Original Research Paper

Volume-8 | Issue-4 | April-2018 | PRINT ISSN No 2249-555X

Physiology

CORRELATION BETWEEN BLOOD VOLUME AND AMPLITUDE OF QRS COMPLEX IN YOUNG HEALTHY INDIVIDUALS

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ABSTRACT

Back ground

Hemodynamic instability following trauma is perhaps the commonest cause of loss of life. The standard vital signs used to determine hemodynamic status are static measurements rather than dynamic, and may not truly reflect early volume loss. The Brody effect proposes a direct relationship between the QRS complex voltage and ventricular blood volume, a theory which has been supported by both human and animal studies.

Aim

To correlate blood volume and amplitude of QRS complex.

Material and Methods

Lead II ECG was recorded for 1 min in 56 healthy adult male volunteers (20-40 years) using the student Physiograph(Bio Devices). The amplitude of the largest QRS complex was measured in µV. Blood volume (in litres) was calculated by Nadler's method using height and weight.

RESULTS: Blood volume showed positive correlation with QRS amplitude.

KEYWORDS : QRS complex, blood volume

Introduction

Road traffic accident (RTA) is an emerging epidemic. It is one of the leading causes of morbidity and mortality worldwide. It is the eighth leading cause of death among young people (15–29 years) globally and is believed to rise in the coming years.[1]

National Crime Records Bureau reports that more than 135,000 traffic collision-related deaths occur in India every year, which is among the highest in the world.[2,3] One of the greatest challenges in trauma care in the present era is early identification and management of haemodynamic instability. Hemorrhage continues to be a leading cause of death in our country, which leads to development of new approaches for early detection of blood loss as a research priority. Several triage criteria and tools have been advocated to determine injury severity, mode of transport, priorities of treatment and patient vital-signs data. These measurements are expected to provide a snapshot of patient stability. Inspite of all the measures taken the morbidity and mortality resulting cause a very big hindrance to the overall economic growth of the country.

During early volume loss, a series of reflex cardiovascular and neurohormonal mechanisms maintain normal arterial pressures with only mild tachycardia. The baroreceptor reflexes, chemoreceptor reflexes, and cerebral ischemia initiate strong sympathetic responses that result in intense vasoconstriction and help defend against severe hypotension. [4]The standard vital signs though cannot be used as a true determinant of hemodynamic status as it may not truly reflect early volume loss.[5]A linear relationship between body-surface voltage and intracardiac volume has been reported by few studies.If R-wave amplitude faithfully represents cardiac volume independent of reflex responses, then continuous electrocardiograph (ECG) R-wave amplitude evaluations may serve as an improved early marker of central blood-volume reductions.[6]

Previous animal and human experiments have shown that reduction in central blood volume either increases or decreases the amplitude of R waves in various electrocardiograph (ECG) leads.[3] The conductivity of the intracavitary blood mass is approximately ten times that of the surrounding tissue.[5] On this basis it might be expected that the intracavitary blood mass would exert some sort of short-circuiting effect upon potentials generated within the myocardium.

A direct relationship between QRS complex voltage and ventricular volume was put forth by Brody. This theory has been substantiated by both human and animal studies.[5] However, other investigators have reported varying results, with QRS amplitude having an inverse or no relationship with central hypovolemia.[7,8,9]
Given these contradictory results, this study was undertaken to assess the effect of total blood volume on the amplitude of the QRS complex in healthy adult male subjects.

Aim

To correlate total blood volume and amplitude of QRS complex in human adult volunteers in supine position.

Methodology

This descriptive study was conducted in the Department of Physiology Pondicherry Institute of Medical Sciences from September 2014 to November 2014. Ethical clearance was obtained from institutional Ethics Committee. A detailed informed written consent was obtained from each participant before including them in the study.

The participants in this study included 56 young healthy adult male volunteers in the age group of 20-40 years. A detailed history was taken and thorough physical examination was conducted to rule out any systemic diseases. On the day of study, the subjects were asked to report at a fixed time in the morning an hour after a light breakfast. All participants were asked to abstain from caffeine intake and over the counter medication use in the morning of the study visit. In the laboratory, after explaining the procedure, anthropometric measures and basal vital parameters were recorded.Lead II ECG was recorded for 1 min in 56 healthy adult volunteers using the student physiograph (Bio Devices) after 5 minutes of rest in the supine position. The amplitude of the largest QRS complex was measured in µV. Blood volume (in liters) was calculated by Nadler's method using height ,weight and gender.[6]

Nadler's equation-
Patient Total Blood Volume (mL) =
Male (0.006012 x H 3)/ (14.6 x W) +604
Female (0.005835 x H 3)/ (15 x W) +183
H= height in inches
W= weight in pounds

Results were obtained using Pearson correlation. A graph was plotted between blood volume in litres and QRS amplitude in µV which is given in figure 1.

Results

Table 1: Demographic table

	Height (cm) (H)	Weight (kg) (W)	BMI Kg/m2	Blood volume (litres)	QRS Amplitude (µV)
Mean	166.87	64.92	23.27	4.27	847
SD	7.77	10.15	3.07	0.53	194

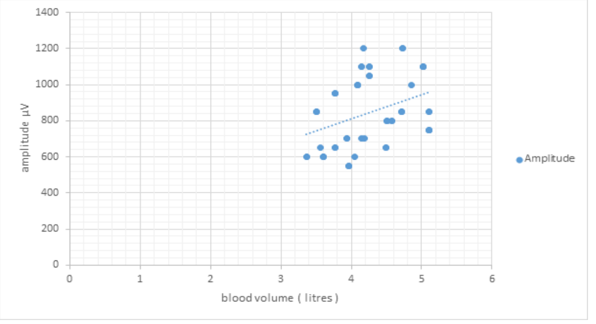

Fig 1: Correlation between Blood volume and QRS Amplitude

There is a significant (r value= 0.363, $p<0.005$) positive correlation between QRS amplitude and total blood volume.

Discussion

The present study brought forth that ECG voltage indexes are strong and independent predictors of adverse cardiovascular outcomes. Left ventricular volume overload states, increases the QRS wave amplitude.[10] Heart lead relationship derives a powerful influence from intracavitory blood mass. .On the basis of a mathematical model, Brody suggested that intracardiac blood as a highly conductive mass, augments the electrocardiographic surface potential if the progress of myocardial excitation is radial to the blood mass.[5]

A direct correlation between total blood volume and QRS amplitude was noted in the present study. It has been documented by an earlier study that an increase in Left Ventricular volume is accompanied by an increase in surface QRS amplitude and vice versa.[6] With more blood volume cardiac surface comes closer to recording electrodes. The anatomical position of the heart within the chest, changes the relationship between cardiac regions and the axis, and also change recording voltages.[11]Higher blood volumes are effective in conducting cardiac potentials to body surface. Dilated ventricles will effectively augment radially directed dipoles because of the increase in intracavitory blood mass and thereby increase the voltage at body surface.[8] An increase in R-wave amplitude is associated with a higher cardiac volume.[12]

Conclusion

Changes of QRS amplitudes occur before changes of arterial pressures, and, therefore, amplitude monitoring may allow for early identification of blood loss as a result of haemorrhage. ECG monitors that may in the future support analysis of R-wave amplitude could improve the ability to predict severity of haemorrhage and to facilitate early decisions regarding diagnosis and treatment.

Further studies in hypovolemic patients using highly sensitive ECG monitors supporting the analysis will give a means for faster resuscitative measures. In summary; we postulate that new noninvasive technologies may pave a way for comparison of QRS complex changes synchronously with extracellular water /blood volume (BV) changes.

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