P wave duration and P dispersion in healthy children

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To determine the normal values of P wave duration and P dispersion (P_d=maximum P wave duration–minimum P wave duration) in healthy children, electrocardiograms of 232 healthy children (143 boys, 89 girls, aged 7 to 15 years) were examined. There was no significant gender difference in maximum P wave duration (103±9.5 msec vs 102±8.4 msec, p=0.23) or P dispersion (27.2±5.3 msec vs 26.8±6.2 msec, p=0.643). Maximum P wave duration (r=0.23, p<0.01) and P dispersion (r=0.16, p<0.01) were related to age. We conclude that age affects the P wave duration and P dispersion in healthy children, and thus, should be taken into account when maximum P wave duration and P dispersion are considered for any purpose in healthy children.

Electrocardiographic P wave represents atrial depolarisation signals, and the maximum duration of P wave corresponds to the duration of the atrial activation. The clinical significance of P wave duration has been demonstrated in many clinical conditions, especially in adult patients with paroxysmal atrial fibrillation (AF)[1-6]. Several studies have shown that prolongation of intraatrial and interatrial conduction time as well as an nonhomogeneous propagation of sinus impulse are characteristic for patients with AF[7,8]. P dispersion, that is the range of P wave durations in individual leads in a 12-lead surface echocardiography (ECG), has been recently described and suggested for the identification of adult patients with history of paroxysmal AF[4]. In addition, children with atrial septal defect had significantly longer P dispersion compared to controls[9]. Consequently, normal limits of the P wave duration and P dispersion are important for further noninvasive studies in children at potential risk of paroxysmal AF. Although P wave is the simplest of all electrocardiographic waves, its normal duration and dispersion in healthy children have not been studied in a large number of healthy subjects. The aim of this present study was to determine the normal values of P wave duration and P dispersion in healthy children.

Material and Methods

Twelve-lead ECGs were obtained in a population of 232 healthy children: 143 boys (mean age 12±3, range 7-15 years) and 89 girls (mean age 13±2, range 7-15 years). None of the children had any cardiovascular symptoms and all clinical examinations were normal. P wave duration was calculated in all 12 leads of the surface ECG which were simultaneously recorded. P wave duration measurements were obtained manually by two of the investigators using calipers and magnifying lens for accurate definition of the electrocardiogram deflection as defined in previous studies. The onset of the P wave for positive waves was defined as the point of the first visible upward departure of the trace from the bottom of the baseline. On the other hand, the onset of the P wave for the negative waves was defined as the point of the first downward departure from the top of the baseline. The return to the baseline of the bottom of the trace in positive waves and the return to baseline of the top of the trace in negative waves was considered to be the end of the P wave. If the baseline noise was over 1.0

mV and/or the peak of the P wave amplitude from isoelectric line was below 1.5 mV, the lead was excluded from the analysis. If the P wave was measurable in at least nine leads, the patient was kept for further analysis. P_{max} in any of the 12-lead surface ECGs was calculated and used as a marker of prolonged atrial conduction time. The difference between P_{max} and P_{min} durations was defined as P wave dispersion ($P_d=P_{max}-P_{min}$)$_4$. The average values of P wave maximum and minimum durations and P_d that were obtained from two investigators were used. Intra-observer and inter-observer coefficients of variation (standard deviation of differences between two observations divided by mean value and expressed as percent) were found to be 3.9% and 4.2% for P_{max} and 4.3% and 4.8% for P_d.

Data were presented as mean values±standard deviation. Comparisons between the ECG measurements were made using t-test. Relations between variables were assessed using linear regression analysis and Pearson's correlation coefficient. Overall significance level of 0.05 was used for the statistical tests. Significance of the test results was expressed as p-values in the tables.

Results

In the study population, there was no significant difference between boys and girls in age (12±3 vs 13±2 years, p=0.54) or heart rate (78±12 vs 79±11 beats/min, p=0.72). We found that P_{max} and P_d were 102.5±8.7 ms and 27.0±5.4 ms, respectively, in the whole of the study population.

The maximum P wave duration was 103±9.5 ms in boys and 102±8.4 ms in girls (p=0.23, Fig. 1).

P dispersion was 27.2±5.3 ms in boys and 26.8±6.2 ms in girls (p=0.64, Fig. 1). Of age, gender and heart rate tested univariately in all subjects, only age was mildly associated with P wave dispersion (r=0.16, p<0.01) and P wave duration (r=0.23, p<0.01).

Discussion

The principal findings of this study are the P wave duration and P dispersion are affected by age in healthy children.

In healthy children, the duration of P wave was reported to vary from 50 to 100 ms[10]. Thus, our measurements are somewhat higher than those given by other authors. The method of measurement may be partly responsible for discrepancies between different studies. In this study, we used caliper and magnifying glass to magnify the P waves and to measure the P wave duration manually.

We also found similar P wave durations in boys and girls. But there was a mild relation between P wave duration, P dispersion and age. This relation may be due to increasing heart weight and size with age[11,12]. The duration of the P wave reflects the activation of atrial muscle and may depend primarily upon the mass of tissue excited. Thus, the P wave duration and

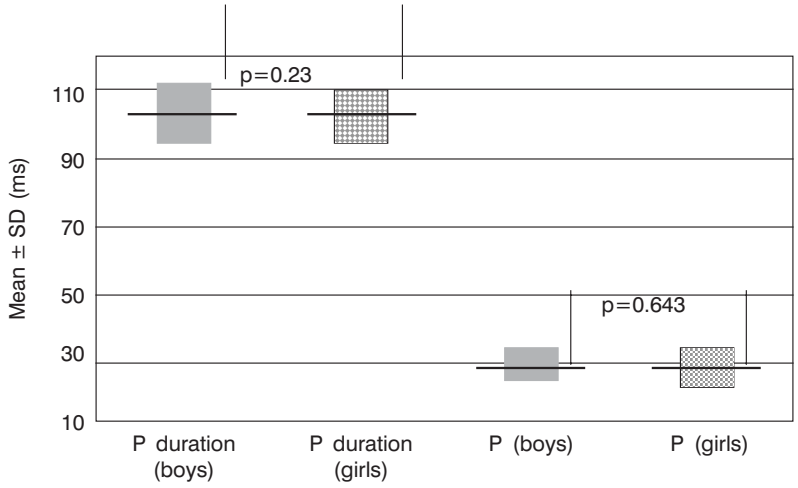

Fig. 1. Maximum P wave duration and P dispersion values in boys and girls. Pd: P dispersion.

P dispersion should be correlated with age in healthy children.

The heterogeneity of structural and electrophysiological properties of the atrial myocardium is thought to play a major role in the initiation of atrial re-entry because of the increased likelihood of unidirectional block of premature impulses[13]. The non homogeneous and discontinuous atrial conduction in patients with paroxysmal atrial fibrillation has been recently evaluated with P wave dispersion[4]. Dilaveris et al.[4] and Aytemir et al.[14] measured the P wave dispersion in patients with a history of paroxysmal AF and found that P wave dispersion was longer in patients than in controls. Weber et al.[15] studied the utility of P wave dispersion in patients undergoing bypass surgery to predict emergence of atrial fibrillation in the postoperative period. They found a significant difference in P wave dispersion between patients who later developed AF and those who did not (49±12 ms vs 41±12 ms). Ho et al.[9] investigated P maximum duration and P dispersion in 94 children with secundum atrial septal defect in comparison with that of 65 age-matched normal controls. These authors found that children with atrial septal defect had significantly longer P dispersion compared to controls (30.2±11.1 vs 26.4±6.6 ms, p=0.008). We evaluated the P wave duration and P dispersion in a larger group, and our measurements (27.0±5.4 ms) in normal healthy children are in accordance with the findings of Ho et al.[9].

It is a recognized fact that low P wave onset and offset amplitudes constitute the main source of error in manual measurement of P waves. On-screen manual evaluation of P wave duration is likely to be more precise compared to on-paper evaluation. However, it was shown that consistent and clinically relevant results were obtained irrespective of the method used for P wave measurements[16].

In conclusion, age effects the P wave duration and P dispersion in healthy children. Thus, age should be considered when maximum P wave duration and P dispersion are referred to for any purpose in healthy children.

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