Effect of Deep Inspiration and Expiration on QTc Interval in Normal Healthy Subjects

Gautam Y, Bade M

Department of Physiology

Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal.

Corresponding Author

Yubina Gautam

Department of Physiology

Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal.

E-mail: yubinagautam@kusms.edu.np

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ABSTRACT

Background

It is a well known fact that phases of respiration cause change in heart rate and autonomic tone of the heart. But how cardiovascular autonomic reflexes affect the electrocardiographic Heart rate-corrected QT interval (QTc) during the inspiratory and expiratory phase of respiration also need to be established.

Objective

To determine whether the respiratory phases influence the QTc interval or not.

Method

This was a quantitative, observational, cross-sectional study done at Kathmandu University School of Medical Sciences, Pre-Clinical Basic Science Block, Chaukot. Total one hundred students between 18 to 25 years of age, studying at KUSMS Pre-clinical science Block were included. QTc interval was recorded for normal respiration, deep inspiration and deep expiration by electrographic recording using ADInstruments. The values obtained were later analyzed using paired t-test in SPSS 16.0.

Result

The mean QTc interval during normal respiration was 392.1±21.6 milliseconds, during deep inspiration was 384.2±15.5 milliseconds and that following deep expiration was 395.0±13.1 milliseconds. There was no significant difference between QTc interval at the end of deep inspiration (p value < 0.05) and QTc interval at the end of deep inspiration (p value<0.05) when compared with normal respiration.

Conclusion

This study shows that neither the inspiratory phase nor expiratory phase alters the QTc interval in normal healthy individual. Thus, it can also be implied that alteration in inspiratory and expiratory phase in various respiratory diseases does not cause any change in QTc interval.

KEY WORDS

Expiratory phase, Inspiratory phase, Phases of respiration, QTc interval

INTRODUCTION

QT interval is the interval from the beginning of QRS complex to the end of the T wave. It represents ventricular depolarization and repolarization.[1] Bazett's formula is a standard clinical formula for calculating the heart rate-corrected QT interval (QTc) given by QT/√RR where QT interval (in seconds) divided by square root of RR interval (in seconds).[2] Heart is regulated by the Autonomic nervous system. Sympathetic stimulation increases the heart rate (HR) and myocardial contractility whereas the parasympathetic stimulation has an antagonistic action.[3] HR accelerates during inspiration and decelerates during expiration. This phenomenon is known as Sinus arrhythmia which is primarily due to fluctuations in the parasympathetic output to the heart.[4]

Of the researches available, there are few researchers who have concluded no significant differences between QTc interval during maximum inspiration and maximum expiration compared with those in normal breathing.[5-7] On the contrary, some researches have shown that phases of respiration affects the QTc interval.[8,9] More so, the effect of respiratory phases on QTc interval is still controversial.

Alterations in QTc interval are known to induce life threatening ventricular arrhythmias.[10] If deep inspiration and expiration alter QTc interval significantly, then this might be the cause of arrhythmias in some respiratory diseases. This is why the present study was undertaken to see whether deep inspiration and deep expiration affect the QTc interval or not.

METHODS

This was a quantitative, observational, cross-sectional study conducted at Pre-Clinical Basic Science Block, Kathmandu University School of Medical Sciences (KUSMS), Chaukot, Nepal. One hundred students between 18 to 25 years of age, studying at KUSMS Pre-clinical Basic Science Block who were healthy, free from cardiovascular and respiratory diseases and not under any medication were included in the study. Ethical approval was obtained from the Institutional Review Committee (IRC) of KUSMS. The participants were explained about procedure of the study in detail and they had given informed written consent for participation.

The study was conducted in the Exercise Physiology Laboratory in Physiology Department, KUSMS, Chaukot, ¬Nepal. On the day of data collection, the participants were asked to refrain from any physical task just before the procedure. Electrocardiography (ECG) recording was obtained from ADInstruments (Model:ML856,Serial:T26-4025). Standard lead II was recorded by placing positive electrode on left arm and negative electrode on the right arm, and the grounding was done on the right foot. ECG was recorded for 15 seconds and analysis was done by LabChart 7 Pro v7.3.3.

ECG was recorded in each participant three times, i.e. initially while the person inspired normally, at the end of deep inspiration and later at the end of deep expiration.

The recordings were entered in MS-Excel worksheet and later exported to SPSS 16.0. Paired t-test was applied to find whether there was significant difference between QTc interval at the end of deep inspiration and deep expiration compared with QTc during normal breathing.

RESULTS

One hundred healthy students aged between 18 to 24 years were included in this study. Of the total participants, 60 were female and 40 were male as given in figure 1. The mean age of the participants was 19±1 years. The mean Body Mass Index (BMI) was 21.28±2.95 Kg/m^2.The mean Systolic Blood Pressure (SBP) of the participants was found to be 116±9 mmHg and mean Diastolic Blood Pressure (DBP) was found to be 77±6 mmHg. The mean HR of our participants was 80±8 beats per min (bpm) as given in figure 2. The QTc interval during normal respiration was 392.1±21.6 milliseconds(ms), the QTc interval at the end of deep inspiration was 384.2±15.5 ms, and QTc interval at the end of deep expiration was 395.0±13.1 ms respectively as shown in figure 3. The comparison of difference between these three values was analyzed (Table 1). It was found that the differences of QTc interval between normal breathing and deep inspiration as well as normal breathing and deep expiration were not statistically significant (p>0.05).

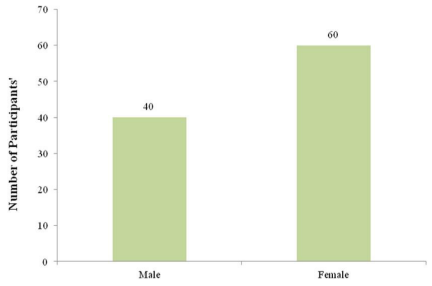

Figure 1. Number of participants' based on Gender

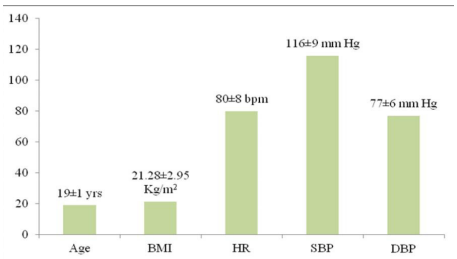

Figure 2. Mean age, BMI, Heart Rate and Blood Pressure of the Participants'

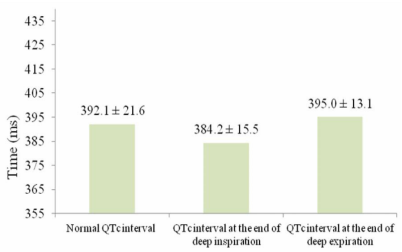

Figure 3. **QTc interval during normal inspiration, at the end of deep inspiration and at the end of deep expiration respectively**

Table 1. **Comparison of QTc interval during normal respiration, with QTc interval at the end of deep inspiration and also the comparison of normal QTc with QTc at the end of deep expiration**

	N	Mean (ms)	Std. Deviation	p-value
QTc interval during normal respiration	100	392.1	21.6	
QTc interval at the end of deep inspiration	100	384.2	15.5	0.138
QTc interval at the end of deep expiration	100	395.0	13.1	0.300

DISCUSSION

The normal QT varies depending on age and gender, and it ranges between 360 to 440 ms.[11] In our study, the normal QTc is found to be 392.10±21.6 ms. Of the researches available, a study done by Kabir et al. on effect of phases of respiration on beat-to-beat QT interval found that respiration affects QT interval independently from its effect on RR interval, thus the correction of QT interval should include both RR interval as well as respiratory phase.[12] Also a study done in the changes in QT dispersion magnitude during respiratory phases i.e. maximum inspiration and expiration by Yetkin et al. found that there was no significant difference between QTc (max) interval during maximum inspiration vs normal respiration (409±20 ms vs 417±26 ms, p>0.05) and normal respiration vs maximum expiration (417±26 vs 412±18 ms, p >0.05) respectively.[5] These findings were similar to our study where we have also found that QTc interval during normal respiration and deep inspiration (392.1±21.6 ms vs 384.2±15.5 ms, p>0.05) and QTc interval during normal breathing and deep expiration (392.1±21.6 ms vs 395.0±13.1 ms, p>0.05) were not significantly different. In the same study by Yetkin et al., it was found that the QT dispersion magnitude during both maximum inspiration and maximum expiration was lower than normal breathing which may be due to the position of heart which was more stationary during maximum inspiration and maximum expiration than during normal respiration.[5] Nevertheless, a study by Krupienicz et al. on QT dispersion magnitude in relation to respiratory phases found that reflex parasympathetic stimulation did not influence QT interval duration, although it may have an effect on T wave morphology. This may be due to very little time allowed for application of parasympathetic stimulus, which may have allowed the QT interval to adapt.6 In the same way, a study by Zwain et al. on QT-dispersion and JT- dispersion in responses to control, deep inspiration and deep expiration found that there was no significant changes in QT dispersion between control and deep inspiration and also no significant changes between control and deep expiration.[7] Also there was no significant difference between the QT dispersion for deep inspiration and deep expiration phase. The reason for these findings may be because the QT dispersion, like most of the other ECG variables , was not dependent on HR as well.[7] In addition, in another study by Yetkin et al., it had been reported that deep breathing at 6 breaths/min had beneficial effect on the heart.[13] There was reduction of premature ventricular complexes along with decreased QT dispersion due to vagal modulation to the sinus node and atrioventricular (AV) node.[13] On the contrary, a study by Haapalahti et al. on effects of cardiovascular autonomic function tests on QT dispersion ,QT-peak dispersion was greater on deep expiration than deep inspiration (49±20 ms vs 37±14 ms, p<0.05). However, there was no change in QT dispersion during any of the phases of respiration due to rapid cardiac autonomic reflex adjustment in young adult males. In addition, QT dispersion did not change during hyperventilation as well. The confounding factors in this study may be intrathoracic volume and intrathoracic pressure which might have affected the QT dispersion methods.[9] In addition, a study done by de Lalla et al. on normal respiratory variation of cycle length, QT interval, and QTc interval of the electrocardiogram found that QTc increased with inspiration in most of subjects.[8] Nevertheless, by the findings observed by Magnano et al. while comparing the effect of exercise, atropine and isoproterenol on QT shortening for a given increase in HR, they found that autonomic conditions directly affect the ventricular myocardium of healthy subjects causing differences in QT that are independent of HR.[14]

HR increases with inspiration and decreases during expiration.[4] QT varies with HR but QTc is unaffected by HR. Thus, in our study we did not find significant difference in QTc interval in different phases of respiration. As HR changes with respiratory phases, so does the QT but not the QTc.

CONCLUSIONS

This study shows that neither the inspiratory phase nor expiratory phase alters the QTc interval in normal healthy individual. Thus, it can also be implied that alteration in inspiratory and expiratory phase in various respiratory diseases does not cause any change in QTc interval. However, further research by involving more participants of various age groups should be done in order to obtain results which can be generalized and applicable for a broader population.

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