Original Article

Effect of Age and Gender on QRS Complex Amplitude in Healthy Adults

Yasir M. Khaleel* **MBChB, MSc**
Baybeen K. Al-Selevany* **PhD**
Muzahim F. Mahmood* **MBChB, MRCP (U K), MRCPI, FRCP (Lond)**

Summary:

Background: There is controversy about the upper normal value of QRS complex amplitude in adult population under the age of 40 years. Most of the left ventricular hypertrophy voltage criteria were designed or tested for people above 40 years. In addition to age, QRS amplitude is also affected by gender and racial factors.

Objectives: To evaluate the impact of age on QRS amplitude in each gender separately in healthy adults.

Patients and Methods: Electrocardiograms from 563 overtly healthy adults (386 male and 177 female) aged 18-40 years were obtained using Cardios PC based ECG machine, 12-lead ECGs were recorded and QRS amplitude was measured as the sum of (SV1+RV5) and (SV2+RV6) both by computer and manual revision. The mean QRS amplitude was calculated for the entire study sample and then for each sex separately. The mean QRS amplitude was then compared between the two genders and in different age groups in the study sample. Linear regression lines of QRS amplitude versus age were drawn for each gender separately.

Results: The mean ± SD of QRS amplitude in the study sample was within normal range. Also It was found that males have significantly higher mean QRS amplitude than females (p=0.001), and there was highly significant decline in mean QRS amplitude with increasing age group in the study sample (p=0.001). Linear regression lines of QRS amplitude versus age in each gender separately have shown that males have greater QRS amplitude than females and there was a clear decline in QRS amplitude with increased age from 18- to- 40 years in males, but the picture was different in females as they have shown a very slight increase in QRS amplitude with increased age from 18- to- 40 years.

Conclusions: The mean QRS amplitude in males was significantly higher than females. There was a clear decline in QRS amplitude with increased age from 18-40 years in males ‘on the contrary, in females there was a very slight increase in QRS amplitude with increased age from 18-40 years.

Keywords: QRS amplitude, healthy adults, age and gender.

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Introduction:

The process of normal healthy aging without disease is accompanied by many physiological changes in different body systems and organs and these changes may be influenced by many genetic, racial, environmental and lifestyle factors.

It is well known that QRS voltage is higher in adolescents and young adults than older individuals 1 and most of the electrocardiographic (ECG) voltage criteria for diagnosing left ventricular hypertrophy (LVH) were derived and tested for populations above the age of forty. The question then; LVH still can occur at younger ages as a result or complication of different diseases, in which cases is it still possible to use ECG voltage criteria for diagnosing LVH?

The QRS amplitude also affected significantly by gender, males having higher QRS amplitude than females in both limb and chest leads and this difference is more pronounced in chest leads. This difference persists after adjustment for body size and cardiac mass 2-7. S wave in V3 (SV3) is the main measurement with the largest gender difference 5. Some voltage criteria for diagnosing LVH show significant improvement in their performance with gender adjustment, but the adjustment is not the same for all criteria 2.

Racial effect on QRS amplitude also has been observed and studied; African-American subjects are reported to have higher QRS voltage than Caucasian subjects. In a study of 114 healthy adolescents the upper limit for the S wave amplitude in lead V1 was 3.4 mV in black males, 3.2 mV in white males, 2.6 mV in black females, and 1.6 mV in white females. The corresponding values for the R amplitude in lead V6 were 3.0, 2.4, 2.2, and 2.4 mV 8. In another study of 15-19 year old adolescents the sum of S in V1 and R in V6 amplitudes averaged 3.69 mV in black males and 3.13 mV in white males. No significant differences were found between black and white females 9.

The echocardiograms showed that the left ventricular posterior wall was thicker and the distance between the anterior chest wall and the mid-left ventricle was shorter in black males than in white males. No such racial differences were observed in

*Correspondence Auther: Yasir M. Khaleel
Dept. of Physiology/ College of Medicine/ University of Mosul, Iraq.
E-mail: ymk6889@gmail.com

females 1, 9.

In Mosul city there is no reference value of normal QRS amplitude for the population.

The aim of this study is to assess the effect of age on QRS complex amplitude in each sex separately.

Methods:

The present study has been conducted on 563 overtly healthy individuals 386 male and 177 female aged 18-40 years. The study was conducted over a period of eleven months from 26th Feb. 2012 to 23rd Jan. 2013. Individuals included in this study were selected free from any cardiovascular abnormality or any other disease or condition affecting the cardiovascular system according to data collection form which was filled by the researcher according to information obtained from participants during interview. Careful clinical examination was done and only normal subjects were included. The source of participants was the outpatient clinics E.N.T, Dermatology, Allergy, Ophthalmology, Urinary, General surgery, and Internal medicine in Ibn Sina and Al-Zahrawee general teaching hospitals in Mosul city. Participant's consents were obtained by signing their names on the consent form after careful reading.

Inclusion criteria

1- Both sexes; age 18-40 years

2- Free history of any cardiovascular disease or any chronic illness that affects the cardiovascular system.

3- No physical chest deformities like kyphosis or scoliosis

4- Negative drug history; the participant should have no chronic use of any drug for any reason.

5- Data collection form was filled by the researcher according to information obtained from participants; the form should show no exclusion results.

6- Clinical examination was done carefully to exclude cardiovascular diseases.

Blood Pressure: Systolic <140 mmHg; Diastolic <90 mmHg.

Precordial examination should be normal

Oral temperature: should be normal 36.2-37.2 C°.

Exclusion criteria

1- Age: < 18 years; > 40 years.

2- Any positive history of cardiovascular disease, diabetes mellitus, chronic respiratory disease, connective tissue disease and any other systemic chronic illness that affect the cardiovascular system like thyroid diseases.

3- Data collection form showed exclusion results.

4- Clinical examination:

Blood Pressure: Systolic ≥ 140 mmHg; Diastolic ≥ 90 mmHg

Precordial examination: Any abnormal heart sounds and murmurs. Oral temperature < 36.2 C°; > 37.2 C°

According to the exclusion criteria 397 intended participants were excluded.

Electrocardiogram: ECGs were done in supine position and subjects were allowed to have at least 20 minutes rest before doing ECG. A conventional 12-lead electrocardiogram was recorded using Cardios computerized ECG machine and HP Pavilion g series laptop computer. Careful cleansing of the skin by 70% alcohol at the sites of electrodes placement to clean the skin from sebaceous secretions, then electrolytic gel was applied. Great care was taken to avoid the presence of any conducting material in the vicinity of electrocardiogram machine. The machine was calibrated as 1 mV equal to 10 mm amplitude, and the recording speed 25 mm/second.

QRS Amplitude : The assessment of QRS amplitude was done by measuring the sum of S wave in V1 + R wave in V5 (SV1+RV5), and the sum of S wave in V2 and R wave in V6 (SV2+RV6) as these leads are used by most of the precordial ECG criteria for the diagnosis of LVH 2, 10-13. The measurement was done both by computer and manual revision.

Data Analysis and Statistical Tests: Data analysis was performed by using Minitab version 14.2 software statistical programs. Frequencies, percentage, mean and SD were used in describing ECG parameters. Independent T-test for two means and One-way ANOVA-test for more than two means were used. P-value <0.05 was considered significant during data analysis.

Results:

The mean age (±SD) of the study sample was 28.70 ± 7.34 years, of whom 386 (68.56%) were males and 177 (31.14%) were females.

The mean QRS amplitude (±SD) with minimum and maximum value as measured by (SV1+RV5) and (SV2+RV6) in the whole study sample are shown in (Table 1)

Table 1: Mean QRS voltage in the study sample (n=563).

QRS amplitude	Mean	±SD	Min	Max
QRS_voltage (SV1+RV5) mV	2.55	0.85	0.13	5.93
QRS_voltage (SV2+ RV6) mV	2.24	0.71	0.13	4.96

The number and point prevalence for subjects having QRS amplitude >3.5 mV was calculated (Table 2).

Table 2: The number and point prevalence of reported QRS amplitude >3.5 mV (SV1+RV5 or SV2+ RV6 >35 mm) in the study sample (n=563).

QRS amplitude	number	Point prevalence
SV1+RV5 > 35 mm	77	13.68%
SV2+ RV6 > 35 mm	26	4.62%

The mean QRS amplitude ± SD for each sex was found and compared; males have shown highly significant greater mean QRS amplitude than females (p=0.001), (Table 3).

Table 3: Comparison of mean QRS amplitude between males and females in the study sample (n=563).

QRS amplitude	Male [n = 386] Mean±SD	Female [n = 177] Mean±SD	P-value*
QRS_voltage SV1+RV5 mV	2.83± 0.84	1.96± 0.51	0.001
QRS_voltage SV2+RV6 mV	2.42± 0.72	1.85± 0.48	0.001

* Independent T-test of two means was used.

The study sample was divided into 5 age groups and the mean QRS amplitude (±SD) has been compared in these age groups. There was highly significant decline in the mean QRS amplitude with increased age of the group (p=0.001), (Table 4).

Table 4: The effect of age on QRS amplitude in different age groups of the study sample (n=563).

Parameters	Age groups (years)					P-value*
	18 – 20 [n= 106] Mean±SD	21 – 25 [n= 121] Mean±SD	26 – 30 [n= 96] Mean±SD	31 – 35 [n=104] Mean±SD	36 – 40 [n=136] Mean±SD	
QRS_voltage SV1+RV5 mV	2.84 ± 0.93	2.72± 0.89	2.48 ± 0.81	2.38 ± 0.68	2.37 ± 0.83	0.001
QRS_voltage SV2+RV6 mV	2.47 ± 0.85	2.42± 0.76	2.24 ± 0.63	2.09± 0.57	2.02± 0.59	0.001

* One-way ANOVA-test for more than two means was used.

The effect of age on QRS amplitude in each sex separately has been studied by drawing linear regression lines for each gender alone, (Figure 1) and (Figure 2). In males QRS amplitude has show significant decline with age 'on the contrary, in females QRS amplitude has shown a very slight increase with increasing age from 18- to 40 years.

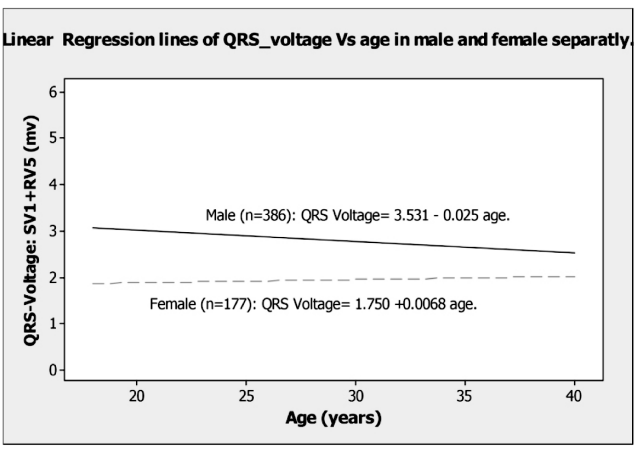

Figure 1: The effect of age on QRS amplitude (SV1+RV5) in each gender separately drawn as linear regression lines.

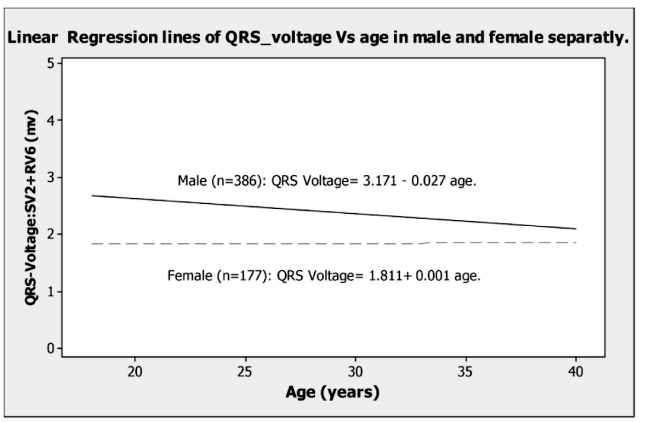

Figure 2: The effect of age on QRS amplitude (SV2+RV6) in each gender separately drawn as linear regression lines.

Discussion:

The mean QRS amplitude found in the present study was within normal value (SV1+RV5) or (SV2+RV6) ≤ 3.5 mV 1, 2. The prevalence of subjects having (SV1+RV5) and (SV2+RV6) > 3.5 mV in the present study was 13.68% and 4.62% respectively. This finding is different in different places around the world because it is influenced by many demographic and anthropometric variables 14. Male participants were found to have significantly higher mean QRS amplitude than female participants with P-value 0.001 and this is in agreement with most of the references and studies 1, 2, 10-13. The effect of age on QRS amplitude was studied by comparing the mean

QRS amplitude in different age groups of the study sample, a clear and very significant decline in QRS amplitude was found with increasing age group with P-value 0.001, this finding in agreement of many references and studies 1, 2, 8, 10-13. It is known that adolescents, in particular, demonstrate QRS amplitude that is larger in males when compared to females, especially pronounced in the precordial leads 15. A similar difference is also noted in the adult population 16. The significantly higher mean QRS amplitude in men is most impressively seen in leads V3 to V6 15. The effect of age on QRS amplitude in each sex separately in the study sample was studied by using linear regression lines, (Figure 1) and (Figure 2). In male participants there was a clear decline in QRS amplitude with increased age from 18- to - 40 years contrary to female participants in whom there was a very slight increase in QRS amplitude with increased age from 18- to - 40 years.

Conclusions:

The mean QRS amplitude in the study sample was within normal range and there was a significant decline in QRS amplitude with increased age group of the study sample. Males have significantly higher mean QRS amplitude than females and there was a clear decline in QRS amplitude with increased age from 18-40 years in males contrary to females in whom there was a very slight increase in QRS amplitude in the same age range.

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