Editorial

ECG in Children

K.K. Datey,* B.A., M.D., F.R.C.P. (Edin), M.R.C.P. (Lond),
F.A.C.C. (U.S.A.), F.A.M.S., D.C.H. (Eng.),
D.T.M. and H. (Lond), F.I.C.A.,
F.C.C.P. (U.S.A.).

Recognition of the normal must perforce precede that of the
abnormal. Nowhere has this necessity been so clearly evident as in
the interpretation of ECGs of children. For there are as yet no hard and
fast standards for normal ECGs in childhood. Moreover, the ECG patterns
change so rapidly throughout the growing years that they at times baffle
even those who have the utmost familiarity with them. More and more
ECGs of children, normal and abnormal, are being scrutinised, particularly
as more and more heart affections of childhood are coming within the
scope of cardiac surgery. A few words, therefore, about normal patterns
in childhood will be appropriate at this juncture.

The average rate at birth is about 130 per min., perhaps even
higher. But it is almost always a sinus tachycardia. Paroxysmal
tachycardia, even when the rate is very rapid, is extremely rare (Ziegler). With advancing age, the rate gradually falls, the normal adult rate is
reached by the age of about 12 years. Sinus arrhythmia is the rule in
rates under 120 per min. and this explains why it is seen more often in
older children. The PR interval is shorter than in the adult, it is almost
always under 0.2 second. It has not been found by us to vary significantly
with the age or with the heart rate.

Q wave is usually present in limb leads III and II in young children.
Later, with advancing years, as the axis shifts from right to left it appears
in limb leads I and II. As expected, Q waves are also prominent in $V_F$,
due to the vertical position of the heart in children. But what is unusual
is that they may occur in normal children in $V_L$ and sometimes they
may be quite deep here. They are practically never seen in the right
precordial leads, they begin to appear in $V_4$ and may then continue
through to $V_2$. They have, however, appeared in $V_{4R}$ and $V_1$ in a few
of our normal children and later, after a year or so, have disappeared
(Datey and Bharucha).*

* Physician and Cardiologist, K.E.M. Hospital, and G.S. Medical College, Bombay.

Physician and Cardiologist, Bombay Hospital, Bombay.
The R wave in the right precordial leads is tall in younger children up to 5 years of age, and this poses a problem in differentiating it from right ventricular hypertrophy. It gradually falls as they reach the age of 12 years. In the left precordial leads, the amplitude of R remains the same from 5 to 12 years. The R/R+S ratio is consequently affected, it falls from 5 years to 12 years in the right precordial leads and remains about the same in the left precordial leads (Datey and Bharucha). Even in the presence of biventricular hypertrophy the ECG may very closely simulate the normal. Sometimes the R wave in the precordial leads, from 5 to 12 years, may show a sudden isolated decrease in amplitude, in V₃ and/or V₄. A right bundle branch block pattern in leads V₄R, V₁ and even V₂ is occasionally seen in otherwise normal ECGs from 5 to 12 years (Barker and Valencia).

The T wave changes in the precordial leads are particularly interesting. Only three of them will be mentioned here. At birth, the T waves in right precordial leads are usually positive or diphasic (Datey and Bharucha). From the third to the fifth day of life, the T becomes negative in the right precordial leads. At the end of the week, it is negative or diphasic in all the right precordial leads and usually positive in V₆ and V₇. While this is the rule, there are many exceptions even in normal infants. In our series, T wave at birth was negative in V₄R in 2 per cent. At one week, it was negative in 11 per cent of the cases in V₆. Another change in V₄R and V₁ noted by us in three normal infants within an hour or so of birth is worth mentioning. The T wave was negative or diphasic at first, but by the end of the first 24 hours it became more positive and then followed the usual changes described above. This may possibly be due to changes in the serum potassium (Lepeschkin et al.).

After infancy, T waves are usually inverted in the right precordial leads and positive in the left ones. The transition is never abrupt, it is always gradual. The transitional zone of T wave possibly coincides with the position of the interventricular septum (Rosenburg and Agress). As the child becomes older, the transitional zone shifts to the right though there are some differences between males and females (Suarez and Suarez).

The electrical axis of P in the frontal plane remains about the same from birth to adolescence. That of QRS, however, shifts considerably. From being markedly right at birth (average +130°), it shifts to the left and is about +50° at the end of one month. After the first month the axis remains within the normal range of +90° to 0°. The axis of T shifted slightly to the left in the first week of life in our cases and thereafter remained constant.

These are merely a few of the kaleidoscope of changes in the normal child’s ECG. Their genesis may be explained by the thinness of the chest
wall, the position of the heart or the high diaphragm in children. It may also be due to the relative sizes of the two ventricles at different periods of childhood. Most important of all, they may be due to differences in pulmonary and systemic resistance before, at and after birth.

Recognition of the normal is important as it simulates so often and so closely the abnormal. Time alone will elucidate the exact mechanism of these changes and the limits of their normality.

References

3. Ibid.: Under publication.
4. Ibid.: Under publication.