



Study of Effect of Age and Gender on ECG Pattern in Normal Paediatric Population of Rajasthan

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Abstract

Background: *The most cardiologists who care for adults have no or minimal experience with electrocardiograms (ECGs) recorded in infants. So far, this has had no practical implications because only seldom are they requested to examine a neonatal ECG. To established or find out normal developmental, age and sexes related changes in ECG pattern with their normal variation, facilitate the evaluation of the ECG in children by producing clear, easily understandable graph and tables, established data bank of ECG from normal children that will serve as normal limit/reference value for screening and eventually diagnostic interpretation of ECG and find out peak age at which child's heart attained adult ECG variant.*

Material and Methods: *The present study was conducted on healthy or apparently healthy 200 subjects of paediatric age groups population (Birth to 14 years) of either sex. Those who attended the post natal wards, immunization clinics and hospitals of Jodhpur district and the students of various schools were the subjects of this study. The age was confirmed by hospital record, birth certificate and school records. Periodically visit to child health centers was done for a physical-clinical examination and ECG recording.*

Results: *In our study the mean value of the R-wave amplitude in V6 for children aged 8-12 years is 1.2mv as compared to PR Rijnbeek, et al 2001, 2.09 mV and 1.68 mV in the study of Davignon et al. Higher R-wave amplitudes in V6 were also presented by Macfarlane et al, who found a mean R-wave amplitude in V6 of 1.9 mV for children aged 5-12 years.*

Conclusion: *In our study the incidence of congenital heart disease is 5/1 000 live birth, may be still lower than the developed country. Significant sex differences could be demonstrated for amplitude measurements and QRS duration. ECG parameters are useful for the interpretation of paediatric ECG, in circumstance of western Rajasthan.*

Keywords: *ECG, QRS duration.*

Introduction

Interpretation of pediatric electrocardiograms (ECGs) can be challenging for the Emergency Physician. Part of this difficulty arises from the fact that the normal ECG findings, including heart rate, rhythm, axis, intervals and morphology, changes from the neonatal period through infancy, childhood, and adolescence. These changes occur as a result of the maturation of the myocardium and cardiovascular system with age. Along with these changes, up to 20% of pediatric ECGs obtained in the acute setting may have clinically significant abnormal findings, including the variety of congenital heart diseases seen in children.¹ Interpretation of ECGs in children; including heart rate, rhythm, axis, intervals and morphology, change from the neonatal period through infancy, childhood, and adolescence. The age-related findings and alterations on the normal pediatric ECG, associated with pediatric cardiac diseases, including the congenital heart diseases seen in children. The electrocardiogram (ECG) is a graphic recording of electric potentials generated by the heart the signals are detected by means of metal electrodes attached to the extremities and chest wall and are then amplified by sensitive voltmeter, such as the electrocardiograph. It is a quick, non invasive, inexpensive and highly versatile test. The normal heart rate in neonates varies between 91-166 beat /min and attain the normal adult value 60-119,(85) beat /min at the age of 12-14 years. The heart rate >140 beat / min (85-125) in 2 year of age and >160 beat /min (110-150) in infants is significant, but less than 200 beat/min is considered as sinus tachycardia. The heart rate < 60 beat / min in children at 2 year of age and <80 beat / min in infants is considered as sinus bradycardia.

Established or find out normal developmental, age and sexes related changes in ECG pattern with their normal variation. Facilitate the evaluation of the ECG in children by producing clear, easily understandable graph and tables. established data bank of ECG from normal children that will serve as normal limit/reference value for screening and

eventually diagnostic interpretation of ECG. find out peak age at which child's heart attained adult ECG variant.

Material and Methods

The present study was conducted on healthy or apparently healthy 200 subjects of paediatric age groups population (Birth to 14 years) of either sex. Those who attended the post natal wards, immunization clinics and hospitals of Jodhpur district and the students of various schools were the subjects of this study. The age was confirmed by hospital record, birth certificate and school records. Periodically visit to child health centers was done for a physical-clinical examination and ECG recording. The children with previously known cardiovascular abnormalities were excluded from the study. The total population was divided into five age groups, similar to the grouping used by Tarek Ahmed et al 1984.² All children up to 1 month of age were combined in one group, because of the relatively small sample size. Each group is subdivided to made subgroup according to sex, male/female. For each child, weight, height, physical and clinical examination was done prior to record the ECG. Data for weight and height corresponded well with the WHO / API growth standard. The study was approved by the local ethics committee. All the subjects, his or her attendants were explained the purpose of this study and each subject was carefully and completely examined with a full history (present + past history) of illness.

Results & Discussion

Considerable differences in R- and S-wave amplitudes compared to PR Rijnbeek, et al 2001³, but quite similar to Davignon et al⁴, especially in V6. For example, in our study the mean value of the R-wave amplitude in V6 for children aged 8-12 years is 1.2mv as compared to PR Rijnbeek, et al 2001³, 2.09 mV and 1.68 mV in the study of Davignon et al.⁴ Higher R-wave amplitudes in V6 were also presented by Macfarlane et al, who found a mean R-wave amplitude in V6 of 1.9 mV

for children aged 5-12 years. the upper limits of normal of the R-wave amplitude in V6 are substantially lower in our study, e.g. 1.7 mV for children aged 5-8 years compared to PR Rijnbeek et al 2001³, is 3.14 mV and 2.65 mV in the study of Davignon et al.⁴ Notably, the upper limit of normal of the R-wave amplitude in V3R, V2 and especially V 4 is lower in almost all age groups. For instance, Davignon et al⁴ report an upper limit of normal of 4.5mV in V4 for children aged 3-5 years, and 3.27 m V reported by PR Rijnbeek, et al 2001³, are quite higher as compared to 2.9 mV in our study. R-wave amplitudes in V4 larger than 3.5 mV are exceptional in our material. S-wave amplitudes are considerably lower than the reported by PR Rijnbeek, et al 2001³, and quite similar as compared to Davignon et al⁴ in V6 for all age groups, and in V 4 after 3 years of age. In the other precordial leads the S-wave amplitude is comparable in most age groups. These findings suggest that the amplitude criteria for ventricular hypertrophy should be adjusted. Influence of sex differences on the paediatric ECG has been reported III a number of studies (Strong WB

1972⁵, Macfarlane PW 1994⁶, Pearl W 1996⁷, Walker CHM, 1961⁸ and Rautaharju PM 1992⁹). However, to our knowledge this is the first study that examined sex differences in amplitude measurements for children in all age groups in Rajasthan. In our study, amplitudes of the Q, Rand S waves are higher for boys than for girls especially during adolescence.

The ECGs of healthy children change markedly from birth to young adulthood. Knowledge of the normal variation of ECG measurements with age is essential for proper interpretation of the paediatric ECG. Previous studies that determined normal limits for the paediatric ECG had discrepancy in their normal limits: In this study, ECGs were recorded at a relatively low sampling rate, ECG measurements were taken manually, or normal limits were presented only for a limited set of parameters, as in study of Devignon et al 1979⁴. While in some other studies, the normal limits of ECG parameters were based on computerized analysis of a large set of ECGs recorded at a high sampling rate, thus obviating some discrepancy with previous studies.

Table 1: Mean p wave amplitude with age and sex

Age Group	P wave duration(sec.) in Lead II						P wave amplitude(mV) in Lead II					
	Sex	Min	2%ILE	Mean	98%ILE	Max.	Min	2%ILE	Mean	98%ILE	Max	No. sub.
0-1mnth	M	0.05	0.05	0.07	0.1	0.1	0.15	0.15	0.19	0.25	0.25	10
	F	0.04	0.04	0.06	0.08	0.08	0.05	0.06	0.13	0.19	0.2	10
>1m- 1yr	M	0.03	0.03	0.06	0.08	0.08	0.1	0.1	0.135	0.19	0.2	10
	F	0.05	0.05	0.07	0.084	0.084	0.15	0.15	0.176	0.24	0.25	10
>1yr-4 yr	M	0.06	0.06	0.078	0.1	0.1	0.1	0.1	0.148	0.24	0.25	10
	F	0.06	0.06	0.084	0.178	0.2	0.1	0.1	0.146	0.2	0.2	10
>4yr- 6yr	M	0.06	0.06	0.08	0.1	0.1	0.1	0.1	0.109	0.144	0.15	10
	F	0.06	0.06	0.08	0.1	0.1	0.1	0.1	0.115	0.158	0.16	10
>6yr-14yr	M	0.06	0.06	0.08	0.1	0.1	0.1	0.1	0.115	0.15	0.15	10
	F	0.06	0.06	0.08	0.15	0.15	0.1	0.1	0.11	0.15	0.15	10

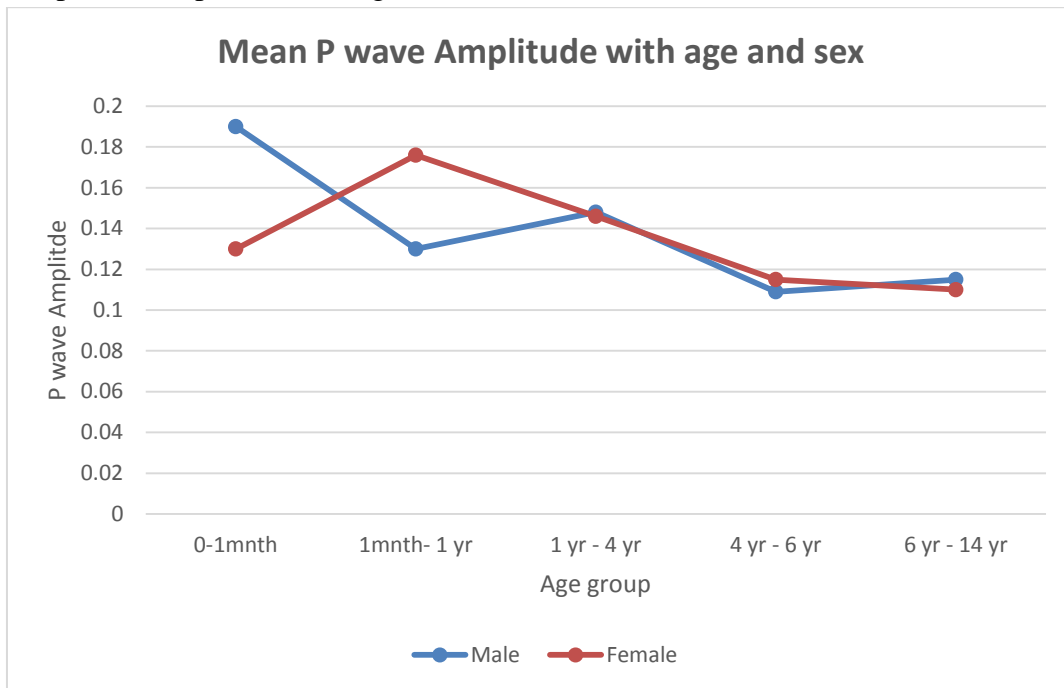
Table 2: PR Interval (sec.) in lead II

Age Group	Sex	Min	2%ILE	Mean	98%ILE	Max	No. sub.
0 – 1 mnth	M	0.06	0.64	0.09	0.118	0.12	10
	F	0.06	0.06	0.09	0.17	0.18	10
>1m – 1 yr	M	0.06	0.06	0.095	0.138	0.14	10
	F	0.04	0.045	0.10	0.176	0.18	10
>1yr – 4 yr	M	0.1	0.1	0.129	0.156	0.16	10
	F	0.06	0.06	0.1	0.156	0.16	10
>4yr – 6 yr	M	0.12	0.12	0.134	0.16	0.16	10
	F	0.08	0.083	0.128	0.16	0.16	10
>6 yr – 14 yr	M	0.12	0.12	0.132	0.156	0.16	10
	F	0.12	0.12	0.136	0.16	0.16	10

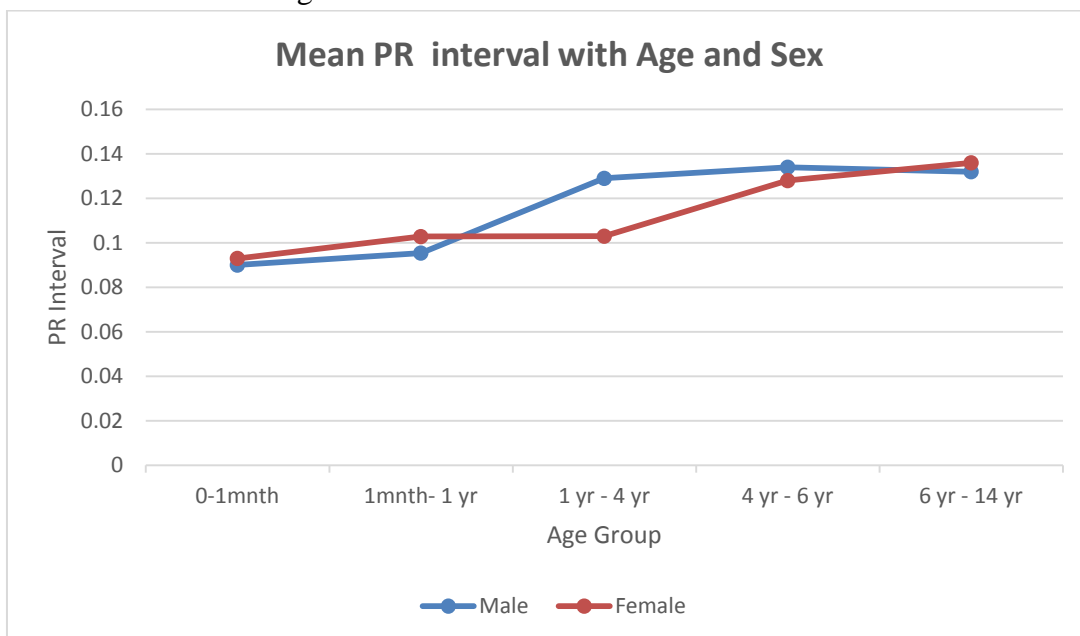
Table 3: QRS axis with age and degree

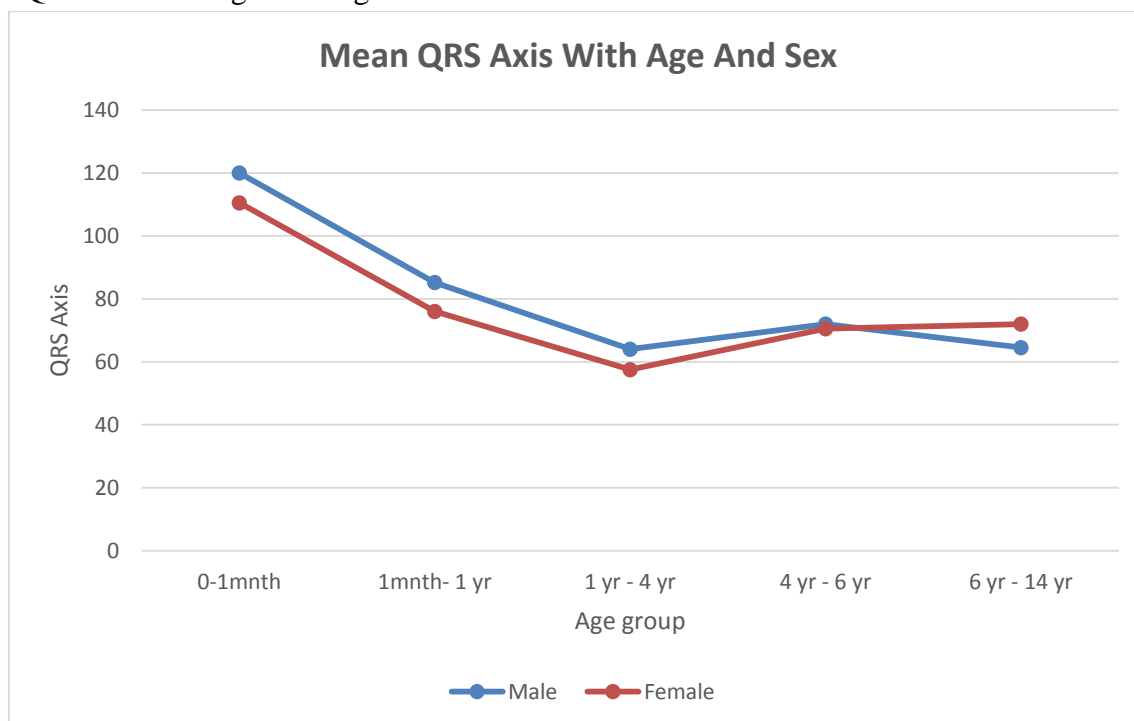
Age Group	Sex	Min	2%ILE	Mean	98%ILE	Max	No. sub.
0 – 1 mnth	M	60	66.3	120	174	180	10
	F	60	62	110	138	140	10
>1m – 1 yr	M	37	41	85	117	120	10
	F	0	5.4	76	125	130	10
>1yr – 4 yr	M	30	30	64	102	105	10
	F	0	2.7	51	99	105	10
>4yr – 6 yr	M	30	32	72	105	105	10
	F	45	48	70	105	105	10
>6 yr – 14 yr	M	45	45	64	99	105	10
	F	30	32	72	102	105	10

Graph 1: Mean p wave amplitude with age and sex



Graph 2: Mean PR interval with age and sex



Graph 3 : QRS axis with age and degree**Conclusion**

Congenital heart disease is 5/1 000 live births, may be still lower than the developed country. (8.8/1 000 live birth, Hoffman et al 1978). Significant sex differences could be demonstrated for amplitude measurements and QRS duration. These findings are clinically significant and suggest that diagnostic criteria for the paediatric ECG should be adjusted. Normal limits of many ECG measurements were shown to differ from those reported earlier. So we are, therefore, hopeful that these sex specific ECG parameters are useful for the interpretation of paediatric ECG, in circumstance of western Rajasthan.

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