

RELATIONSHIP BETWEEN ANKLE BRACHIAL PRESSURE INDEX AND LEFT VENTRICULAR HYPERTROPHY IN ADULTS WITH SYSTEMIC HYPERTENSION IN RIVERS STATE, NIGERIA

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ABSTRACT

Introduction: Peripheral arterial disease is associated with increased cardiac morbidity and mortality, and left ventricular hypertrophy could be a major contributor. **Aims:** This study aims to determine the relationship between the left ventricular mass index (LVMI) and the ankle brachial pressure index (ABPI) in hypertensive patients in a tertiary hospital. **Methodology:** One hundred and sixty hypertensive subjects were evaluated. Assessment of peripheral arterial disease was made by measurement of the ankle brachial pressure index. Assessment of left ventricular hypertrophy was done with trans-thoracic echocardiography. Chi square (χ^2) and Student t tests were used to assess statistically differences between categorical and continuous variables respectively. Correlation and regression analysis was used to assess the relationship between ankle brachial pressure index and left ventricular mass index. **Results:** The prevalence of PAD using the ABPI was 11% in this cohort of hypertensive cases. The left ventricular mass index was significantly higher in hypertensive patients with PAD $162.1 \pm 83.3 \text{ gm/m}^2$ compared to hypertensive patients without PAD $128.2 \pm 55.6 \text{ gm/m}^2$, ($p=0.023$). The prevalence of echocardiographic left ventricular hypertrophy when indexed to body surface area was significantly higher in hypertensive patients with PAD (88.9%) compared to those without PAD (50.0%); $p=0.02$. Hypertensive subjects with PAD were 8 times more likely to develop LVH (OR=8; 95%CI= 1.77-36.08, $p=0.007$). **Conclusion:** There is a high prevalence of left ventricular hypertrophy in hypertensive patients with PAD. Prompt identification and follow up for all patients with PAD is essential to effectively prevent future cardiac morbidity and mortality.

KEYWORDS: Peripheral Arterial Disease, Left Ventricular Hypertrophy, ABPI, Hypertension, Nigeria.

INTRODUCTION

Systemic hypertension is a major cause of premature cardiovascular disease as it results in structural and functional changes to the heart and blood vessels. Elevated blood pressure is associated with increased risk for total mortality, cardiovascular disease mortality, coronary heart disease mortality, myocardial infarction, heart failure, left ventricular hypertrophy (LVH), atrial fibrillation, stroke, peripheral arterial disease, and renal failure.^[1] It is now recognized that, beginning at levels well within the so-called "normal" range, higher levels of blood pressure (BP) generally increase risk in a continuous and graded fashion for multiple cardiovascular sequelae.^[1]

Peripheral arterial disease is associated with an increased risk of mortality from all causes, and the excess risk of death is due almost entirely to cardiovascular disease. The high risk of cardiac death is generally attributed to coincidental coronary artery disease, leading to cardiac death due to fresh ischaemic events.^[2] While coronary artery disease is undoubtedly important, left ventricular abnormalities could also be a major contributor to cardiac death in these patients, causing arrhythmic as opposed to ischaemic deaths. These left ventricular abnormalities consist of both left ventricular hypertrophy and left ventricular systolic dysfunction.^[3]

Left ventricular hypertrophy is a strong risk factor for cardiovascular events as it significantly increases the risk of congestive heart failure, stroke, cardiac arrhythmia,

and sudden cardiac death.^[4] There are several reasons to believe that LVH might be particularly common in PAD. Hypertension causes both PAD,^[5] and LVH,^[6] which means that hypertension could cause PAD and LVH to coexist frequently. Also, by its very nature, PAD implies stiff large arteries, which should increase left ventricular afterload and in theory promote LVH. PAD patients have been shown to have an increased incidence of renovascular disease, which would increase blood pressure and thereby promote LVH.^[7] Therefore, detecting and treating LVH could be a major new opportunity to reduce cardiac disability in PAD patients as regression of LVH is associated with improved prognosis, irrespective of blood pressure changes.^[8] Future studies should now investigate whether screening for and specifically regressing LVH would reduce cardiac deaths in PAD over and above merely achieving target blood pressure.

Wright et al reported is a high prevalence of LVH in patients at first diagnosis of PAD, which could infer that LVH is common enough in PAD patients to potentially make a major contribution to their high rate of cardiac death.^[7]

This study aims to determine the relationship between the left ventricular mass index (LVMI) and the ankle brachial pressure index (ABPI) in hypertensive patients in a tertiary hospital.

METHODOLOGY

We retrospectively analysed data collected from 160 patients with systemic hypertension attending the Cardiology Clinic of the Medical outpatient department at the University of Port Harcourt Teaching Hospital, Port Harcourt, Nigeria. We collected the demographic information, physical examination findings, with emphasis on anthropometry and blood pressure. The ankle brachial pressure index (ABPI) was performed by the lead investigator using a handheld doppler with a vascular probe with a frequency of 8megaHertz. The ankle brachial pressure index was calculated for each leg, and the lower value was the patient's overall ABPI. An abnormal value in either leg indicated peripheral artery disease. Subjects with ABPI ≤ 0.90 were diagnosed to have PAD.

A trans-thoracic echocardiographic study was done by the investigator for all patients with an Aloka Prosound SSD 4000 echocardiography machine equipped with a 2.5Hz transducer to assess for left ventricular hypertrophy. With the patient in the lateral decubitus position, targeted echocardiographic estimations were taken. Calculations were made using the internal analysis software of the echocardiography device. Left ventricular mass was indexed to body surface area. Left ventricular hypertrophy was defined in absolute terms as LVMI $>134 \text{ g/m}^2$ in men and $>110 \text{ g/m}^2$ in women.^[9]

Participants

We included 160 patients above the age of 40years on management for systemic hypertension seen in the Cardiology clinic. Patients who use tobacco in any form, persons living with diabetes mellitus, chronic kidney disease as well as pregnant women were excluded from the study.

Outcome measure

The primary aim of the study was to determine the relationship between the ankle brachial pressure index and left ventricular hypertrophy in patients with systemic hypertension.

Ethical considerations

Ethical approval was obtained from the ethical board of the hospital and documented Informed consent was given by the participants.

Statistical analysis

All data were analyzed using the commercially available statistical package for social sciences (SPSS) version 21 analytic software. Normally distributed variables were expressed as mean \pm standard deviation and variables without normal distribution as median and range. Continuous variables were compared with the Students t-test, or one-way analysis of variance as appropriate. Proportions or categorical parameters were compared with the chi-square test. Relations among continuous variables were assessed using Pearson correlation test and multiple linear regression analysis. All tests were considered to be statistically significant at the p-value < 0.05 .

RESULTS

A total of 160 subjects with systemic hypertension were included in this study. The mean age of the recruited patients with systemic hypertension was 56.3 ± 8.2 years with a range of 42-72 years. There were more females than males in a ratio of 1.8:1 as 103 (64.4%) of the cases were females and 57 (35.6%) were males.

Ankle brachial pressure index

The mean ankle brachial pressure index in the study population was 1.02 ± 0.11 with a range of 0.71 to 1.33. The mean ABPI among the males was 1.01 ± 0.12 while it was 1.02 ± 0.11 in the females. There was no statistically significant difference in the mean ABPI between the males and females ($p=0.536$).

A total of 18 persons (11.0%) had an ABPI ≤ 0.90 . Eleven cases had mild PAD, seven cases had moderate PAD while there was no case with severe PAD. Eight cases with abnormal ABPI (44.4%) were male while 10 (55.5%) were female.

Comparing the hypertensive subjects with PAD to those without PAD, the mean age for the cases with PAD was 64.2 ± 7.4 years compared to 55.3 ± 7.8 years in those without PAD and this was statistically significant ($p <$

0.001). Eight (44.4%) of the hypertensive cases with PAD were males while 10 (55.6%) were females but this was not statistically significant ($p = 0.407$).

The median duration of hypertension was higher among the cases with PAD (4 years; range 6months to 18years) compared to those without PAD (3 years; range 2years to 15years) but this was not statistically significant. ($p = 0.401$).

Among the eighteen cases with PAD, 10 (55.6%) had reduced pulses in the lower limbs by palpation. The mean BMI, waist circumference and waist-hip ratio was lower in the cases with PAD than in those without PAD. (BMI was $24.6 \pm 4.4\text{kg/m}^2$ and $29.4 \pm 5.1\text{kg/m}^2$ respectively; $p < 0.001$) (Waist circumference was $89.7 \pm 15.1\text{cm}$ and 97.9 ± 10.5 respectively; $p = 0.011$) (WHR was 0.9 ± 0.1 and 0.9 ± 0.4 respectively; $p = 0.191$). Only 6 (33.3%) of the cases with PAD had increased WC, while 7 (38.9%) had increased WHR.

The mean systolic and diastolic blood pressures were higher in the cases with PAD, but this was not significant ($p = 0.639$ and $p = 0.692$ respectively). Of the 18 cases with PAD, 15 (83.3%) had sub optimal blood pressure control.

Left ventricular mass

The mean left ventricular mass was $282.8 \pm 154.5\text{gm}$ in the cases with PAD whereas it was $233.5 \pm 110.3\text{gm}$ in cases without PAD but this was not statistically significant ($p = 0.079$). Among the male study population, the mean LVM was $275.3 \pm 114.8\text{gm}$ in the PAD present cohort which was significantly higher than in the PAD

absent group whose mean LVM was $212.6 \pm 56.6\text{gm}$ ($p = 0.007$). The mean LVM among the females was 219.4 ± 113.3 in the PAD present group and 160.2 ± 39.8 among the PAD absent group and this difference was statistically significant ($p < 0.001$).

Left ventricular mass index

The mean left ventricular mass index was significantly higher in the cases with PAD compared to those without PAD; both generally and across both sexes. The mean LVMI for the PAD cases was $162.1 \pm 83.3\text{gm/m}^2$ compared to $128.2 \pm 55.6\text{gm/m}^2$ in cases without PAD ($p = 0.023$). For the males, it was $153.7 \pm 51.3\text{g/m}^2$ in the PAD cases and $123.8 \pm 26.4\text{g/m}^2$ in the no PAD cases ($p < 0.001$); while among the female population, it was $135.5 \pm 52.7\text{g/m}^2$ in the PAD cases versus $103.0 \pm 31.1\text{g/m}^2$ in the no PAD cases ($p < 0.001$).

Left ventricular hypertrophy

Among the cases with PAD, 16 (88.9%) had left ventricular hypertrophy while 71 (50.0%) of the cases without PAD had LVH and this was statistically significant ($p = 0.002$).

There was a negative correlation between the LVMI and the ABPI among the cases in this study, but this correlation was not statistically significant ($r = -0.060$, $p = 0.450$).

Hypertensive subjects with PAD were 8 times more likely to develop LVH than subjects without PAD and this was statistically significant. (OR=8; 95% CI = 1.77 to 36.08; $p = 0.007$).

Table I: Characteristics of the hypertensive subjects with and without PAD.

VARIABLE	PAD present (n=18) MEAN (\pm SD)	PAD absent (n=142) MEAN (\pm SD)	p VALUE
Age (years)	64.2 ± 7.4	55.3 ± 7.8	<0.001
BMI (kg/m^2)	24.6 ± 4.1	29.4 ± 5.1	<0.001
WC (cm)	89.7 ± 15.1	97.9 ± 10.5	0.011
WHR	0.9 ± 0.1	0.9 ± 0.4	0.191
SBP (mmHg)	143.8 ± 20.3	141.8 ± 16.5	0.639
DBP (mmHg)	89.6 ± 7.0	88.7 ± 9.2	0.692
ABPI	0.80 ± 0.05	1.04 ± 0.08	<0.001
IVSd (mm)	13.4 ± 3.7	12.0 ± 3.5	0.107
LVPWd (mm)	14.1 ± 3.3	11.4 ± 3.6	0.003
LVM (grams)	282.8 ± 154.5	233.5 ± 110.3	0.079
LVMI (gm/m^2)	162.1 ± 83.3	128.2 ± 55.6	0.023
LVH (%)	88.9	50.0	0.002

Key: Data expressed as mean \pm standard deviation. BMI= body mass index; WC= waist circumference; WHR= waist hip ratio; SBP= systolic blood pressure; DBP= diastolic blood pressure; ABPI= ankle brachial pressure index; IVSd=interventricular septal thickness in diastole; LVPWd= left ventricular posterior wall thickness in diastole; LVM= left ventricular mass; LVMI= left ventricular mass index; LVH (%) = left ventricular hypertrophy prevalence.

DISCUSSION

This was a study of 160 hypertensive subjects receiving follow up care in a tertiary health institution that set out to determine the relationship between peripheral arterial disease (by measuring the ABPI) and left ventricular hypertrophy (by assessing the LVMI).

The prevalence of peripheral arterial disease among the cases with systemic hypertension in this study was

11.0%. This figure is similar to Farkas et al.^[10] who reported a prevalence of 14.4% in hypertensive subjects even though their study did not exclude current smokers and subjects with diabetes mellitus, with the exclusion of these subset, the prevalence is expected to be lower.

Vascular physical examination of the lower limbs provides valuable information when investigating lower limb PAD. In this study, of the 18 patients with PAD, 10 (55.6%) had reduced pulses. The sensitivity of an abnormal lower limb examination to detect peripheral arterial disease was 55.6% while the specificity was 100%. Armstrong et al.^[11] reported similar figures with a sensitivity of 58.2% and a specificity of 98.3% of an abnormal lower limb examination compared to the ABPI to make a diagnosis of PAD. Palpation of lower limb pulses is highly dependent on the skill and interpretation of the examiner, but this should not detract from its usefulness. Thus, emphasis in PAD detection should also be directed toward encouraging a thorough physical examination.

Echocardiographic determination of LV hypertrophy in patients with hypertension is a strong independent predictor of cardiovascular morbidity and mortality. The prevalence of left ventricular hypertrophy was high in the hypertensive cases with PAD in this study and the mean LVMI was significantly higher in the cases with PAD compared to the cases without PAD. This study shows a non-significant negative correlation between LVMI and ABPI.

Wright et al.^[7] also reported a high prevalence of LVH in their subjects with PAD and age was the most important predictor of LVH in their PAD patients. Albuquerque et al.^[12] reported a lower prevalence but the sample size in this study was small which will tend to underestimate the true prevalence, although the mean LVMI was significantly higher in hypertensive cases with PAD compared to the hypertensive cases without PAD.

Although PAD is common in hypertensive patients with LVH, there is no significant correlation between ABPI and LVMI. This is because although hypertension can pathophysiologically account for both the LVH.^[6] and PAD,^[5] the degree of the end organ damage to the heart (LVH) and to the peripheral arteries (PAD) may be independent of each other. In this study, hypertensive cases with LVH were however eight times more likely to develop PAD. Larger studies may be required to confirm this relationship.

CONCLUSION

Hypertension is the largest risk factor for cardiovascular diseases and is associated with increased morbidity and all-cause mortality. The prevalence of LVH among the subjects with PAD in this study was high and hypertensive subjects with PAD were more likely to have LVH. This study did not establish a significant correlation between the LVMI and the ABPI.

Limitations of the study

1. The ABPI does not detect occlusive disease distal to the ankle
2. This was a hospital based cross sectional study which limits conclusions about causality.

Disclosure of conflict of interest

The authors declare no conflict of interest.

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None.

Statement of informed consent

A written informed consent was obtained from the proposed study participants before recruitment in accordance with ethical principles.

Statement of Ethical approval

Ethical approval was given by the University of Port Harcourt Teaching Hospital Ethical Committee and the Research Ethics group of the Centre for Medical Research and Training, College of Health Sciences, University of Port Harcourt. (UPTH/ADM/90/S.II/VOL.X/61)

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