New QT and JT correction methods in right bundle branch block in children

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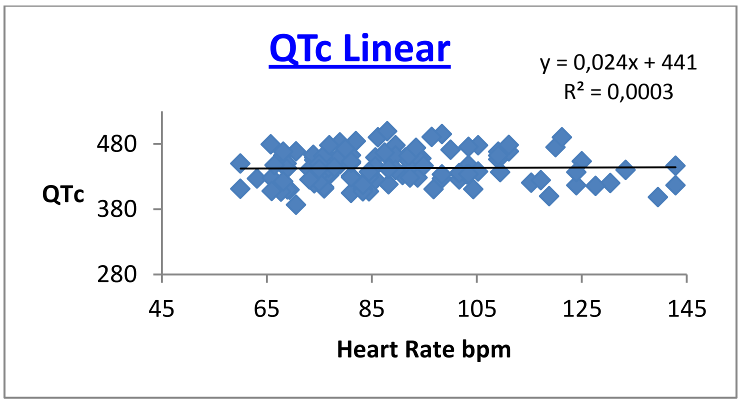
Introduction: QT interval prolongation on the surface ECG is a marker of abnormal repolarization and the potential for arhythmogenesis. In patients with right bundle branch block (RBBB), the assessment of ventricular repolarization remains controversial. We set out to compute the best derived QT and JT formula correction factors in children with RBBB.

Methods: we enrolled a cohort of 96 children with RBBB. In 3 non-surgical patients, RBBB occurred secondary to an underlying dilated cardiomyopathy (secondary to anthracycline in 2). In the other 93 patients, RBBB occurred following cardiac surgery. In this group, 44 had a Tetralogy of Fallot repair, 10 repair of double outlet right ventricle with pulmonary stenosis, 2 patients Truncus arteriosus repair; 7 isolated large VSD repair, 3 patients had undergone a Rastelli operation for pulmonary atresia and VSD, 5 others with transposition with VSD and pulmonary stenosis with interposition of a pulmonary conduit, 9 arterial switch operation for transposition of the great arteries, in 10 post complete atrio-ventricular septal defect repair, in an additional 2 this condition with tetralogy of Fallot and one with interrupted aortic arch type B. While in a quiet resting state, lying supine, a digital 12-lead electrocardiogram was recorded using a MAC 5500 (Marquette Medical Systems, Milwaukee, WI, USA) at a speed of 50 mm/second. The digital electrocardiograms were stored on a server and subsequently retrieved for analysis. In 9 patients, more than one ECG was obtained at different follow-up intervals (total number of 129 ECG's studied) The QT, JT and RR intervals were measured digitally from lead II using incorporated on screen calipers and were magnified. The QT was measured from onset of the Q wave to the end of the T wave (average of 6 cycles). The RR interval was measured from the average of 10 cycles. Descriptive statistics were calculated and expressed as mean, standard deviation and range. Linear regression techniques allows for the estimation of the slope, which can be used for standardizing the data to a normalized heart rate of 60 beats per minute. The QT/RR and JT/RR curves were fitted with 2 regression analysis. Firstly a linear regression for constant **α**, whereby QTc = QT + α x (1-RR), and JTc = JT + α x (1-RR) and secondly a natural log-linear regression analysis for constant β whereby QTc = QT/RRβ and JTc = JT/RRβ. Additionally, linear regression analyses of QTc/RR and JTc/RR for each two formulae were performed as well as QTc/JTc vs QRS duration to obtain slope and R^2. A slope and R^2 close to zero were judged to eliminate the effect of heart rate on QT interval. The level for statistical significance was set at a P value < 0.05.

Results: there were 50 male and 46 female patients. The mean age was 8.4 years, range 0.3 -18 years, median 7.0 years. The mean QRS duration was 124 milliseconds (ms) SD ± 18 ms, median 120 ms, range 90– 174 ms. From linear regression analysis, the computed correction factor for JT was **α = 0.19** and **β =0.43** and for QT **α** was 0**.22** and **β = 0.39**. Formulae obtained were thus: **QTc = QT + 0.22 x (1-RR)** and **JTc = JT + 0.19 x (1-RR)** and **QTc = $QT/RR^{0.39}$** and **JTc = $JT/RR^{0.43}$** Linear Regression plots for QTc and JTc against RR intervals 5Figues 1 and 2) revealed the following: QTc linear: slope 0.024 R^2 < 0.005, QTc log: slope < 0.05 R^2 <0.01, JTc linear slope 0.039 R^2 >0.001, JTc log slope -0.034 R^2 < 0.001. QRS duration plotted against JTc α R^2 0.028 and JTc β R^2 0.019; QTc α R2 0.3, QTc β 0.32. Correction for heart rate was good for both JT and QT new formulae. With regard to QRS duration correction, as expected, the QT formulae correlated at the extremes of QRS lengthening (Figure 3). The computed 98th percentile for the Jtc linear was 352 ms, for JTc Log 347 ms, QTc Linear 490 ms, and QTc log 491 ms.

Conclusion: For pediatric subjects with RBBB, these new JTc and the QTc correction formulae perform well for heart rate correction. When QRS duration is beyond 150 milliseconds the QTc formulae may overcorrect, not seen with the JTc formulae.

Figure 1



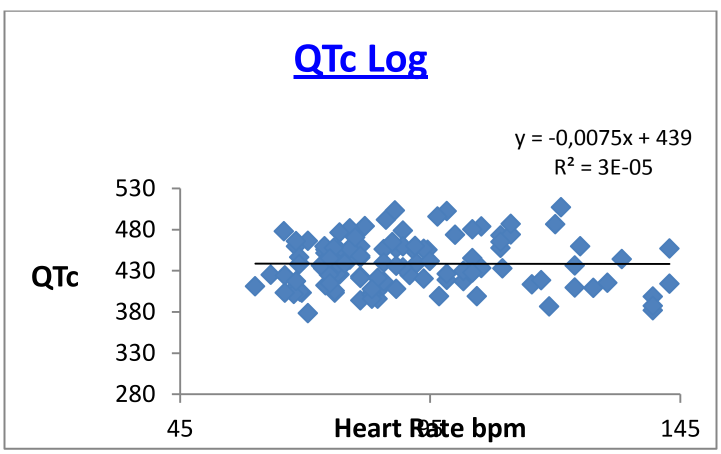
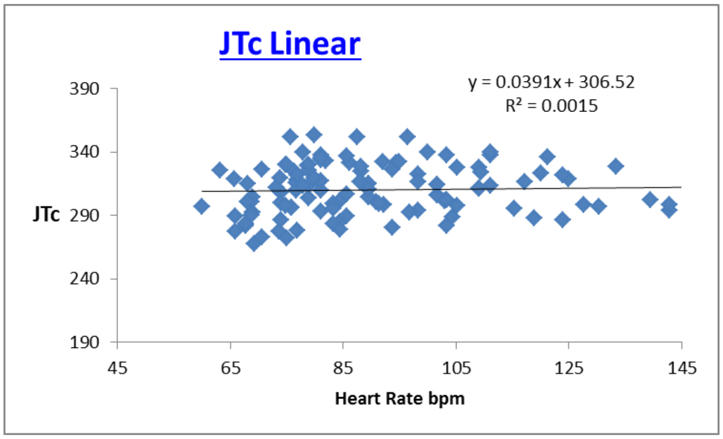


Figure 2


JTc Linear
y = 0.0391x + 306.52
R² = 0.0015
390
340
JTc 290
240
190
45
65
85
105
125
145
Heart Rate bpm

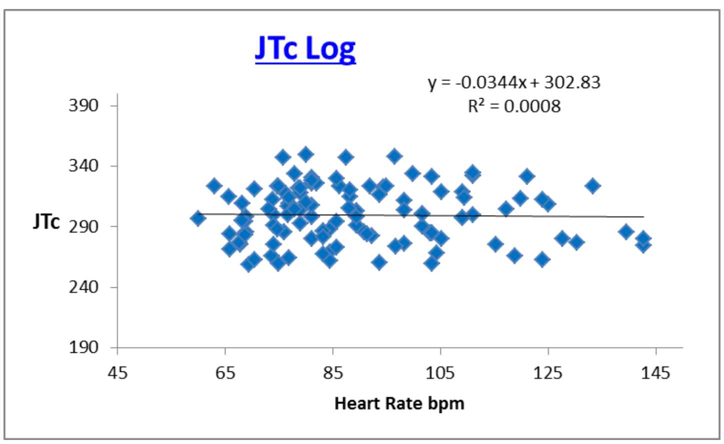
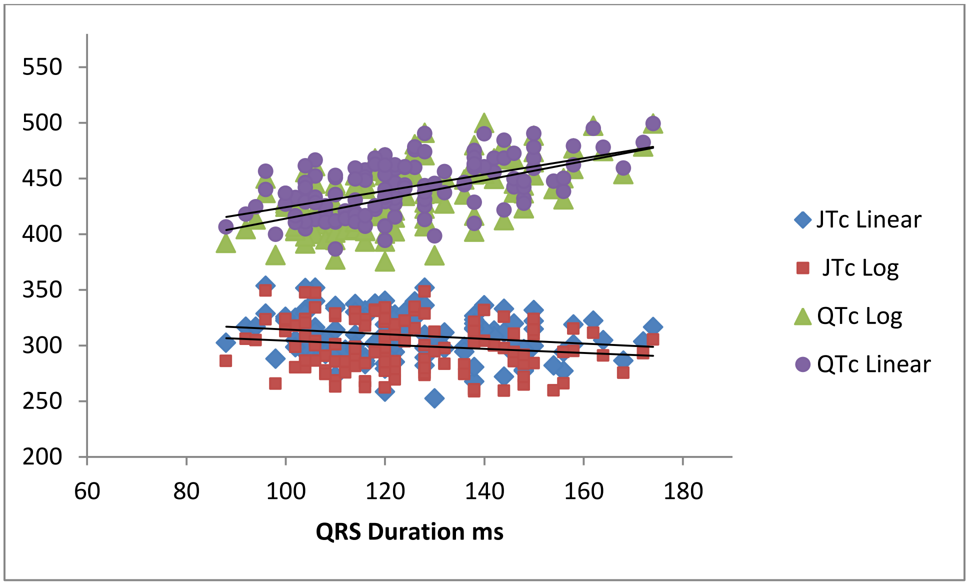

JTc Log
y = -0.0344x + 302.83
R² = 0.0008
390
340
JTc 290
240
190
45
65
85
105
125
145
Heart Rate bpm

Figure 3


550
500
450
400
350
300
250
200
60
80
100
120
140
160
180
QRS Duration ms
JTc Linear
JTc Log
QTc Log
QTc Linear