Dispersion of QT and QTc interval in healthy children, and effects of sinus arrhythmia on QT dispersion

H Ercan Tutar, B Öcal, A Imamoglu, S Atalay

Abstract

Objective—To determine the normal values of QT and QTc dispersion and the effects of sinus arrhythmia on QT dispersion in healthy children.

Patients and setting—The study was carried out in a university hospital on 372 local schoolchildren (200 male, 172 female), aged seven to 18 years.

Methods—The QT and preceding RR intervals of at least one sinus beat were measured manually in a range of nine to 12 leads on standard 12 lead surface ECGs. The corrected QT interval was computed by the method of Bazett. Dispersion of QT and QTc were defined as (1) the difference between the maximum and minimum QT and QTc intervals occurring in any of the 12 leads (QTD and QTcD), (2) the standard deviation of the QT and QTc interval in the measurable leads (QT-SD and QTc-SD).

Results—There was no significant difference in QT, QTc, and RR dispersion between girls and boys. Overall 53% of children had sinus arrhythmia. Although QTD and QT-SD were not affected by sinus arrhythmia, both QTcD and QTc-SD were significantly greater in children with sinus arrhythmia than in those without (QTcD: 52.9 (17.4) vs 40.9 (13.1); QTc-SD: 17.5 (5.9) vs 13.2 (4.0); p < 0.001).

Conclusions—As calculation of QTc dispersion is affected by sinus arrhythmia, which is common in childhood, we suggest that QT dispersion should not be corrected for heart rate in children.

(Heart 1998;80:77–79)

Keywords: QT dispersion; heart rate; children; sinus arrhythmia

Table 1 Heart rate, RR, QT, and QTc intervals, and QT, QTc, and RR dispersion parameters for normal boys and girls

<table>
<thead>
<tr>
<th>Boys (n = 200) mean age 12.3 (2.1) years</th>
<th>Girls (n = 172) mean age 12.5 (2.3) years</th>
<th>Whole group (n = 372) mean age 12.4 (2.6) years</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR (beats/min)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>89.1 (13.7)</td>
<td>89.7 (13.3)</td>
<td>89.4 (13.6)</td>
</tr>
<tr>
<td>Mean RR (ms)</td>
<td>680.3 (116.1)</td>
<td>671.9 (104.3)</td>
</tr>
<tr>
<td>Mean QT (ms)</td>
<td>324.3 (22.6)</td>
<td>328.4 (26.1)</td>
</tr>
<tr>
<td>Mean QTc (ms)</td>
<td>396.1 (20.2)</td>
<td>402.6 (18.2)</td>
</tr>
<tr>
<td>QT max (ms)</td>
<td>359.2 (23.2)</td>
<td>343.4 (27.7)</td>
</tr>
<tr>
<td>QTc max (ms)</td>
<td>420.7 (23.4)</td>
<td>425.8 (18.8)</td>
</tr>
<tr>
<td>QTcD (ms)</td>
<td>29.8 (9.8)</td>
<td>30.0 (10.9)</td>
</tr>
<tr>
<td>QTc-SD (ms)</td>
<td>47.9 (16.9)</td>
<td>46.5 (16.2)</td>
</tr>
<tr>
<td>QTc-SD (ms)</td>
<td>9.7 (3.1)</td>
<td>10.0 (3.3)</td>
</tr>
<tr>
<td>RR (ms)</td>
<td>15.5 (5.6)</td>
<td>15.4 (5.5)</td>
</tr>
<tr>
<td>RR-SD (ms)</td>
<td>96.9 (70.3)</td>
<td>89.8 (64.4)</td>
</tr>
</tbody>
</table>

HR, heart rate.
Table 2  Correlations of QT and QTc dispersion parameters with age and other ECG measurements

<table>
<thead>
<tr>
<th>Mean RR</th>
<th>Mean QTc</th>
<th>Mean QT</th>
<th>QTcD</th>
<th>QT-D</th>
<th>QTc-SD</th>
<th>QT-SD</th>
<th>RRc</th>
<th>RR-SD</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.78 (&lt; 0.001)</td>
<td>-0.43</td>
<td>-0.06</td>
<td>-0.12</td>
<td>-0.06</td>
<td>-0.15</td>
<td>0.52 (&lt; 0.001)</td>
<td>0.55 (&lt; 0.001)</td>
<td>-0.37</td>
<td></td>
</tr>
<tr>
<td>Mean QTc</td>
<td>0.20</td>
<td>0.12</td>
<td>0.11</td>
<td>0.14</td>
<td>0.13</td>
<td>0.36</td>
<td>0.35</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Mean QT</td>
<td>0.06</td>
<td>-0.0005</td>
<td>0.09</td>
<td>0.00</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>QTcD</td>
<td>0.52 (&lt; 0.001)</td>
<td>0.89 (&lt; 0.001)</td>
<td>0.44</td>
<td>0.08</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>QT-D</td>
<td>0.53 (&lt; 0.001)</td>
<td>0.93 (&lt; 0.001)</td>
<td>0.44</td>
<td>0.08</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>QTc-SD</td>
<td>0.49</td>
<td>0.09</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>QT-SD</td>
<td>0.58 (&lt; 0.001)</td>
<td>0.59 (&lt; 0.001)</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>RRc</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>RR-SD</td>
<td>0.09</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.04</td>
<td></td>
</tr>
</tbody>
</table>

r Values are presented as Pearson’s correlation coefficients. Numbers in parentheses are p values.

was a significant positive correlation between RR and QT intervals (r = 0.78). We found that QTcD and QTc-SD did not vary significantly with RR, RRc, or RR-SD, but both QTcD and QTc-SD varied significantly with RR and RRc (table 2). Sinus arrhythmia was present in 198 children (53%). QTcD and QTc-SD were not affected by sinus arrhythmia, but both QTcD and QTc-SD were significantly greater in children with sinus arrhythmia than those without (table 3).

In the 50 selected ECGs, the mean of QT intervals measured, and the mean of QTc intervals calculated, were similar between observer 1 and observer 2 (QT: 334.6 (26.1) ms v 335.6 (23.8) ms, p = 0.5, r = 0.92; QTc: 391.9 (25.4) ms v 393.7 (27.7) ms, p = 0.31, r = 0.90).

### Discussion

In a large normal adult population (n = 1555), Macfarlane et al showed that the upper limit of QT dispersion using an automated method was 40 ms. In addition, data for matched controls in most studies including adults suggest that QTcD and QTc-SD in normal subjects are usually in the range of 30–50 ms and 40–60 ms, respectively. As far as is known, there are no published limits of normal QT interval dispersion in the paediatric age group, and it is possible that the data in our study are the first in which such results are presented. QT interval dispersion results of our population study, which included a relatively large number of children, are correlated with adults results. Dispersion of QT and QTc intervals were found to be 29.9 (10.2) ms and 47.3 (16.6) ms, respectively. We also used standard deviation of QT, QTc, and RR intervals as a measure of dispersion, to minimise probable errors resulting from non-measurable leads. We found that QTcD, QTc-SD, and RR-SD correlated significantly with the corresponding values of QTcD, QTc-SD, and RRD.

In a recent study, Pearl showed that QTc intervals were significantly greater for girls than for boys in the 14 to 18 year age range. We also showed this sex difference in our study group.

In a small number of healthy adult subjects (n = 25), Fei et al showed that the difference in the QT dispersion between men and women was significant. However, we did not find that sex had a significant impact on QT or QTc dispersion parameters in children. Macfarlane et al also showed that there was no difference between men and women for QT interval dispersion. In our study, age and heart rate...
were not found to have an effect on QT and QTc dispersion in children either.

Nearly half of the children in our study group had sinus arrhythmia. We therefore determined whether sinus arrhythmia had an effect on QT and QTc dispersion in children. Although QT dispersion parameters (QTD and QT-SD) did not vary significantly with RR variation (for example, with RRD and RR-SD), we observed that QTc dispersion parameters did vary significantly with RR dispersion. As a result, children with sinus arrhythmia not surprisingly have greater QTcD and QTc-SD values than children without sinus arrhythmia. Indeed, Anderson showed that despite a large valuesthan children withoutsinusarrhythmia.

remained relatively stable in sinus arrhythmia,

Indeed, Anderson showed that despite a large variation in RR interval, the QT interval variation (for example, with RRD and RR-SD)did not vary significantly with RR dispersion. Although QT dispersion parameters (QTD and QTcD) we observed that QT dispersion parameters did not vary significantly with RR dispersion. We havenot been able to analyse the beats all through the respiratory cycle and this is the limitation of our results. We might have found a smaller variation in QTc in children with sinus arrhythmia if we had been able to analyse the beats in this way.

In conclusion, as QT interval changes are not correlated significantly with beat to beat RR variation, the computation of QTc dispersion is seriously affected by the presence or absence of sinus arrhythmia if simultaneous 12 lead ECG recordings are not used. Thus we suggest that, since sinus arrhythmia is a common condition in childhood, QT dispersion should not be corrected for heart rate in children.


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