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QTc and dispersion of QT in neonates babies with cardiac arrhythmias

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Abstract

Background: *The aim of the study was to assess the QTc interval and the dispersion of QT interval (dQT) in neonates with cardiac arrhythmias.*

Material and methods: *The study group consisted of 109 neonates with arrhythmias, divided into three groups according to ECG result: group I — 56 babies with premature beats, group II — 35 with bradycardia (heart rate below 80/min) and group III — 18 with tachyarrhythmia (heart rate above 180/min). The control group consisted of 35 healthy neonates.*

Results: *QTc in the neonates with arrhythmias was calculated from 0.280 s to 0.474 s, with a mean of 0.39 s. In 8 babies it was longer than 0.44 s. The dispersion of QT interval ranged from 10 ms to 80 ms, with a mean of 31 ms. In the control group QTc ranged from 0.324 to 0.432, with a mean of 0.382 s, and dQT from 10 ms to 30 ms, with a mean of 19 ms. The neonates with arrhythmias had significantly longer ($p < 0.05$) mean values of QTc and dQT compared with the control group. QTc and dQT were also significantly ($p < 0.05$) longer in the neonates with myocarditis. At the time of discharge from hospital, when the children were aged nearly one month, only 14% had cardiac arrhythmias. After one year follow-up arrhythmias were detected in 8% of them and the mean dispersion of QT was significantly lower ($p < 0.05$) at this time.*

Conclusions: *Cardiac arrhythmias in neonates are fairly benign and may disappear during the neonatal period. Greater values of the dispersion of the QT interval in the neonates can be a predisposing factor for arrhythmia. The neonates with myocarditis had greater values of QTc and the dispersion of QT. The neonates with myocarditis had increased values of QTc and QT dispersion.* (Folia Cardiol. 2006; 13: 302–306)

arrhythmia, neonates, QTc, dQT, myocarditis

Introduction

The immaturity of the cardiac conduction system and the autonomic nervous system are conducive to arrhythmia in neonates [1, 2]. A total of 109 neonates babies with cardiac arrhythmias but without any coexisting heart defect were hospitalised over the last three years, constituting approximately 30% of the neonates treated throughout this period in the Department of Cardiology. One of the potential causes of arrhythmia is congenital long QT

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syndrome associated with abnormal ventricular repolarisation, predisposing to the occurrence of polymorphic ventricular tachycardia of the *torsade de pointes* type and to ventricular fibrillation [3–6].

The aim of the study was to analyse the QTc interval and QT interval dispersion in neonates with cardiac arrhythmias as markers of the presence of dangerous cardiac arrhythmias.

Material and methods

The study involved 109 neonates (51 girls and 58 boys) with cardiac arrhythmias. QT and QTc intervals were analysed (according to the Bazett formula) and QT interval dispersion (dQT) was calculated as the difference between the longest and the shortest QT interval in a 12-lead standard ECG recording.

Depending on the type of arrhythmia found during the standard and/or Holter electrocardiographic examination, the following groups of subjects were selected.

Group I — 56 neonates with premature ectopic beats, including (Ia), 47 neonates with premature supraventricular beats and (Ib), 9 neonates with premature ventricular beats.

Group II — 35 neonates with bradycardia (i.e. heart rate below 80/min).

Group III — 18 neonates with tachyarrhythmia (i.e. heart rate above 180/min).

The examinations were performed three times: the first following admission to the Clinic, the second prior to discharge (i.e. at the age of approximately one month) and the third at 12 months.

Of 109 neonates with arrhythmias myocarditis was diagnosed in 66 (60%) on the basis of the clinical symptoms and signs, inflammatory status indices and elevated activity of intracellular enzymes (CK, LDH, GOT, troponin).

The control group consisted of 36 healthy neonates matched according to gender and age, on whom an ECG recording and a Holter test were performed after the informed consent had been obtained from the mothers.

Results

In a standard ECG recording the corrected QT interval (QTc) in neonates with cardiac arrhythmias ranged from 0.280 s to 0.474 s, with a mean of 0.394 s. In 8 (7%) neonates a prolongation of the corrected QT interval above 0.44 s was found. Dispersion of QT equalled on average 31 ms and ranged from 10 ms to 80 ms.

In the control group of healthy neonates the QTc interval was 0.324–0.432 s, with a mean of 0.382 ± 0.025 s (median 0.382 s). Dispersion QT was 10–30 ms, with a mean of 19 ± 1 ms (median 20 ms).

Statistically significant ($p < 0.05$) higher values of QTc and dQT were found in the neonates examined with cardiac arrhythmias as compared to the control group, although the values were within the normal range (Table 1).

Similarly significantly higher mean values of QTc and QT dispersion were found in neonates with cardiac arrhythmias and coexisting myocarditis in comparison with the control group (Table 2).

Statistical analysis showed that the groups investigated who were characterised by various types of cardiac arrhythmias did not significantly differ in respect of QTc values (Table 3). The range of QTc values in particular groups was as follows: in group I — 0.280–0.471 s, in group II — 0.316–0.474 s,

Table 1. Mean QTc and dQT in the neonates with arrhythmias and in the control group

Group	QTc [s]	dQT [ms]
With arrhythmia	0.394 ± 0.032	31 ± 18
Control	0.382 ± 0.025	19 ± 1
P value	0.0310	0.0003
	< 0.05	< 0.05

Table 2. Mean QTc and dQT in the neonates with myocarditis and in the control group

Group	QTc [s]	dQT [ms]
With myocarditis	0.397 ± 0.033	32 ± 19
Control	0.382 ± 0.025	19 ± 1
P value	0.0194	0.0002
	< 0.05	< 0.05

Table 3. Mean QTc and dQT in the groups examined

Examined group	QTc [s]	dQT [ms]
Group I	0.397 ± 0.033	30 ± 17
Group II	0.389 ± 0.029	37 ± 19
Group III	0.393 ± 0.031	23 ± 15
P value	0.5393	0.0201
	> 0.05	< 0.05

Table 4. Mean QTc and dQT in the neonates with supraventricular and ventricular premature beats

Examined group	QTc [s]	dQT [ms]
Group Ia	0.406 ± 0.029	35 ± 15
Group Ib	0.422 ± 0.016	36 ± 6
P value	0.5999	0.6741
	> 0.05	> 0.05

Table 5. Mean QTc and dQT at the time of admission and at discharge from hospital

Study time	QTc [s]	dQT [ms]
At admission	0.394 ± 0.032	31 ± 18
At discharge	0.393 ± 0.025	25 ± 11
P value	0.5468	< 0.0001
	> 0.05	< 0.0001

and in group III — 0.324–0.442 s. However mean dQT in neonates with bradycardia was statistically significantly higher as compared with the group of neonates with tachyarrhythmia.

The analysis showed that subgroups of neonates with supraventricular and ventricular excitations did not differ significantly in statistical terms with respect to either of the parameters tested (Table 4), although slightly higher values of QTc and dQT were found in the subgroup with additional ventricular premature beats.

QTc and QT dispersion values (dQT) were also compared between the groups of neonates investigated and the control group. Statistical analysis concluded that the mean value of QTc in the neonates group with premature beats was significantly higher statistically ($p < 0.05$) than in the control group. However, statistically significantly higher QT dispersion values were found in neonates with bradycardia and in the group with premature beats compared to those for the control group.

The hospitalisation period for neonates with cardiac arrhythmias was, on average, 19 ± 5 days. In a standard ECG recording performed on the day of discharge cardiac arrhythmias were registered in 15 (14%) neonates; in 14 these were single premature supraventricular beats and in 1 ventricular. QTc time was in the range 0.381–0.422 s, with an average of 0.393 s, whereas QT dispersion was 10––60 ms, averaging 30 ms. In none of the children did QTc prolongation above 0.44 s occur at this time.

Cardiac arrhythmias throughout this period were significantly more frequent in occurrence in children with a history of myocarditis ($p = 0.0403$, $p < 0.05$). They were present in 29 (74%) neonates with myocarditis and in 10 (26%) without myocarditis.

When the results obtained at discharge and at admission were compared, significantly lower values of dQT were found in the neonates investigated at discharge (Table 5).

A control test performed after completion of the first year of life showed a persistence of cardiac arrhythmias in 8 (7%) children. During 24 hour ECG monitoring single premature supraventricular beats were registered in 7 children, and ventricular beats in 1 child. QTc time ranged from 0.324 to 0.431 s, with a mean of 0.391 s, whereas QT dispersion was 10–50 ms, with a mean of 20 ms. These results show significantly lower values of QT dispersion as compared with the results obtained at discharge, although no statistically significant difference was observed when QTc values are compared (Table 6).

Table 6. Mean QTc and dQT in one-month and one-year old children

Study time	QTc [s]	dQT [ms]
At discharge	0.393 ± 0.025	25 ±11
One year later	0.391 ± 0.019	22 ±8
P value	0.2023	0.0044
	> 0.05	< 0.05

Discussion

Cardiac arrhythmias are an increasingly common cause of hospitalisation of neonates babies. The aetiology of arrhythmias and their predisposing factors vary [1, 2, 7].

In assessing the standard ECG recording performed on the neonates investigated, particular attention was paid to the markers of the presence of dangerous cardiac arrhythmias such as QT and QTc interval timing and its dispersion — dQT. The mean values of QTc for the whole group investigated was 0.394 s and, although this was within the normal range, it was significantly higher ($p < 0.05$) compared with the group of healthy neonates, in whom no cardiac arrhythmias had been recorded. However, when a comparison was made between the length of the QTc interval in groups of neonates with various types of cardiac arrhythmias and

a control group, significantly higher QTc values were found in neonates with premature beats, whereas in those with bradycardia and tachyarrhythmia the QTc time was similar to the QTc time of the control group. In all the groups investigated the mean values of QTc time were within the normal range. This was also the case in the subgroup of neonates with premature ectopic beats of both supraventricular and ventricular origin.

When particular cases were analysed, it was found that in 8 (7%) of neonates, 5 with bradycardia and 3 with premature supraventricular beats, the QTc time was prolonged beyond 0.44 s. The longest QTc interval in neonates with cardiac arrhythmias equalled 0.474 s, whereas in the control group it was 0.432 s. Some authors report that the QTc interval in the neonates period can be longer than 0.44 s and as much as 0.47 s [6, 8, 9]. These children, however, require close monitoring because of the risk of life-threatening cardiac arrhythmias occurring. This is of particular importance in the case of neonates in whom bradycardia is present. In the group investigated when taken as a whole the longest QTc interval was registered in the subgroup of neonates with sinus bradycardia. According to Emeriaud et al. [10] and Beinder et al. [11] bradycardia can be one of the earliest signs of congenital long QT syndrome. Complex ventricular arrhythmias were not recorded in the neonates with borderline QTc values in the present investigation. In this group there were no neonates whose family history would suggest the possibility of a congenital long QT syndrome diagnosis. In none of the infants were blood chemistry abnormalities found which could have been responsible for the prolongation of the QT interval [3, 12]. Nor had these children received drugs which could have influenced the length of the QT interval [13, 14]. In recent years several reports have been published suggesting that prolongation of QT is possible in neonates treated for gastro-oesophageal reflux with cisapride [15, 16]. This drug was not used in any of the children investigated. It should also be mentioned that gastro-oesophageal reflux, one of the factors mentioned as predisposing to arrhythmia in the neonates period [1, 17], was diagnosed in only three neonates in the group under observation. In the ECG monitoring performed at the end of the first month of life (i.e. before discharge from the Clinic) QTc ranged from 0.381 to 0.422 s and was within the normal range in all the children. Similarly, in tests performed in these children after a year of follow-up QTc time was normal.

Myocarditis was confirmed in 66 (60%) of the neonates with cardiac arrhythmias who were investigated. It was present in 67% of neonates with premature beats, in 51% with bradycardia and in 55% with tachyarrhythmia. Myocarditis was diagnosed quite frequently in neonates with sinus bradycardia, as has already been reported by Dobrzańska et al. [18]. In adult patients with myocarditis tachycardia is usually observed rather than sinus bradycardia [19, 20]. Analysis of the standard ECG recording in neonates with myocarditis showed that the mean values of QTc and dQT were statistically significantly higher than in the control group. No reports have been published in the available references on assessment of QT dispersion in neonates. The possibility of a prolongation of QTc in neonates with myocarditis is indicated only in isolated reports [7]. The mean value of QT dispersion of 30 ms in the whole group of neonates with cardiac arrhythmias was significantly higher than the mean value of dispersion found in the control group, where it equalled 20 ms ($p < 0.05$). In healthy children dQT values range from 29 ± 10 ms to 40 ± 10 ms [21]. In adults a range of dQT values 20–50 ms is believed to be normal [20].

Comparison of the mean values of QT dispersion between particular groups and the control group showed that both in the group of neonates with premature beats and in those with bradycardia the mean value of QT dispersion was significantly higher than in healthy neonates ($p < 0.05$). Additionally, during tests performed in neonates immediately following admission into the Clinic, higher mean values of QT dispersion were found than in tests performed following the first month of life. In the majority of neonates at the end of the first month of life no cardiac arrhythmias were registered. It should be presumed then that greater QT dispersion in the early neonates period, reflecting irregular refraction of the cardiac muscle, may predispose to arrhythmias in this period of life.

In older children and adults increased QT dispersion is one of the acknowledged factors predisposing to life-threatening cardiac arrhythmias and sudden cardiac death [22–24]. Many authors consider QT dispersion above 75–100 ms to be an increased value [25]. In a recently published study Goldhammer et al. [26] found increased QT dispersion in infants with ALTE (apparent life-threatening events) syndrome. In the group of 89 infants with this syndrome investigated by the authors QT dispersion was significantly higher than in a control group. In none of the neonates investigated in the present study was dispersion greater than 80 ms, whereas in the case of long QT syndrome it could reach values as high as 150–200 ms. Values of

60–100 ms have been reported with cardiac muscle damage in the course of myocardial infarction [27, 28]. The lower mean values of QT dispersion, approaching normal values, would seem to confirm that the course of cardiac arrhythmias was mild in the group of neonates investigated in the present study.

Conclusions

1. Cardiac arrhythmias in neonates are fairly benign and may disappear during the neonatal period.
2. Greater values of dispersion of the QT interval in neonates can be predisposing factors of arrhythmia.
3. The neonates with myocarditis had increased values of QTc and QT dispersion.

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