QT Analysis of Intrauterine Growth Retarded and Normal Children at 10 Years Old

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Abstract

The main objective of the work described in this paper is to develop an algorithm to detect QT, other ECG intervals and to find any correlation between QT, ST, QRS, Heart rate (HR) of normal and IUGR children at 10 yrs. The cohort under study is described in chapter 2 as 41 IUGR and 34 as normal. The ECGs of 24 hour for each child were used to find any differences between the two groups.

Normal children have QRS intervals during awake (73.96 ±13.65 ms) and asleep (78.75±14.76 ms), and IUGR has (73.94 ±12.85 ms day, 75.98±14.80 ms night), and IUGR children have a slightly higher corrected QTc (418.25±28.92ms Day, 437.22±20.17 ms night), compared to normal (411.37 ±36.13 ms day, 431.79±20.12 ms night).

At 10 years of age the measured ECG intervals of all normal and IUGR children was unable to show any deviation from the normal paediatric limits.

IUGR children are relatively more prone to longer QTc intervals.

1.   Introduction

Coronary heart diseases are one the major causes of death in the world. Studies of Barker [1], showed that intrauterine growth retarded children (IUGR) are prone to coronary heart diseases and hypertension in their adulthood.

An ECG has many important intervals and segments, such as R to R, QT and ST segments. A prolonged QT indicates a myocardium at risk for triggered activity, where the cardiac cell will rapidly and repeatedly depolarize, and this is associated with dangerous ventricular tachyarrhythmia.

This work is to compute the QT for the IUGR and normal children and see if there are any significant differences between the two groups.

2.   Method

The ECG signal was subjected to re-sampling of the ECG from 128 Hz to 512 Hz was implemented [2] for jitter reduction.

The basis of the QT algorithm developed using MATLAB is, firstly to detect the QRS by the modified Pan and Tompkins technique [3] and finding the local maximum value of the ECG, which represents the peak of the R wave, then to window the data before the R peak to find all the details such as: Q (the lowest value before the R peak), start of the Q wave by setting a threshold and comparing the data values with this threshold and when they are equal this point will be marked as the beginning of the Q wave, Secondly, to window the data of the ECG after the R peak, where we can detect, by means of maximum and minimum points of the data, the Q, S and the T waves. The positions of the start of the T wave and the end of the T wave were detected using the same type of threshold comparison used to find the beginning of the Q wave. Figure (1) shows the ECG with R, Q, S, and T waves detected, as well as the onset and offset of each of the waves, so that important intervals can be measured. The algorithm was used to find the corrected QT interval, QRS interval, and ST interval by means of detection and delineation of Q, S, and T waves.
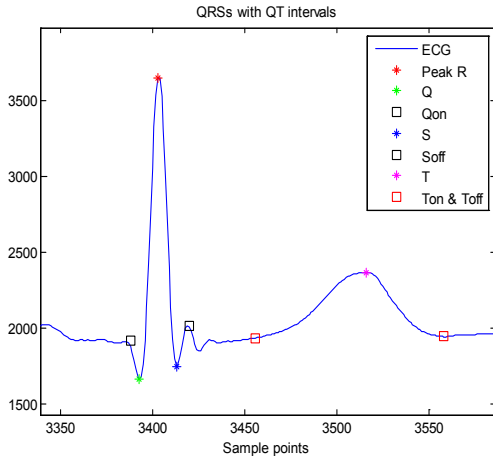
Figure 1. ECG waves detections.

3. Results

A self-developed algorithm was used and implemented to measure the relevant intervals on the children ECG signals. First, ECG data was read. Then, the algorithm estimates the locations of all onsets and offsets for all ECG intervals.

Figures (2, 3, 4 and 5) show the average values of the HR, ST, corrected QT, and HR.

The average values of Normal children were compared with those of the IUGR children.

HR is higher in Normal children at day time and at sleep time HR is the same for both groups, see figure (2).
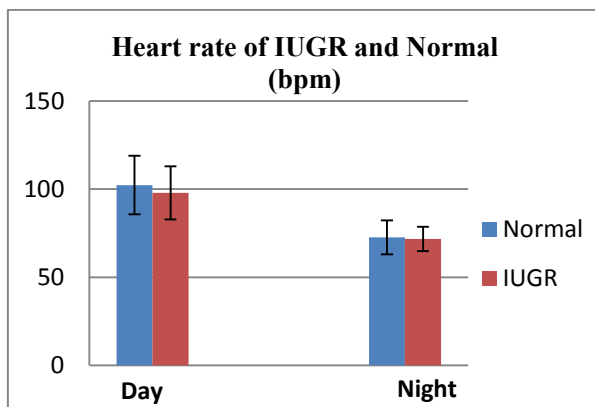

Figure 2. Heart rate of IUGR and Normal children.

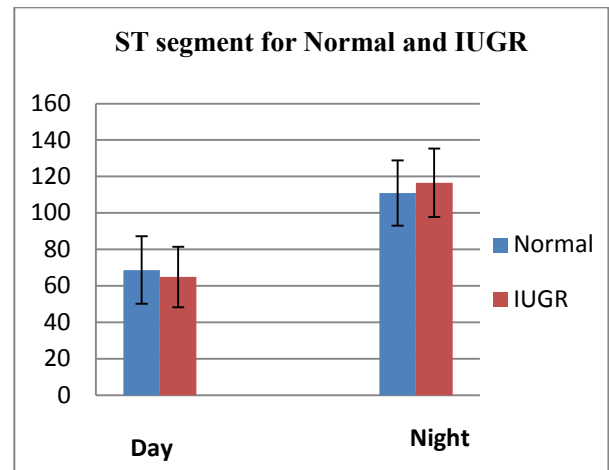ST segment in the Normal group is less than that in IUGR as shown in figure (3).

Figure 3. ST segment for IUGR and Normal at Day and night time.

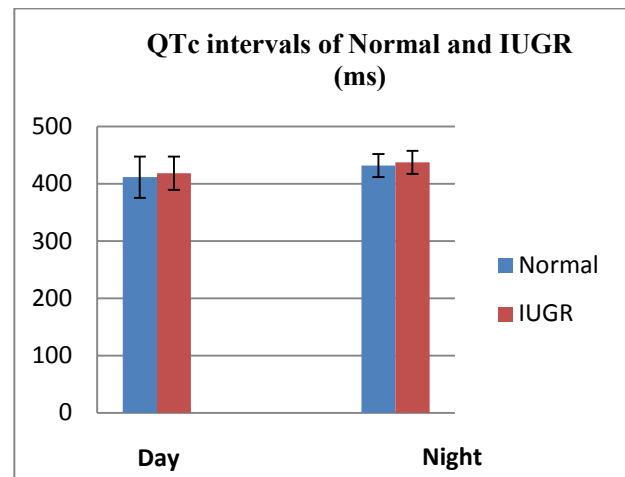Figure (4), shows IUGR children have a slightly higher corrected average QT.

Figure 4. QT intervals for IUGR and Normal at day and night.

Figure (5) shows Normal and IUGR children have very similar QRS intervals during awake and asleep.

Normal children have QRS intervals during awake (73.9 ±13.7 ms) and asleep (78.7±14.8 ms), and IUGR has (73.9 ±12.8 ms day, 75.98±14.8 ms night), and IUGR children have a slightly higher corrected QTc (418.2±28.9 ms Day, 437.2±20.2 ms night), compared to normal (411.4 ±36.1 ms day, 431.8±20.1 ms night).

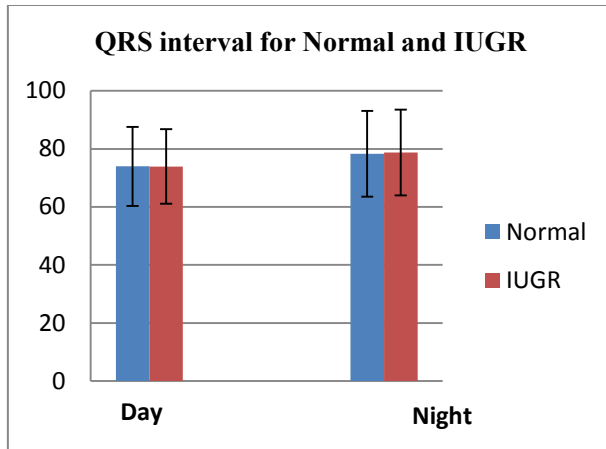Figure 5. QRS intervals for Normal and IUGR children.

Table 2. Statistical analysis of the ECG intervals results.

ECG intervals	Normal Vs IUGR (P value)	95% CI (lower, upper)	
HR-DAY	0.195	(-11.4	2.35)
HR-NIGHT	0.623	(-4.58	2.77)
ST-DAY	0.313	(-10.87	3.52)
ST-NIGHT	0.164	(-2.30	13.36)
QT_c-DAY	0.123	(-1.92	15.83)
QT_c-NIGHT	0.064	(-0.420	10.79)
QRS-Day	0.973	(-4.67	4.51)
QRS -Night	0.91	(-4.8	5.43)

4.   Statistical analysis

Statistical analysis using independent t-tests shows that there is no significant difference between the ECG intervals of the IUGR and the normal children. QTc at night time comparison gives a p value of 0.064 which is border line non-significant, The mean values indicate that IUGR children might have longer QTc (437.22 ±20.17) than the normal children. Larger samples of IUGR children and normal are needed to confirm this in another study done on the same population's ECG intervals when they become older than 10 yrs.

Table 1. All ECG intervals data for Normal and IUGR children and published Paediatric ECG limits. *[4]

ECG features children	Heart rate /day bpm	Heart rate/Night bpm	ST /day (ms)	ST /night (ms)	QTc /day (ms)	QTc/Night (ms)	QRS/Day (ms)	QRS/Night (ms)
Normal	102.31 ±16.60	72.70 ±9.63	68.72 ±18.50	110.94 ±17.83	411.37 ±36.13	431.79 ±20.16	73.96 ±13.65	78.75 ±14.76
IUGR	97.82 ±15.06	71.78 ±6.94	64.91 ±16.52	116.59 ±18.81	418.25 ±28.92	437.22 ±20.17	73.94 ±12.85	78.75 ±14.80
Published Data Paediatric ECG limits*	Boys 78(55,101) Girls 80(58,110)				Boys 411(373,440) Girls 410(365,447)		Boys 85(67, 103) Girls 82(66,99)	

5.   Conclusion

The algorithm tested had shown to measure the correct values of the ECG limits for signals with good SNR. At 10 years of age the measured ECG intervals of all normal and IUGR children was unable to show any deviation from the normal paediatric values [5], [6]. The algorithm needs to be improved further for general use to cater different changes and shapes associated with paediatric ECG and the ones with higher SNR.

The analysis of the data showed that the IUGR children are relatively more prone to longer QTc intervals. Children with long QT syndrome LQTS are relatively more prone to atrioventricular block, multiform premature ventricular contractions, and torsade de pointes than other children. Patients with QTc of more than 0.60 are at particularly high risk for sudden death [7].

Acknowledgements

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