertension on the grades of atherosclerosis.

MATERIALS AND METHODS

This was a prospective postmortem study. The postmortem suite and the histolopathology laboratory unit of the Department of Morbid Anatomy, University of Benin Teaching Hospital, Benin city, Edo State, South-South, Nigeria was the location for this study. This hospital is a referral centre to all other secondary and primary health care facilities within Edo and Delta sub-region and from elsewhere especially its catchment area of Ondo, Kogi and Anambra states. This study was carried out over one year period from June 2012 to May 2013. The information about the pre-morbid hypertensive/non-hypertensive state of each subject in the study population was obtained from the clinical case note. Using the consecutive sampling technique, we recruited the study population which comprises subjects with a pre-morbid history of hypertension and a control without a pre-morbid history of hypertension. At postmortem, hand lens was employed to assess luminal narrowing of the left coronary artery (LCA) proximally at the level of the ostium in the vicinity of the ascending aorta above the aortic valves, then 2 to 4 transverse serial sections along the course of the LCA was made. The most distal serial section was taken just above the bifurcation of the LCA into left circumflex artery and left anterior descending artery. These sections were reflected and with the aid of the hand lens assessed for luminal narrowing; the resultant stenosis was used to grade the coronary artery of each subject into one of four grades on the basis of the percentage of cross-sectional area stenosis (Prabhu et al., 2013; Song et al., 2013). The grades ranged from grade 0 (no narrowing/normal) to grade IV (complete obliteration). Grade - 0: Normal; Grade - I: 1-25% stenosis; Grade - II: 26-50% stenosis; Grade - III: 51-75% stenosis; Grade - IV: 76-100% stenosis (Prabhu *et al*., 2013; Song et al., 2013).

The biodata (age, sex) and the clinical history of each case were obtained from the patient's case note and or mortuary/autopsy register.

The data obtained was analyzed with the SPSS version 20. Chi square test was used to compare grades of coronary atherosclerosis between hypertensive's and non-hypertensive's using a 2-tailed test. The level of statistical significance was set at $p \leq 0.05$. Multinomial logistic regression on SPSS was utilized to obtain the odds ratio which was used to measure the dependent relationship between hypertensive (independent variable) and the severity of coronary atherosclerosis (dependent variable), while age, sex and diabetes were used as co-independent variables in this analysis.

Approval for this study was obtained from University of Benin Teaching Hospital ethics committee as recommended by the provisions of the Declaration of Helsinki in 1995 (revised in Edinburgh 2000) (Tyebkhan, 2003).

A limitation of this study was its inability to predict the effect a change in all the known documented risk factors implicated in the development of atherosclerosis would have on the severity of the grades of coronary atherosclerosis in subjects with pre-morbid history of hypertension at postmortem. Another limitation of this study was that of paucity of similar research work hence limiting the depth of discuss in this regard, thus making references to clinical studies where feasible.

RESULTS

A total of 296 post-mortems were carried out during the study period. Of these, 142 cases were recruited for this study with an age range of 18 to 97 years. Their mean age was 49.86 years (SD ± 16.87), with median and modal ages of 50.5 and 50 years, respectively (Table 1). The overall peak age for coronary atherosclerosis was in the 6th decade, while the 3rd , 6th, and 7th decades accounted for the peak ages of grades I, II and III, respectively (Table 2). There was a statistical significant difference between the grades of atherosclerosis in the study population less than 50 years of age in comparison with those 50 years of age and above ($p = 0.0001$) (Table 3). There were 105 males and 37 females in this study giving a male to female ratio of 2.8:1 (Table 1). There was no statistical significant difference in the grades of

Table 2. Risk factors distribution of the grades of coronary atherosclerosis in the study population.

Parameter	Coronary atherosclerosis			Total	p value
	Grade I	Grade II	Grade III		
Age group					**0.0001**
10-19	1	0	0	1	
20-29	17	3	0	20	
30-39	15	7	0	22	
40-49	3	16	3	22	
50-59	0	25	10	35	
60-69	0	13	13	26	
70-79	0	3	9	12	
80-89	0	1	2	3	
90-99	0	1	0	1	
Total	36	69	37	142	
Diabetes mellitus					**0.0001**
Yes	0	8	18	26	
No	36	61	19	116	
Total	36	69	37	142	
Sex					**0.127**
Male	22	54	29	105	
Female	14	15	8	37	
Total	36	69	37	142	
Hypertension					**0.0001**
Yes	1	38	32	71	
No	35	31	5	71	
Total	36	69	37	142	

Table 3. Grades of coronary atherosclerosis in the study population with age and the corresponding *p* value.

Age (years)	Coronary atherosclerosis			Total	p value
	Grade I	Grade II	Grade III		
<50.00	36	30	5	71	
≥50.00	0	39	32	71	0.0001
Total	36	69	37	142	

coronary atherosclerosis in the study population that were males in comparison with females (p = 0.127) (Table 2). Half (71) of the study population were hypertensive while the remaining half (71) were non hypertensive. At a p value of 0.0001, there was a statistical significant difference between the grades of atherosclerosis in hypertensive when compared with the non-hypertensive (Table 4).

The hypertensive had an age range of 40 to 97 years with a mean age of 61.47 years (SD ±11.47), median and modal ages of 60 and 68 years, respectively (Table 1). There was a statistical significant difference between the grades of atherosclerosis in the hypertensive less than 50 years of age in comparison with those that were 50 years of age and above (p = 0.04) (Table 5). There were 54 hypertensive males and 17 hypertensive females giving a

Table 4. The age, sex and diabetes distribution in hypertensive/non-hypertensive, their corresponding Chi square and *p* value in the severity of coronary atherosclerosis.

Parameter		Hypertensive	Non - hypertensive	Total	Chi square	p value
Age group	10-19	0	1	1	37.091	0.0001
	20-29	0	20	20		
	30-39	0	22	22		
	40-49	9	13	22		
	50-59	25	10	35		
	60-69	23	3	26		
	70-79	10	2	12		
	80-89	3	0	3		
	90-99	1	0	1		
	Total	71	71	142		
Sex	Male	54	51	105	2.888	0.236
	Female	17	20	37		
	Total	71	71	142		
Diabetes Mellitus	Yes	17	9	26		0.0001
	No	54	62	116		
	Total	71	71	142		

Table 5. Grades of coronary atherosclerosis in hypertensive/non-hypertensive with age and the corresponding *p* value.

Hypertension		Age (years)			Total	p value
		Grade I	Grade II	Grade III		
Yes	<50.00	1	7	3	11	0.04
	≥ 50.00	0	31	29	60	
	Total	1	38	32	71	
No	<50.00	35	23	2	60	0.0001
	≥ 50.00	0	8	3	11	
	Total	35	31	5	71	

male to female ratio of 3.2:1 in the hypertensive (Table 1).

The non-hypertensive had a mean age of 38.30 years (SD ± 13.00), a median age of 36 years and a modal age of 23 years. Their age ranged from 18 to 72 years (Table 1). The non-hypertensive had a peak age in the 4th decade (Table 4). There was a statistical significant difference between the grades of atherosclerosis in the non-hypertensive less than 50 years of age in comparison with those that were 50 years of age and above at $p =$ 0.0001 (Table 5). Fifty one (51) males and 20 females were non-hypertensive giving a male to female ratio of 2.6:1 (Table 1).

The odds of a hypertensive developing grade III coronary atherosclerosis relative to grade I was 17.655 higher with a 95% confidence interval of 1.138 to 273.872. Table 4 shows that age and diabetes had a significant stastiscal association with the severity of coronary atherosclerosis while sex had no statistical signanificant association with the severity of coronary atherosclerosis.

DISSCUSSION

Atherosclerosis is a progressive, disseminated condition that affects the coronary artery and all other vascular beds (Amudha et al., 2003). Obstructive coronary atherosclerosis is the cause of perfusion imbalance in

over 90% of cases of ischaemic heart disease (IHD) (Mitchell, 2015). For this reason, IHD is frequently called coronary artery disease (CAD) or coronary heart disease (Mitchell, 2015). The concept of “risk factors” in CAD or coronary heart disease (CHD) was first coined by the Framingham heart study (FHS) in the 1950s (Hajar, 2017). This study demonstrated the epidemiologic relations of hypertension amongst other risk factors to the incidence of coronary artery disease (CAD) (Hajar, 2017). Hypertension has been shown, in epidemiologic and experimental studies, to accelerate atherosclerotic vascular disease and increase the incidence of clinical complications (Hajar, 2017; Kannel, 2000). Cases with and without essential hypertension in comparative epidemiological studies of atherosclerosis have supported the view that arterial hypertension has an atherogenic effect (Matova and Vihert, 1976). This is based mainly on clinical data on the rates of ischaemic heart disease and cerebrovascular lesions in persons with hypertensive disease (Matova and Vihert, 1976). In the same vein, Okeahialam *et al*. (2011), Jos University Teaching Hospital, reported that hypertensive had more marked carotid artery intimal media thickening in comparison with normotensive.

This study noted a significant difference between the grades of coronary atherosclerosis in hypertensive and non-hypertensive. This is consistent with the findings of previous studies that documented more advanced atherosclerotic lesion in hypertensive when compared with the normotensive (Williams et al., 1975; Matova and Vihert, 1976; Oalmann et al., 1997; Tabatabaei et al., 2009; Vihert et al., 1996; Wilkins et al., 1959).

This study also noted that atherosclerotic lesion is more marked with increasing age as there was a statistical difference between the grades of atherosclerosis in the study population, hypertensive and non-hypertensive less than 50 years of age in comparison with those more that were 50 years of age and above. This is in keeping with previous documented work as most cases of atherosclerotic vascular disease become clinically apparent in patients aged 40 years or older (Oguejiofor et al., 2008). At autopsy, the severity of coronary atherosclerosis had been shown to increase with age (Maru, 1989; Webber et al., 2012). Ogunnowo et al. (1986) reported that coronary occlusive disease among Nigerians occurred in elderly affluent and hypertensive patients exposed to Western diets and habits. The development of this lesion in children tend to be promoted by exposure to risk factors at an early age or during childhood (Raitakari et al., 2003).

Atherosclerosis is more common in men than in women (Hayashi et al., 1995; Jaagus et al., 2010). This is consistent with the findings of this study. This study population is however skewed in favour of the males as seen in most other studies of similar nature (Tabatabaei et al., 2009). The higher prevalence of atherosclerosis in men is thought to be due to the protective effects of female sex hormones. This effect is absent after menopause in women (Barrett-Connor and Bush, 1991; Jane, 2001; Mankad and Best, 2008). This highlights the importance of cardiovascular risk factor screening from early ages of third decade and thus accentuates the significance of a methodology in the prevention of cardiology that includes but not limited to coronary artery disease early in life (Tabatabaei et al., 2009; Tracy et al., 1995).

As already noted, risk factors contribute to the development of atherosclerosis (Mitchell, 2015). These risk factors, particularly the major ones have been shown to be responsible for the continuous and graded effect of CAD risk (Theodorson, 1995). To this end, they have some additive and multiplicative effect in the development of CAD (Mitchell, 2015; Elosua et al., 2016). The presence of two to three risk factors in an individual increases the risk of development of this lesion by approximately four-fold to a factor of seven, respectively (Mitchell, 2015). These factors cluster in individuals and have been shown to cause joint multiplicative deleterious effect in terms of the increased incidence of CAD (Theodorson, 1995). This study shows that age and diabetes were significantly associated with the development of coronary atherosclerosis. It therefore follows from the foregoing that they contributed to an increase risk of development of CAD in the study population. This study also showed that in hypertensives the odds of developing grade III atherosclerosis relative to grade I is 17.655 higher.

Conclusion

This study noted a statistical significant difference in the grades of atherosclerosis in association with hypertension. The hypothesis that there is no significant difference on the grades/severity of coronary atherosclerosis in hypertensive and non-hypertensive is therefore rejected. It stands to reason that prompt and suitable treatment with resultant control of this modifiable risk factor (that is, hypertension) in the development of atherosclerosis could be helpful in reducing the severity of coronary atherosclerosis and also deaths due to CAD.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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