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Normal values of the pediatric ECG/VCG with a focus on the ventricular gradient and QRST-angle

Kamphuis V.P. (1,2,3), Blom N.A. (1,3), Ten Harkel A.D.J. (1), Van Zwet E.W. (4), Man S. (5), Maan A.C. (6), Swenne C.A. (6)
Department of Pediatric Cardiology, Leiden University Medical Center, Leiden, The Netherlands (1); Netherlands Heart Institute, Utrecht, The Netherlands (2); Department of Pediatric Cardiology, Academic Medical Center, Amsterdam, The Netherlands (3); Department of Medical Statistics, Leiden University Medical Center, Leiden, The Netherlands (4); Physiologic, Amsterdam, The Netherlands (5); Department of Cardiology, Leiden University Medical Center, Leiden, The Netherlands (6)

Introduction: The diagnostic performances of the electrocardiogram (ECG) and the vectorcardiogram (VCG) are relatively similar. However, additional spatial information (notably, the ventricular gradient, VG, and the spatial QRS-T angle, SA) can be derived from the VCG, not directly accessible in the 12-lead ECG and not explored in conventional VCG diagnostics. In an adult population, the VG and SA have been shown to provide extra diagnostic and prognostic value. However, normal values of VG and SA have not been published for children. Therefore, our study aims to assess normal values of the pediatric ECG and the vectorcardiographic VG and SA.

Methods: ECGs of children under 18 years old with a structural and functional normal heart, demonstrated by a normal echocardiogram, physical examination and ECG, were retrospectively selected from the pediatric cardiology outpatient clinic data. Also, ECGs of reportedly healthy first-year medical students aged 18-24 years were added. ECG/VCG analysis was done with the Matlab-based LEADS program. VCGs were synthesized by the Kors-matrix and VG (spatial QRST integral) and SA (planar angle between the spatial QRS and T axes) were calculated. Normal values (presented as 2nd and 98th percentiles) were assessed by quantile regression with smoothing by splines.

Results: The study group consisted of 1124 subjects. Trends of heart rate, QRS duration, QT time and QTc agree with the literature. Graphs for normal values of the spatial QRS-T angle and ventricular gradient are shown in Figure 1. SA shows a dip at age 7 (Fig. 1a). VG shows an increase in magnitude over time (Fig 1b).

Conclusions: Normal values of the pediatric ECG and VCG (VG and SA) were established. These normal values are important for future studies using VG and SA for risk stratification in structural heart disease in children.

Figure 1. Age-dependent percentiles of the spatial QRS-T angle and the ventricular gradient