

THE ELECTROCARDIOGRAM IN HEALTHY NIGERIANS RESIDENT IN LAGOS STATE.

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ABSTRACT

The normal electrocardiograms of 520 healthy Nigerians age 15-49 years resident in Lagos were analysed. Normative values and frequency pattern of normal variants of the ECG of Caucasians and South African Bantu were compared to the Nigerian data. The results show significantly higher QRS voltages in Nigerians than in Caucasians (R-wave amplitude 10.87 ± 4.32 : 1-29mm in males and 9.24 ± 3.84 : range 1-20mm in females for Nigerians. 6.23 ± 2.20 : range 0-15mm in males and 4.22 ± 2.52 : range 0-10mm in females for Caucasians). The QRS voltages of Nigerians were similar to those of South African Bantu.

The QRS interval value was similar to those previously reported by other authors for Caucasians. Difference in this interval was statistically significant between sexes. S-T segment elevation and T-wave inversion were very common in Nigerian subjects. Another racial difference noted was the extent of T-wave inversion. While T-wave inversion beyond lead V_1 is rare in adult Caucasians, in Nigerian subjects it may reach up to V_3 regardless of age. The results show that right and left axes deviations are rare in normal Nigerian population.

KEY WORDS: Electrocardiogram, T-wave inversion, S-T segment elevation, Axis deviation Nigerians.

INTRODUCTION

Several investigators have shown that the electrocardiogram (ECG), which is a graphic recording of the electrical potentials associated with the heartbeats, of Africans and peoples of African descent are at variance with those of the Caucasians when standardized for age and sex (Brink, 1956; Somers and Rankin, 1962). Other racial groups also shown to have different pattern of the ECG compared with the Caucasians include Ceylonese (Dharmadasa and Nadarajah, 1968) and the Indians (Srikantia, et al, 1964).

These findings support the need for each racial or ethnic group to have its own normal standards of the ECG. The aim of the present study was to establish 'normal' values for electrocardiographic data in Nigerians. A sample of 520 healthy Nigerian adults were studied. Selected ECG items of these subjects were compared with values obtained previously by other authors for Caucasians and for South African Bantu.

MATERIALS AND METHODS

This study was done on a population sample of 520 normal adult Nigerians resident in Lagos the former capital of Nigeria. Their ages ranged from 15 to 49 years. The subjects for this study were made up of students, civil servants, farmers, cyclists, taxic drivers, and housewives. The selection was based only on those participants who presented themselves voluntarily for the tests.

All our subjects appeared healthy. The following criteria were required for acceptance as a 'normal' subject: No history of cardiac disease or evidence of disease which could be expected to affect cardiac function, capacity to cooperate adequately during the

tests, blood pressure not exceeding 140/90mmHg, subjects have been residing in Nigeria for the past 5 years and both parents are Nigerians.

Chest radiographs were not obtained at the time of this study. Electrocardiograms were recorded using a portable heat-writing, single-channel machine (Cardisun Electrocardiograph, Model 5010, Fukuda Medical Electronics, Tokyo, Japan) with the subjects lying supine and after a 20-30 minutes of rest. The electrodes were positioned as recommended by the American Heart Association (1975). A paper speed of 25mm/sec. was used throughout the recording. The machine was standardized at each tracing to show a pen deflection of 10mm per 1 millivolt.

All the electrocardiograms were manually read, with upward deflections measured from the top of the baseline and downward deflections from the bottom of the baseline. The electrical axis of the heart was determined by the triaxial reference system (Edemeka, 1984). The IBM (Model 360) computer at the University of Lagos Computer Center was used to estimate the means and standard deviations for the parameters measured. Statistical test of significance between mean values were obtained using the student's t-test.

RESULTS

1. Heart rate and rhythm

Normal sinus rhythm occurred in 270(84.12%) of the males and in 177(88.95%) of the females. Sinus arrhythmia was seen in 15(4.67%) of the female subjects and in 5(2.51%) of the female subjects. Sinus tachycardia was noted in 4(1.24%) of the males and in 6(3.01%) of the female subjects. 2(0.62%) male subjects showed extrasystoles while this feature was noted in only one (0.5%) female subject. Bradycardia occurred in

30(9.34%) of the male subjects while this was noted in 10(5.02%) of the female participants. Female subjects recorded higher heart rates than their male counterparts. Whereas the mean heart rate in adult male subjects was 77 ± 8 beats/minute, their female counterparts had 79 ± 7 beats/minute. The range of heart rate in females was 53 to 125 beats/minute while in the males it was 41 to 115 beats/minute.

2. Electrical axis of the heart

Tables 1 and 2 show the means and standard deviations in five year age groups in males and females subjects respectively. Mean electrical axis of the heart in the males was $56.94 \pm 17.56^\circ$ while the females was $54.64 \pm 15.96^\circ$. Left axis deviation (mean electrical axis of the heart of -30° or less) occurred in 6 (1.86%) male subjects, while this was noted in 2(1.0%) of the female subjects. None of our subjects had right axis deviation (electrical axis greater than or equal to $+110^\circ$).

3. The P-R interval

The P-R interval ranged between 0.12 and 0.24 second in both sexes. Fifteen males (4.67%) had P-R interval greater than 0.20 second. Mean P-R interval in male subjects was 0.167 ± 0.03 second, and in the female subjects was 0.164 ± 0.04 second. There was a progressive increase in the P-R interval with increasing age in both sexes (tables 1 and 2).

4. The QRS interval

The QRS interval ranged between 0.04 and 0.12 second in both sexes (mean: 0.078 ± 0.014 second in males and 0.074 ± 0.012 sec. in the females). Tables 1 and 2 depict the means and standard deviations in five-years age groups. The result of this study shows that there is a progressive increase in the QRS duration with increasing age in the both sexes. In addition, the QRS interval in the males is longer than that of the females although the difference was not statistically significant (> 0.05).

5. The R-wave amplitude

For the R-wave amplitude in lead 2, the mean value in the males was 10.872 ± 4.32 mm (range: 1-29mm), and in the females 9.247 ± 3.84 mm (range: 1-20mm). Tables 1 and 2 depict the means and standard deviations for the R-wave in lead 2 in five-years age groups. As the tables depict, there was a progressive decrease in mean R-wave lead 2 amplitude with increasing age.

For the R-wave amplitude in lead aVL, the mean value in males was 5.93 ± 2.32 mm (range: 00-19.5mm) and in the females 5.46 ± 2.44 mm (range 00-14mm). There was no significant sex variation however, there was a progressive increase in the mean value with increasing age (Tables 1 and 2).

For the R-wave amplitude in lead aVF, the mean value in the males was 8.36 ± 3.32 mm (range: 1.5-19mm) and in the females 8.46 ± 3.52 mm (range: 2-17mm). There was a progressive decrease in the mean values with increasing age (Tables 1 and 2).

6. S-T segment elevation in the precordial leads

S-T elevations measuring 2mm or more was

more prevalent in the males than in the females. Tables 3 and 4 depict the distribution pattern in the male and female subjects.

7. T-wave inversion in the precordial leads

Inversion of the T-wave in the precordial leads was a common occurrence among the participants used for this study. The frequency decreased with increasing age. Tables 5 and 6 show the distribution pattern in the subjects studied.

DISCUSSION

In this study, normal sinus rhythm occurred in 84.12% males and in 88.95% females. These figures are comparable with the 70% in males and 85% in females reported by Araoye (1982). Oyediran et al (1972) reported a 98% incidence. The high incidence of sinus rhythm observed in this study is consistent with the popular maxim that the sino atrial node (SAN) is the pacemaker in the mammalian heart.

The P-R interval range in our subjects is comparable with that of the Bantu Africans. Somers and Rankin (1962) reported 97% of their subjects as having P-R interval within 0.12 to 0.02 second. In this study, 95.32% males and 98.48% females had P-R interval between 0.12 and 0.20 second. The high proportion of 95% (95 percentile) suggests that this be adopted as the normal limits of P-R interval in adult Nigerians.

In this study, 2% of the subjects had P-R interval greater than 0.20 second. This low incidence is in contrast with the high incidence rate (20%) reported in the Caucasians by Johnson et al (1960).

The range of the QRS interval in the Caucasians is variable. Grant (1957) reported 0.08-0.09 second while Brobeck reported 0.08-0.10 second. In the present study, the range varied from 0.04 to 0.12 second in both sexes. Results of this study show that the males had longer QRS duration than the females. This finding is in concordance with the report to Araoye (1982). The reason for the sex variation is not clear. However, it is our opinion that the difference could be attributed to the greater ventricular muscle in males than in the females (Cohen et al, 1980) causing depolarisation to be slower in the males than in the females. The larger heart volume in males (500ml/m^2) compared to females (450ml/m^2) as reported by Hurst et al (1990) makes the pathway for the transmission of impulses to be longer in males than in the females.

The mean QRS axis in adult Nigerians of Yoruba tribe as reported by Araoye (1982) is $50.2 \pm 18.6^\circ$ in the young (under 40 years of age) while in the elderly (above 40 years of age) $39.0 \pm 22.4^\circ$. Sofola and Ndur (1970) reported a mean value of $54 \pm 3.17^\circ$. The mean value of $56.94 \pm 17.56^\circ$ observed in male subjects in the present study is comparable with these earlier reports. Compared to the report on teenage Caucasians, Nigerian subjects show a greater orientation of the QRS axis towards the left. Wershing and Walker (1963) reported the following values for Caucasian teenage subjects: $68.4 \pm 26.9^\circ$ in males and $69.9 \pm 20.5^\circ$ for the females. The reason for the racial difference is unknown. However, it is our opinion that the difference could be due to variability in constitutional variables (such as chest build) which have already been

established to influence the anatomical and electrical positions of the heart (Ishikawa, 1976; Edemeka, 1984).

The result of our investigation shows that right and left axes deviations are rare in normal Nigerian population. Similar observations have been reported in other groups of Negroid population. Thus, Schamroth & Blumsohn (1960) reported that 1.1% of their 95 American Negroes aged 16 – 67 years had left axis deviation. This is in contrast with the 8.4% incidence rate reported by Steward & Manning (1944) on their series of 500 airforce men aged 18 – 26 years.

Several studies on the Negroes have shown that their mean R-wave amplitude in both the limb and precordial leads are higher than the reported values for the Caucasians. For instance, Golbarg et al (1970) reported mean R-wave amplitude in lead aVL for normal healthy Caucasian subjects aged 16 to 19 years as 2.44 ± 2.35 mm for males and 2.62 ± 2.10 mm for the females. In the present study, subjects for similar age structure had: 3.93 ± 2.93 mm for male subjects and 3.73 ± 2.41 mm for the female subjects. The racial difference has been attributed to reduced skinfold thickness and lower lung volumes in Negroes (Edemeka 1984).

S-T segment elevations in the precordial leads have been widely reported by several investigators (Oyediran, et al 1972; Seriki and Smith, 1966; Sofola and Ndur 1970; Walker and Walker, 1969). The finding of S-T segment and J-point elevations in the precordial leads in this study is a further confirmation of the reports of these earlier workers. The genesis of S-T segment and J-point elevation is obscure.

T-wave inversions in the precordial leads have earlier been reported by Seriki & Smith (1966), Walker & Walker (1969), Sofola & Ndur (1970) and Araoye (1982). Observation of T-wave inversions in the present study reconfirms these earlier reports. The spectrum of T-wave inversions as noted in the present study is closely similar to that reported by Walker & Walker (1969) for the South African Bantus but differs significantly from those of the Caucasians. Walker & Walker (1969) obtained the following percentages in their male South African Blacks aged 16 to 19 years: 44% in lead V₁, 12% in lead V₂ and 4% in lead V₃. In the present study, the following percentages were obtained: 42.85% in lead V₁, 21.42% in lead V₂ and 12.8% in lead V₃ for males of similar age structure. In contrast, Wasserburger (1955) reported a 1.2% T-wave inversion in lead V₁ in the Caucasians. In general, T-wave inversion is more common in the Negroes than in the Caucasians. The reason for the occurrence of T-wave inversion in the precordial leads is not certain.

In conclusion, we have presented a quantitative and qualitative analysis of the electrocardiograms of normal healthy Nigerians. We have also attempted to account for the observed differences in some ECG parameters between races and sexes. The awareness of these differences is essential for a proper interpretation of the ECG of Nigerians.

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REFERENCES

- Brink, A. J., 1956. The normal electrocardiogram in the adult South African Bantu. *S. Afr. J. Lab. Clin. Med.* 2, 97 – 105.
- Somers, K., and Rankin, A. M., 1962. The electrocardiogram in healthy East African (Bantu and Nilotic) men. *Br. Heart J.* 24: 542 – 548.
- Dharmadasa, K. and Nadarajah, M., 1968. Electrocardiogram in young Ceylonese. *Br. Heart J.* 72: 153 – 156.
- Srikantia, S. G., Padmavati, S., and Gopalan, C., 1964. The electrocardiogram in some Indian population groups. *Circulation.* 29: 118 – 121.
- American Heart Association, 1975. Committee Reports: Recommendations for standardization of leads and specifications for instruments in electrocardiography and vectorcardiograph. *Circulation*, 52: 11 – 31.
- Edemeka, D.B.U., 1984. Electrocardiographic studies and anthropometric correlations in healthy Nigerians. M.Sc. Thesis, University of Lagos, Nigeria.
- Araoye, M. A., 1982. The 12 lead electrocardiogram (ECG) in healthy adult Nigerians: An investigation of a Yoruba group. M.D. Thesis, University of Lagos, Nigeria.
- Oyediran, A. B. O.O., Basile, U. and Carlise, R., 1972. The electrocardiograms of 200 healthy Nigerian soldiers. *Afr. J. Med. Sci.* 3: 267 – 269.
- Johnson, R.L., Averill, K.H. and Lamb, L.E. 1960. Electrocardiographic findings in 67, 375 asymptomatic subjects. VII A-V Block. *Am. J. Cardiol.* 6: 153 – 159.
- Grant, R. P., 1957. Clinical electrocardiography, New York, McGraw-Hill Publishers.
- Brobeck, J. R., 1973. Best and Taylor's Physiological Basis of Medical Practice. 10th Edition Williams and Wilkins. Baltimore.
- Cohen, J. L., Gupta, P. K., Lichstein, E., and Chadda, K. D., 1980. The heart of a dancer: Non invasive cardiac evaluation of professional ballet dancers. *Am. J. Cardiol.* 45: 959 – 963.
- Hurst, J.W., Logue, R.B., Schlant, R.C. and Wenger, N.K. 1990. The Heart. 5th Edition, McGraw Hill.
- Sofola, O.A. and Ndur, J.D., 1970. Electrocardiograms in Lagos University Medical Students. *Madilag* 1(5): 7 – 12.

- Walker, A. R. and Walker, B. F., 1969. The bearing of race, sex, age and nutrition state on the precordial electrocardiograms of young South African Bantu and Caucasian subjects. *Am Heart J.* 77: 441 – 459.
- Ishikawa, K., 1976. Correlation coefficients for electrocardiographic and constitutional variables. *Am. Heart J.* 92: 152 – 166.
- Schamroth, L. and Blumsohn, D., 1960. The significance of left axis deviation in heart disease of the African. *Br. Heart J.* 23: 405 – 414.
- Stewart, C.B. and Manning, G.W., 1944. A detailed analysis of the electrocardiograms of 500 R.C.A.F. Aircrew. *Am. Heart J.* 27: 502 – 523.
- Glodbar, A.N., Kurczynski, T.W., Hellerstein, H. K. and Steinberg, A. G., 1970. Electrocardiographic findings among the total adult population of a large religious isolate, *Circulation* 41: 257 – 263.
- Seriki, O. and Smith A.J. 1966. The electrocardiogram of young Nigerians. *Am. Heart J.* 72: 153 - 156.
- Wershing, J. M. and Walker, C. H. M., 1963. Influence of age sex and body habitus on the mean QRS electrical axis in childhood and adolescence. *Br. Heart J.* 25: 601 – 609.
- Wesserburger, R. H., 1955. Observations on the 'juvenile pattern' of adult Negro males. *Am J. Med.* 18: 428 – 438.