ORIGINAL RESEARCH

An Analytical Study on Variations in Normal Electrocardiogram in a Teaching Hospital

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ABSTRACT
Background: The Electrocardiogram (ECG) records the electrical activity of the heart at the skin surface, A good quality 12 lead ECG is essential for the evaluation of almost all cardiac patients. Stimulus for every normal ventricular contraction (sinus beat) begins in the right atrium (RA) called the sinus node (SA). The normal ECG consists of P, QRS, T wave pattern and sometimes U wave also. In normal sinus rhythm P wave precedes each QRS complex and the rhythm is regular. **Aim of the Study:** To know the normal variations of Electrocardiogram is healthy adults. **Materials and Methods:** This study has been conducted in the department of General Medicine, Apollo Medical College, Chittoor, for the period of 6 months.
Results: We have included 460 number of participants in this study. Out of these 460, Male participants were 255 and Female participants were 205. The age group is involved is between 20 and 70 years. The most common changes observed were T wave inversion. **Conclusion:** Although most ECG changes found at baseline could be considered as a normal variation, they may progress to more severe heart complications as the subject ages. The results of this study also validate ECG findings of previous studies and underline that diagnostic criteria should be based on gender and age.
Keywords: Electrocardiogram, QRS Axis, T wave inversion, P wave, RBBB

INTRODUCTION

Today, people are living longer than ever before, and therefore, it has become even more important to distinguish between normal ageing-related cardiovascular changes and pathological cardiovascular conditions. In order to detect abnormal findings in a patient population, healthy controls of both genders and of a wide range of ages are required. Controls are often randomly selected from the population and included if they pass an initial clinical investigation and fit the selection criteria. Such a control group was included in a general population study in Umeå, Sweden, where the aim was to identify normal cardiovascular changes due to ageing in otherwise healthy subjects, with a particular focus on determining reference values for use in echocardiographic (echo) examinations of patients (1).

The following study focuses on the age-related changes in the electrocardiographic (ECG) recordings that were carried out on the same controls, but not have been published before: 12-lead resting ECG and 24-h Holter ECG monitoring. Minor ECG changes do not necessarily prevent a subject from being included in an echo reference material (2).
Moreover, previous studies in which healthy adults have been screened with Holter ECGs have revealed that arrhythmias are common in the elderly population. Although most of the changes have been considered as benign, other studies have shown that a minor change in ECG also increases the risk of having more severe heart complications in later life (3). To evaluate the presence of pathological ECG changes in this cohort, we applied the standard criteria used at our clinic: the Minnesota Code for resting ECGs, and pathological

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Holter ECGs were assessed according to the criteria defined by Bjerregaard (4).

A standard 12-lead ECG was performed with the subject in the supine position and at rest using six precordial and six extremity leads. The electrode placement was as follows: black – right leg, green – left leg, red – right arm, yellow – left arm. Precordial: V1 in the fourth intercostal space at the right sternum edge; V2 in the fourth intercostal space at the left sternum edge; V3 diagonally between V2 and V4; V4 in the fifth intercostal space in the midclavicular line; V5 at the height of V4, in the anterior axillary line; and V6 in height with V4 and V5 in the middle axillary line. A paper speed of 50 mm/s was used, as well as a gain setting of 10 mm range for a test signal of 1 mV. The leads were presented in the Cabrera format.

MATERIALS AND METHODS

This study has been conducted in the department of General Medicine, Apollo Medical College, Chittor, Andhra Pradesh, for the 6 months. The total number of participants included are 460, out of these 460, the male participants were 255 and females were 205. The age group involved is from 20years to 70 years. We have excluded the participants with Hypertension, Diabetes, COPD, Coronary artery disease, Obese patients and the patients who are on Beta blockers,Calcium channel blockers.

We have obtained the consent from all the participants by giving consent forms in their local language. After taking clinical history, we have examined all the patients in detailed and advised investigations like complete Blood picture, random blood sugar, X-ray chest, PA view and 12 lead ECG.

RESULTS

Total Number of participants Females - 205

- ■ 20 - 29 yrs ■ 30 - 39 yrs ■ 40 - 49 yrs
- ■ 50 - 59 yrs ■ 60 - 70 yrs
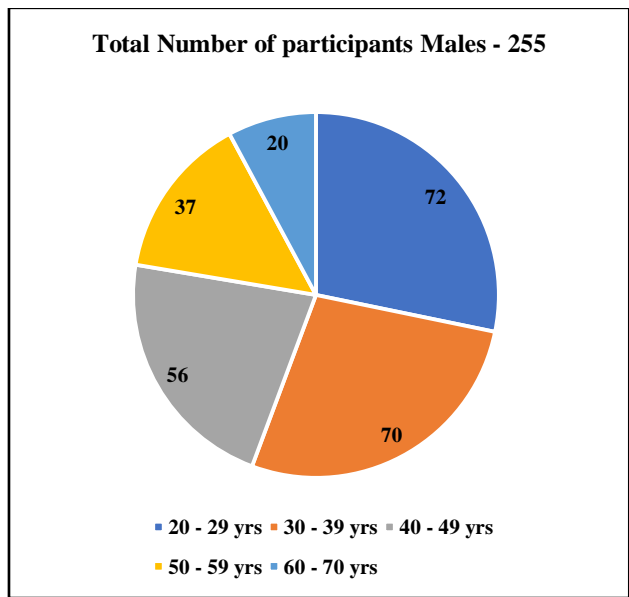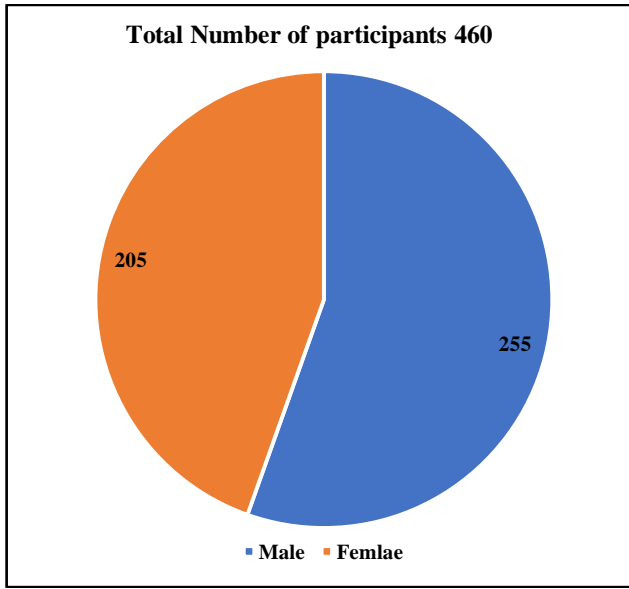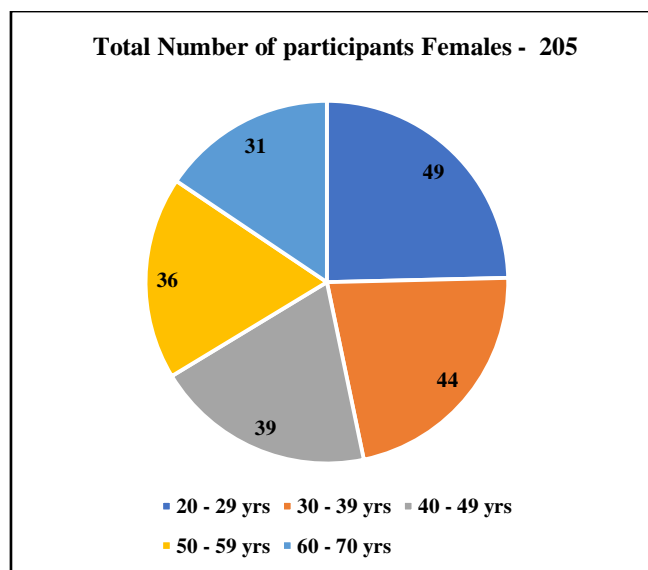
Table 1: Different Age Groups

Age group in years	Number of Participants (M) 255	Number of Participants (F) 205
20 – 29	72 (28.23%)	49 (23.9%)
30 – 39	70 (27.45%)	44 (21.5%)
40 – 49	56 (21.9%)	39 (19.4%)
50 – 59	37 (14.5%)	36 (17.5%)
60 – 70	20 (7.85%)	31 (15.12%)

Table 2: Different Heart Rates

Heart Rate per Minute	Number of Participants (M) 255	Number of Participants (F) 205
50 – 60	31 (12.15%)	15 (7.3%)
60 – 70	52 (20.3%)	45 (21.9%)
80 – 90	96 (37.64%)	89 (43.4%)
90 – 100	22 (8.62%)	35 (17.07%)
>100	17 (6.7%)	21 (10.24%)

Table 3: Different ECG Changes

Different Changes	Number of Participants (M) 255	Number of Participants (F) 205
T wave inversion	30 (11.2%)	37(18.2%)
'ST' Changes	22 (8.6%)	15 (7.3%)
U wave Changes	11 (4.3%)	8 (3.9%)
P wave Changes	9 (3.5%)	5 (2.4%)
VPC's and Others	8 (3.39%)	7 (3.4%)

DISCUSSION

We have included 460 participants in this study, out of these 460, males were 255 and females' participants were 205, the age group involved is between 20 and 70 years. (5) Fleg JL, Kennedy HL.The common ECG changes noticed in our study are sinus bradycardia, sinus tachycardia, T wave inversions, P wave abnormalities and ventricular premature contractions. According to study conducted by Glasser SP, Clark PI, Applebaum HJ etal axis changes and U waves are also normally seen. Normal heart rate is ranges from 60 – 100 bpm (beats per minute). In our study bradycardia was noticed in 12.5% Males and 7.3% of Females observed 7.6% of Males and 4.2% Females were having bradycardia in their study(6). Sinus tachycardia was observed in 6.1% of Males. The study conducted byBrodsky M, Wu D, Denes P, Kanakis C etal (7) shows 4.9% of Males were having sinus tachycardia. Tachycardia is considered as one of the predisposing factors for coronary artery disease. In more than 72% of males and 74.5% of females heart rate was in between 60 and 100 bpm. Among ST, T waves the most common abnormality is T wave inversions. T wave abnormalities are commonly seen in exercise, obesity, after meals. In children almost 50% will have T inversion, but as age in increasing to 20 years Tinversion may be seen in 4-8% of population. In our study T inversion are noticed 11.2% of males and 18.2% of females Chong BH, Pong V, Lam KF, Liu S et al (8) noticed in their study that 8.1% of males were having T inversion, and 13.5% of females were having T inversion, ST, changes are usually more than 1mm

depression or more than 1mm elevation are considered as pathological changes. In our study ST depression nearly 1mm was noticed in 8.6% males. In one study conducted by Dewland TA, Vittinghoff E, Mandyam MC et al shows ST depressions were nearly 4.1%.(9)Another change in ECG is ventricular premature contractions (VPCS). It is very occasional sometimes we may not find on normal ECG, Holter monitoring may be ideal investigation to record VPC's. In our study we noticed VPCS in 3.39% of males and 3.4% of females. The study conducted by Dewland TA, Vittinghoff E, Mandyam MC et al shows almost similar results. 4.8% of Males and 3.1% of females respectively. The other normal variations are 'U' wave appearance; Axis deviations and 'P' wave changes. In few numbers of cases incomplete RBBB was noticed.In this research study, we have assessed ECG changes related to ageing in a cohort of healthy subjects who presented with normal results in other cardiac examinations. We found significant age- and gender-related changes in many ECG parameters; In the youngest age group, bradycardia and LVH were frequently observed, whereas in the oldest age-group, conduction disturbances and morphological changes were more commonly found in the resting ECG. Rhythm disturbances were most frequently observed in the Holter ECG studies in subjects >50 years. In the resting ECG, rhythm disturbances were most frequently observed in the subjects <50 years, and the most common type was bradycardia.

As in previous studies, our subjects with ECGs without pathological findings presented with differences between genders and changes that were consistent with ageing. Both age- and gender-related differences were noted in the P-wave duration and in PQ interval. QRS duration and R+S only presented with differences related to gender. For HR and QTc, differences were only observed between age groups. ECG changes related to ageing have been discussed for a long time and may be related to a change in heart placement that occurs with ageing, which, in turn, can be due to changes in weight, subcutaneous fat distribution, diaphragm position, thorax and lung parenchyma. This may also explain why there is a gender difference in the ECGs.

We also compared the results of this study with the large study from the Netherlands by Rinjbeck et al. (10), in which several variables matched well with the Dutch reference material. The highest mean HR (68 bpm) was observed in both males and females > 65 years, which is similar to the findings of Rinjbeck et al (11). In this study, we noted a tendency to shorter P-duration compared with the reference material. The mean QT duration obtained in this study was marginally lower in all age groups than that found by Rinjbeck et al. In this study, four subjects presented with a prolonged QT duration, and QTc was extended in the older age groups. This, however, can be due to medical treatments, such as antibiotics, antidepressants and antihistamines.

11.2% presented with T-wave changes, which were found among both males and females >65 years. There are T-wave changes in several disease states, for example, in myocardial ischemia, and should not occur in a healthy individual. Therefore, T-wave abnormalities should be given a special attention and be correlated with clinical information.LVH occurs when the heart is continuously exposed to pressure overload, for example, in hypertension, aortic stenosis or due to hard physical exercise. One of the exclusion criteria in this cohort was hypertension, and since the subjects did not receive any medical treatment for heart disease, blood pressure should not have been the main cause for the signs of LVH in this study.

The presence of PVC in 24-h Holter ECGs can indicate an underlying cardiac pathology. In this study, 85% of all subjects presented PVC, with a range of 1–12,800 PVC/24 h. However, of these, only 13% fell within the range of what is classified as pathological. Martin et al. studied apparently healthy subjects aged > 75 years and found that the death rate at 3 years was twice as high in subjects having > 10 PVC/h in a 24-h Holter ECG (12). Frishman et al. stated that 93% of the subjects had PVC, but with a low incidence of non-sustained VT (13). In this study, eight subjects (7%) had VT, which can occasionally occur in healthy subjects. However, this should not be considered as normal, and subjects presenting with VT should always be further examined. (14)

No significant relationships were found between the findings at follow-up and the presence of a pathological ECG at baseline; however, we cannot exclude that minor changes in ECG can be a predictor of more severe cardiac events, as has been reported in previous studies.

CONCLUSION

Standards of normal values to help in the interpretation of the ECG of children have been available for many years. Recent research suggests that some of these standards should be reviewed and perhaps revised to take account of changes in electrocardiographic instrumentation and possible physiologicalchanges in children which might have taken place since the original standards were established. The rhythm changes seen in apparently normal children during random 24-hour periods of observation are well described, but the longer-term implications of these changes (if any) have not been systematically investigated.

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