Left axis deviation and its associated factors in asymptomatic adult Nigerians

Okpara Ihunanya Chinyere*, Adediran Olufemi Sola

Department of Internal Medicine, P. M. B. 102119, Benue State University Makurdi, Nigeria.

*Corresponding author E-mail:iokparajubilee@gmail.com. Phone: 08037067040

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Background
Left axis deviation on the electrocardiogram may be due to underlying heart disease. However in an asymptomatic adult population, it may be due to factors such as age, sex or asymptomatic left ventricular hypertrophy which is a risk factor for stroke and sudden death. In this study we take a look at left axis deviation and its associated factors in an asymptomatic adult Nigerian population.

Method
A total of 229 subjects were selected for the study by a stratified random sampling method. Blood pressure was measured by standard protocols. A 12 lead resting electrocardiogram was performed on all subjects.

Results
The prevalence of left axis deviation in the study group was 3.9%. It was more prevalent in males than females with rates of 4.4% and 3.4% respectively. Left axis deviation was not significantly associated with age ($\chi^2 = 0.860, p = 0.352$) or sex ($\chi^2 = 0.145, p = 0.704$) or hypertension ($\chi^2 = 0.001, p = 0.972$) but was significantly associated with left ventricular hypertrophy ($\chi^2 = 22.593, p < 0.001$).

Conclusion
Left axis deviation in an asymptomatic adult population is significantly associated with left ventricular hypertrophy. Early diagnosis and treatment at this stage can help reduce future cardiovascular mortality.

Key words: Left axis deviation, left ventricular hypertrophy, electrocardiogram, stroke, sudden death.

INTRODUCTION

The QRS axis describes the mean orientation of ventricular depolarization with reference to the limb leads in the frontal plane. Thus left axis deviation (LAD) exists when the mean frontal QRS axis is equal to -30° or less in an adult (Hoffman and Tamer, 1996).

The causes and clinical significance of left axis deviation have been controversial since the early days of electrocardiography (ECG). The concept of interruption of the anterior fascicle of the left bundle branch – commonly designated – left anterior hemiblock as a cause of LAD dominated interest in the seventies (Rosenbaum et al., 1970a; Rosenbaum 1970b; Rosenbaum et al., 1969; Rosenbaum et al., 1970c; Castellanos and Meyerberg, 1976). When a lesion involves the anterior fascicle of the left bundle branch, it alters the sequence of depolarization of the left ventricle. The wave of excitation spreads via the posterior fascicle of the left bundle, and the superior surface of the left ventricle is the last to be depolarized. This results in the left axis deviation of the mean QRS vector in the frontal plane (Bahl et al., 1969).

An electrocardiographic necropsy study of adults with marked left axis deviation called attention to the proposed roles of altered anatomic and electrical positions of the heart, emphysema, left bundle branch block, and factors associated with aging (Curd et al., 1961). It was later reemphasized that LAD occurred in a wide variety of clinical disorders including myocardial fibrosis, infarction, cardiomyopathies, and left ventricular hypertrophy (LVH), congenital or acquired interruptions of the conducting system, and alterations in electrical resistance of pulmonary tissue (emphysema) and in some healthy adult males (Perloff et al., 1979). The increase in LAD with age was attributed to the development of organic heart disease especially coronary artery disease or systemic hypertension (Eliot et al., 1963).

A number of studies have been conducted on the prevalence of LAD according to age and sex (Stewart and Manning, 1944; Parkard et al., 1954). In analysis of ECGs from 500 Royal Canadian Air Force members, LAD was identified in 1.2%. When ECGs recorded as part of a survey of 1303 men and 1348 women older than 15 years in North Western United States and South Western Canada (Goldberg et al., 1970) were studied, a progressive leftward shift of the frontal plane QRS axis...
occurred with age, but healthy persons, including those aged 60 to 90 years, did not reach a QRS axis of -30°. There were no significant age differences in the prevalence of LAD which in the whole group ranged from 1.7% - 4.9% (Goldberg et al., 1970). Similar findings were observed by Ostrander (1971) in his study of 248 ECGs of adults older than 20 years who participated in a comprehensive Medical Examination.

Studies on LAD in Nigeria are few. Okoli et al. (2012) working in Borno State North Eastern Nigeria on electrocardiographic patterns of Nigerian professional foot ballers noted the prevalence of LAD as 6% in their study. Busari et al. (2013) in Western Nigeria studied intraventricular blocks in Nigerians with Hypertensive Heart Disease. He found out that left anterior fascicular block occurred in 52.2% singly or in combination with other blocks and it was the most common block. In a study (Iwobi and Dapper, 2002) on QRS axis deviation in Nigerian women during normal pregnancy, it was noted that the QRS axis showed significant leftward deviation in pregnant subjects compared to non-pregnant subjects and the magnitude increased with the progression of the pregnancy.

The present study aims at determining the prevalence of LAD in an asymptomatic adult Nigerian population and some of its associated factors. This would enable correct interpretation of the ECG during routine Medical Examinations and checks as is usually carried out in many institutions prior to employment and admission. The discovery of LAD on routine Medical Examination of an asymptomatic adult population will help in decision making as to whether to carry out Echocardiography which will better unmask underlying heart disease.

MATERIALS AND METHOD

A total of 229 subjects aged 18 to 80 years were used for the study. These were recruited by a stratified random sampling method of households from the Federal Capital territory (FCT) Abuja Nigeria where the study was carried out between May 2009 and June 2010. Stratification was by age, sex and location. Simple random sampling according to the above mentioned strata was performed in urban and rural locations in FCT Abuja to obtain the sample size. The study was cross sectional and community based.

Ethical approval was obtained from the department of Health Abuja, Abuja municipal area council and the ethical committee of the Benue State University Makurdi. Informed consent in written form or by a thumb print was obtained from the participants after due explanation before they were used for the study. Data collection sheets were used to obtain the age, gender, and relevant clinical history of the participants. Inclusion criteria were individuals of either sex aged 18 to 80 years who were asymptomatic without a history suggestive of heart or lung disease or other relevant clinical history. Exclusion criteria were individuals with a history of heart disease, pregnant women and those with symptoms of lung disease. Based on these criteria 229 subjects were selected for the study.

Anthropometric data which included weight, height and waist circumference (WC) were obtained. The weight was measured to the nearest 0.5 kg using a weighing scale. Height was measured to the nearest 0.5 cm using a stadiometer. The body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters (Quetelet, 1994). The WC was measured at midpoint between the lower border of the rib cage and iliac crests at the end of normal expiration.

Three blood pressure measurements were taken from the non – dominant arm in the sitting position at five minute intervals in the morning after five minutes rest with appropriate cuff and a mercury sphygmomanometer. This is in accordance with the seventh report of the Joint National Committee on Prevention, Detection, Evaluation and treatment of High blood pressure (JNC7) (Chobanian et al., 2003). Systolic blood pressure (SBP) and diastolic blood pressures (DBP) were the first and fifth koroktoff sounds respectively. The mean of the last two measurements was used in the data analysis. Hypertension was defined as SBP ≥140 mmHg and or DBP ≥ 90 mmHg or being on drug therapy for hypertension.

After obtaining the above information, the participants were invited to a nearby venue where a 12 lead resting ECG was carried out on all selected participants using cardiofax ECG – 9620 model machine. Electrodes were placed following the standard ECG configuration. The QRS axis in all participants was determined by plotting the mean QRS axis in the frontal plane of the hexaxial reference system. Significant left axis deviation was defined as QRS axis between -30° and -90° in the frontal plane of the hexaxial reference system (Massie and Walsh, 1960). Left ventricular hypertrophy was diagnosed by the Sokolow – Lyon criteria (Sokolow and Lyon, 1949).

Statistical analysis was performed using the statistical packages for Social Sciences (SPSS) version 20 statistical software. For continuous variables, means and standard deviations were calculated and the means compared using the independent samples t-test. Pearson Chi – Square test was used to analyse the relationship between LAD and age, sex, hypertension and left ventricular hypertrophy. Values of p < 0.05 were considered statistically significant.

RESULTS

Characteristics of the study population

The total number of participants in the study was 229. Males were 113 in number and females were 116 in
Prevalence of LAD in the study population

The mean age of the study population was 42.56±14.42 years. The distribution of mean QRS axis in the population was as follows: 95.2% had normal axis (NA), 3.9% had LAD and 0.9% had right axis deviation (RAD).

Relationship of LAD with age

The population was stratified by age into younger age group (18 – 40) years and older age group (41 – 80) years. LAD occurred in 5.1% of the young group and 2.7% of the older age group. However this difference was not statistically significant ($\chi^2 = 0.860$, $p = 0.354$, OR = 0.679). This is shown in Table 3.

Relationship of LAD with hypertension

There were 52 hypertensive and 117 non hypertensives in the study population. 3.8% of the hypertensive had LAD while 4.0% of the non hypertensive had LAD. This difference was not statistically significant ($\chi^2 = 0.001$, $p = 0.972$, OR = 0.978). This is shown in Table 3.

Relationship of LAD with sex

There were 113 males and 116 females in the study. LAD occurred in 4.4% of males and 3.4% of females. This difference was not statistically significant ($\chi^2 = 0.145$, $p = 0.704$, OR = 1.132). This is shown in Table 3.

Relationship of LAD with left ventricular hypertrophy (LVH)

In the study population, 198 participants did not have LVH while 31 participants had LVH. In the no LVH group, 1.5% had LAD while 19.4% of the LVH group had LAD. This difference was statistically significant ($\chi^2 = 22.593$, $p < 0.001$, OR = 5.867). This is shown in Table 3.

DISCUSSION

The prevalence of left axis deviation in our study was 3.9%. The study also showed that left axis deviation was not significantly associated with age ($\chi^2 = 0.384$, $p = 0.704$) or sex ($\chi^2 = 0.145$, $p = 0.972$) but was significantly associated with left ventricular hypertrophy ($\chi^2 = 22.593$, $p < 0.001$).

Left ventricular hypertrophy has long been considered an important cause of left axis deviation (Burch and Winsor, 1945). In 1944, Wilson et al. (1944) reported that the axis shifted because the endocardial to epicardial QRS vectors produced a wave front that was oblique and not perpendicular to the surface of the hypertrophied ventricle (Wilson et al., 1944; Wilson et al., 1947).

Early evidence that LVH played a role in producing LAD was circumstantial, but it became evident that the basic cause of the axis shift was not the hypertrophy itself (Selzer et al., 1962; Cornea et al., 1965) but rather the presence and location of associated myocardial fibrosis (Cornea et al., 1965) especially of the anterolateral wall of the left ventricle. Concentric LVH produces changes in the amplitude, but not in the direction of the QRS, while right ventricular hypertrophy adds new directional electrical forces to the QRS vector, causing shifts in frontal plane axis to the right culminating in frank right axis deviation. Hence a left axis deviation on the ECG may not be due to LVH but rather due to accompanying myocardial fibrosis of the anterolateral wall involving the left anterior fascicle.

The consensus is that the leftward shift of the mean frontal plane QRS axis in LVH results from delayed anterior fascicle conduction due to fibrosis. This goes to suggest that other causes of LVH such as aortic stenosis or hypertrophic cardiomyopathy may be accompanied by LAD even though the patient is not hypertensive. This goes to explain why in our study, LAD was not significantly associated with hypertension.

Interestingly, LAD had no relationship with old age in our study. It actually occurred more in the younger age group (5.1%) than in the older age group (2.7%). However the difference was not statistically significant. Investigators have shown that the gradual leftward migration of the frontal QRS axis was a consequence of aging independent of the population prevalence of coronary atherosclerosis (Blackburn et al., 1967). Earlier observations set the stage for the current view that isolated age-related degenerative disease of the cardiac fibroskeleton can cause a variety of infranodal conduction defects that are unrelated to coexisting myocardial disease or coronary artery obstruction, which may be negligible or absent. Electrocardiographic studies examining 1000 electrocardiograms chosen by random
Table 1. Characteristics of the study population by locality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Urban n =113 Mean( SD )</th>
<th>Rural n = 116 Mean( SD )</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.24(13.76)</td>
<td>41.91(15.08)</td>
<td>0.70</td>
<td>0.485</td>
</tr>
<tr>
<td>Weight</td>
<td>69.43(13.61)</td>
<td>58.98(8.29)</td>
<td>7.04</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Height</td>
<td>1.59(0.08)</td>
<td>1.61(0.07)</td>
<td>-1.70</td>
<td>0.090</td>
</tr>
<tr>
<td>BMI</td>
<td>27.35(4.96)</td>
<td>22.72(2.50)</td>
<td>8.95</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>WC</td>
<td>90.06(13.83)</td>
<td>80.49(7.26)</td>
<td>6.58</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>SBP</td>
<td>127.13(23.84)</td>
<td>113.98(16.89)</td>
<td>4.83</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>DBP</td>
<td>79.42(15.16)</td>
<td>74.26(9.90)</td>
<td>3.06</td>
<td>0.003*</td>
</tr>
</tbody>
</table>

* = statistically significant, BMI = Body mass index
WC = Waist circumference, SBP = Systolic blood pressure
DBP = Diastolic blood pressure.

Table 2. Characteristics of the study population by gender.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Male n = 113 Mean(SD)</th>
<th>Female n= 116 Mean(SD)</th>
<th>t-test</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>43.04(14.54)</td>
<td>42.09(14.46)</td>
<td>0.50</td>
<td>0.620</td>
</tr>
<tr>
<td>Weight</td>
<td>63.95(9.05)</td>
<td>64.32(14.93)</td>
<td>-0.22</td>
<td>0.825</td>
</tr>
<tr>
<td>Height</td>
<td>1.63(0.06)</td>
<td>1.57(0.07)</td>
<td>6.11</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>BMI</td>
<td>24.07(3.17)</td>
<td>25.91(5.43)</td>
<td>-3.11</td>
<td>0.002*</td>
</tr>
<tr>
<td>WC</td>
<td>83.75(11.34)</td>
<td>86.64(12.44)</td>
<td>-1.84</td>
<td>0.068</td>
</tr>
<tr>
<td>SBP</td>
<td>120.34(19.78)</td>
<td>120.60(23.32)</td>
<td>-0.09</td>
<td>0.926</td>
</tr>
<tr>
<td>DBP</td>
<td>78.27(11.72)</td>
<td>75.38(14.04)</td>
<td>1.69</td>
<td>0.093</td>
</tr>
</tbody>
</table>

* = statistically significant, BMI = Body mass index
WC = Waist circumference, SBP = Systolic blood pressure
DBP = Diastolic blood pressure.

Figure 1. Mean QRS axis distribution of the population.
1 = NA (Normal Axis).
2 = LAD (Left Axis Deviation).
3 = RAD (Right Axis Deviation).

selection for each 5 year segment of the adult population (less than 20 years to 45 years or older) from the records of U.S Air force flying personnel noted a gradual shift of the frontal plane QRS axis with increasing age after 20
Table 3. Left axis deviation and its associated factors.

<table>
<thead>
<tr>
<th>Variable (n)</th>
<th>Prevalence(%) of LAD</th>
<th>Chi-square (χ²)</th>
<th>p – value</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young (118)</td>
<td>5.1</td>
<td>0.860</td>
<td>0.354</td>
<td>0.679</td>
</tr>
<tr>
<td>Old(111)</td>
<td>2.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not hypertensive(177)</td>
<td>4.0</td>
<td>0.001</td>
<td>0.972</td>
<td>0.978</td>
</tr>
<tr>
<td>Hypertensive(52)</td>
<td>3.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female(116)</td>
<td>3.4</td>
<td>0.145</td>
<td>0.704</td>
<td>1.132</td>
</tr>
<tr>
<td>Male(113)</td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No LVH(198)</td>
<td>1.5</td>
<td>22.593</td>
<td>&lt;0.001*</td>
<td>5.867</td>
</tr>
<tr>
<td>LVH(31)</td>
<td>19.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Statistically significant; LAD = Left Axis Deviation; OR = Odd Ratio.

years (Hiss et al., 1960). The lack of association of LAD with age in our study is probably due to the fact that significant LAD was considered as -30° to -90°. Furthermore investigators (Goldberg et al., 1970) have shown that even though a progressive shift of the frontal plane QRS axis occurred with age in these studies, healthy persons including those aged 60 to 90 years did not reach a QRS axis of -30°.

Left bundle branch block associated with LAD is attributable to proximal interruption of the anterolateral division of the left bundle with parietal conduction delay beyond that site (QRS prolongation resembling left bundle branch block) (Libanoff, 1964). In such cases, the initial forces of the QRS were normal and only the anterolateral division of the left bundle branch was blocked.

In an investigation of the prevalence, associated diseases and prognosis of LAD (defined as a mean frontal QRS axis of -30° or less) in 248 of 4678 persons older than age 20 years, the frequency of the axis deviation increased with age, among both sexes, but men had a higher prevalence than women (Ostrander, 1971). This finding agrees with our study where men had a higher prevalence (4.4%) of LAD than women (3.4%) though not statistically significant.

Ischemic heart disease in its own right causes myocardial fibrosis/infarction that partially or completely interrupts conduction in one or more fascicles. LAD has been found to be common in anterolateral infarction due to interruption of blood supply to the left anterior fascicle (Buyukozturk et al., 1977).

Other causes of LAD mentioned above are mainly due to interruption of conduction or delay in the left anterior fascicular conduction to result in activation of the anterior left ventricle solely via the posterior fascicle.

Conclusion

Significant LAD in an asymptomatic adult population without a history of heart disease is significantly associated with a cardiac abnormality such as left ventricular hypertrophy as shown in this study. It seems likely that LVH is associated with myocardial fibrosis and conduction delay in the left anterior fascicle leading to LAD.

Limitations

Exclusion criteria in our study were based on medical history that was given by the participants. Also the diagnosis of LVH was based on ECG alone which is not as sensitive as echocardiography. These may have affected the results.

REFERENCES


LIST OF ABBREVIATIONS

ECG – Electrocardiography/Electrocardiogram
LAD – Left axis deviation
LVH – Left ventricular hypertrophy
NA - Normal axis
RAD – Right axis deviation