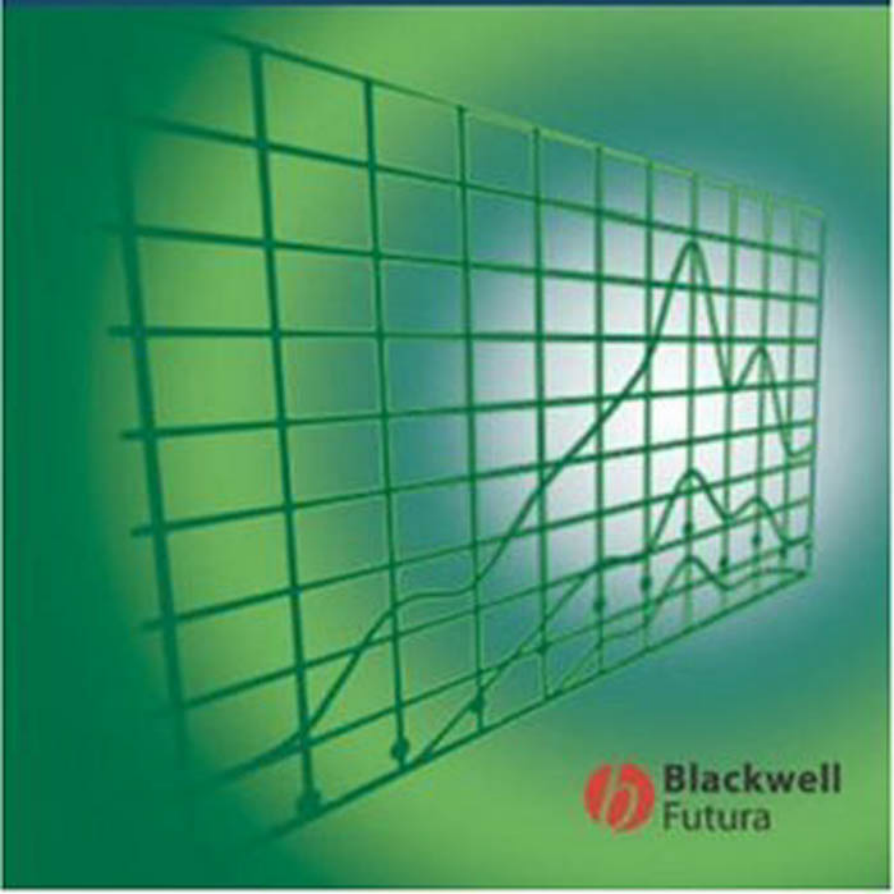
H. C. Lue

ECG in the Child and Adolescent

Normal Standards and Percentile Charts



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ECG in the Child and Adolescent

NORMAL STANDARDS AND PERCENTILE CHARTS

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NORMAL STANDARDS AND PERCENTILE CHARTS

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Part 4 Calculated values on RS amplitude and ventricular activation time by age

Preface

Electrocardiograms (ECGs) are the graphic representation of body surface potential differences generated by the electrical activity of the heart. Bipolar limb leads, augmented unipolar limb leads and precordial leads have been used routinely for recording the ECG, which remains an essential part of the cardiac examination, even after the advent of cardiac catheterization, angiocardiography, echocardiography and many other sophisticated diagnostic modalities.

Fundamental changes in circulation occur immediately after birth, followed by typical and characteristic changes in physiology, position and size of the cardiac chambers relative to the body, throughout infancy, childhood and adolescence. Normal adult values are abnormal in children. Likewise, many of the normal pediatric values are abnormal in the adult. Studies on the developing ECGs reflecting these changes in the healthy pediatric population are of utmost importance, but are still few and limited. Reliable normal standards for P-QRS-T wave intervals and amplitudes are needed as the reference for the diagnosis and evaluation of children with heart disease. Traditionally, normal ECG values in the pediatric population were derived from those published by Ziegler RF (1951) and Davignon *et al.* (1979). We found that the available interpretation packages were inadequate, and not easy to use.

Normal ECG standards for infants, children and adolescents provide not only the reference for physicians in their daily practice of ECG reading, but also provide the database for the study of growing and developing heart and for the computer-assisted electrocardiography analysis. To establish such a set of normal ECG standards and percentile charts in the young in 1995, we started to collect and analyse the electrocardiographic data from healthy newborns, infants, children and adolescents.

Thanks must go to Drs. Y. C. Lai, M. H. Wu, J. K. Wang, M. L. Young, Y. C. Chang, S. J. Yeh, J. H. Lin, and Ms. S. C. Lin together with her team of technicians, who collaborated in this study. Without their efforts collection of the ECGs for analysis of normal standards and percentile charts would not have been possible. The author is grateful to Dr. W. Y. Shau for his advice in the statistical analysis of the normative data, and also to Ms. Renee Shen for her secretarial work.

The author is grateful to the Fukuda Denshi for providing us the FCP-4301 Electrocardiograph with a 500 Hz acquisition program, as recommended by the American Heart Association. Last but not least, the author is grateful to Blackwell Publishing for their efforts in editing and printing.

Hung-Chi Lue

Foreword

One of the most tedious and often unrewarding tasks in medical investigation is obtaining massive normative data on a general population, so that normal standards can be made available to physicians throughout the world. Dr. Hung-Chi Lue and his colleagues have completed a monumental effort of gathering electrocardiographic data on over 1,800 normal infants, children and adolescents, and they have produced a unique monograph which provides normal standards and percentile charts. These published tables will undoubtedly be the basis for comparing values obtained from all components of electrocardiograms on pediatric cardiac patients to the normal range of measurements. These data also should be the basis for the development of valid computer analyses of pediatric electrocardiograms; the present interpretation packages being woefully inadequate.

Although the morphologic diagnostic aspects of electrocardiography have less impact in the modern era because of the advent of echocardiography, the electrocardiogram is vital for the diagnosis and evaluation of patients with cardiac rhythm disorders. Reliable standards for P-QRS-T wave intervals are required to evaluate children with tachyarrhythmias, bradyarrhythmias, first, second, and third degree heart block, WPW, and long QT syndromes.

The format is an especially attractive feature of this monograph. The authors provide 95^{th} and 5^{th} percentile data for all interval and amplitude measurements for all ages, giving access to the limits of normality, so that data from an individual patient can be quickly interpreted in terms of comparison to the general population. The easy-to-use tables will result in data being accessed more often by clinicians and investigators in the field.

This monograph will be especially helpful to those who teach pediatric electrocardiography to medical students, residents, and pediatric cardiology fellows. Many of the teaching points regarding the diagnosis of left, right, and biventricular hypertrophy at various stages, in terms of what is abnormal amplitude of Q, R and S waves as well as RS ratios in the right and left precordial leads, can now be validated (or invalidated), on the basis of this extensive data base for normals.

Those of us in pediatric cardiology owe a debt of thanks to Dr. Lue and his associates for collecting this data, analyzing the material by age groups, and presenting the results in table form which is so easily accessible. The painstakingly careful methodology and large patient population gives us confidence in the reliability of this database, which I hope will be used for the development of accurate computer analyses of pediatric ECG's. Dr. Hung-Chi Lue has made so many contributions to pediatric cardiology that the success of this endeavor

is to be expected. He is an international leader in our field, and the widespread use of this reference manual by his colleagues throughout the world will be another milestone in his outstanding career.

Welton M. Gersony, M.D.
Alexander S. Nadas Professor of Pediatrics
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Columbia University

At the beginning of the twenty-first century, pediatric cardiologists face a uniquely different situation than half a century ago. The diagnostic tools and therapeutic methods available today were almost unimaginable then. Even thinking back only several decades to the days when a combination of the physical examination, the chest roentgenogram, and the electrocardiogram were all that was available to assist in the outpatient clinic and subsequently to the time when physiologic and anatomic data obtained in the catheterization laboratory became more completely understood, the cardiologist today fully appreciates these practical clinical advantages.

Unfortunately, for many present day physicians and students alike, there is a feeling that these valuable diagnostic implements have fully given way to the newer tools such as echocardiography. This is obviously unwarranted.

Important practical clinical information and understanding are made available by the electrocardiographic examination. Of particular importance to both pediatricians and pediatric cardiologists, however, is the fact that the electrocardiogram varies so extensively with the age of the patient. Understanding this has been an issue since the ECG began to be used in pediatric patients and continued later when the difficulties were even more problematic at the time when computerization of pediatric electrocardiography was initially undertaken.

The ECG has stood the test of time and, in contrast to the phonocardiogram, remains important to the cardiologist each and every day. To assist in the implementation of this clinical tool, Professor Hung-Chi Lue has created an impressive and inclusive database showing what is normal and what is not. The careful electrocardiographic examination of almost two-thousand youngsters has provided new and valuable categorized information.

It should not be surprising that Professor Lue has successfully undertaken and completed this gigantic task. As one of the world's leaders in so many aspects of pediatric cardiology, Dr. Lue's continuing contributions – again and again – have been recognized and favorably received not only by the international medical community, but also by his peers in pediatric cardiology. No doubt this book will be equally well received because of the extraordinary detail with which he has displayed these unique data in a clinically usable format.

Professor Hung-Chi Lue is to be congratulated for this effort which will be used by clinicians around the world.

Edward L. Kaplan, M.D.
Professor of Pediatrics
University of Minnesota Medical School

Introduction

The study population consisted of 1884 healthy newborns, infants, children and adolescents enrolled from nurseries, well-baby clinics, kindergartens, and elementary and secondary schools. All children were screened by a specially designed questionnaire, then examined on supine position by a pediatrician, and checked by a pediatric cardiologist. Age was expressed as days, months and years attained at the last birthday. They were divided into twelve age groups: newborns aged less than 1 day, 1–3 days, 3–7 days, and 7–30 days; infants aged 1–3 months, 3–6 months, and 6–12 months; children of 1–3 years, 3–6 years, 6–9 years, 9–13 years and adolescents, 13–18 years.

Appropriate ECG electrodes were placed with no electrical contact between adjacent electrodes to minimize the short-range age-independent ECG variation. ECG was recorded on standardized paper with a stylus, at 10 mm/mV paper speed of 25mm/s, at rest and on supine position. For large amplitude complexes, the half-standard (5 mm/mV) was used. Acquisition of ECG database was performed by an automatic ECG analysis and management program using a Fukuda Denshi FCP-4301 Floppy Utility, Reference MS-DOS/IBM-AT, ECG machine. A 12 lead conventional ECG was taken. Lead V3R was not taken. Analog-to-digital conversion was performed by Fukuda signal acquisition module. The analog potential was digitalized into 5-UV units at a sampling rate of 500 Hz (once every 2 milliseconds). The percentile charts for age were constructed with a variable span smoother (Friedman, 1984).

Morphology measurements were made from the median voltages of the identical P-QRS-T cycles representative of a normal complex selected by the above mentioned analysis program. Amplitude measurements were made using the PR segment as reference for the baseline. The onsets and offsets of the P, QRS, and T were determined by an analysis of the simultaneous slopes in all 12 leads from the earliest onset in any lead to the latest deflection in any lead.

Visual verification using a magnifier and appropriate lighting was systematically performed, by a fellow in pediatric cardiology and an attending cardiologist, on all electrocardiograms in the upper and lower 5^{th} percentile in each age group, with measurements made to the nearest 0.1 mm. In instances of computer wave-recognition errors and of more than 10% differences between visual and computer measurements, the visually determined value was substituted in the data file.

The following ECG parameters were obtained: heart rate, PR interval, QT interval, QTc, QRS duration, RR interval, P-QRS-T axes, P amplitude, Q amplitude, R amplitude, S amplitude, T amplitude and ventricular activation time.

A total of 117 to 125 records, with noises, baseline drifting, bundle branch blocks, WPW, extrasystoles and ECG rhythms other than sinus rhythm detected by computer and verified by one cardiologist and the author were excluded from the data file.

The relation between ECG wave amplitudes and durations, as well as some other ECG indices, (heart rate, age), commonly used in pediatric cardiology were calculated. The normal standards for each age group, including the number of subjects analyzed, the mean and standard deviation and the 95^{th} and 5^{th} percentile values of the variables were listed in tables, and the 5^{th}, 25^{th}, 50^{th}, 75^{th} and 95^{th} values were illustrated in percentile format charts.

How to use this book

The electrocardiogram varies extensively with the age of patients. Easy to use tables and charts of heart rate, duration, interval, axis, amplitude, and calculated values by age provided in this book may help the clinicians and investigators to:

1 Learn the characteristic ECG changes along with the growth and development of infants and children to adolescence. This can be readily recognized at a glance over the percentile charts and the corresponding tables.

2 Find the normal standards of ECG tracings in the young. The mean (± SD) and the limits (5^{th} and 95^{th} percentile) of normality in twelve age groups are provided.

3 Compare the ECG tracings recorded from an individual with the data in this book, thus helping make the assessment and interpretation.

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PART 1

Heart rate, P-QRS-T interval and duration by age

CHAPTER 1.1

Heart rate by age

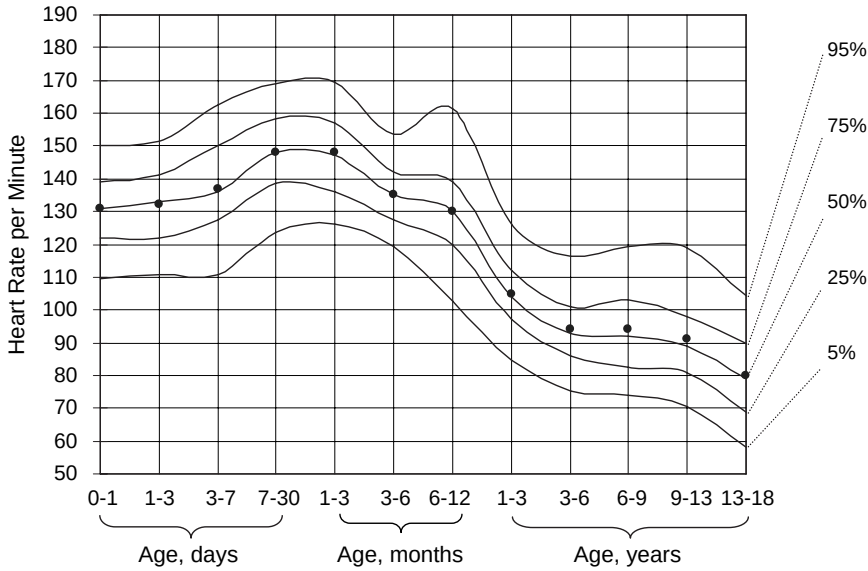

Figure 1.1 Heart rate by age, each curve corresponding to the indicated percentile level (• = mean). Striking changes in heart rate are noted from newborn to adolescence. The heart rate increases from birth to ages 7–30, days and 1–3 months. From that age forward, the heart rate decreases with increasing age, most rapidly from age 6–12 months to 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	150	152	163	169	169	154	161	126	117	119	119	105
Mean	**131**	**132**	**137**	**148**	**148**	**135**	**130**	**105**	**94**	**94**	**91**	**80**
(±SD)	**12.86**	**13.07**	**15.91**	**15.58**	**14.66**	**11.70**	**18.67**	**13.09**	**11.96**	**14.68**	**14.08**	**14.50**
5%	109	111	111	124	126	120	103	85	75	74	70	58
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 1.2

PR interval by age

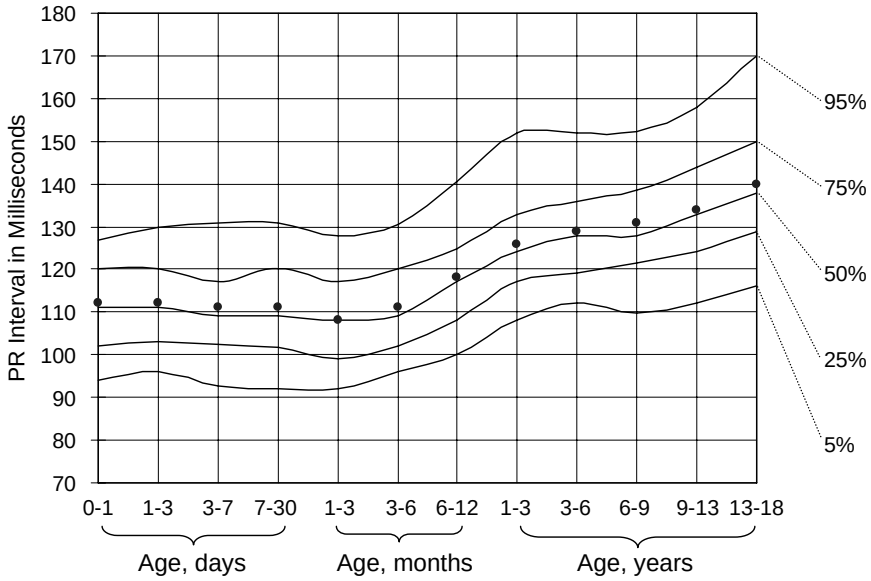

Figure 1.2 PR interval by age, each curve corresponding to the indicated percentile level (• = mean). The PR interval remains little changed after birth and during early infancy. It increases with increasing age, from age 6 months through to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	127	130	131	131	128	131	140	152	152	152	158	170
Mean	**112**	**112**	**111**	**111**	**108**	**111**	**118**	**126**	**129**	**131**	**134**	**140**
(±SD)	**10.65**	**11.54**	**12.65**	**13.48**	**11.81**	**11.36**	**12.93**	**10.85**	**10.56**	**14.52**	**17.35**	**17.94**
5%	94	96	93	92	92	96	100	108	112	110	112	116
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 1.3

PR interval by heart rate

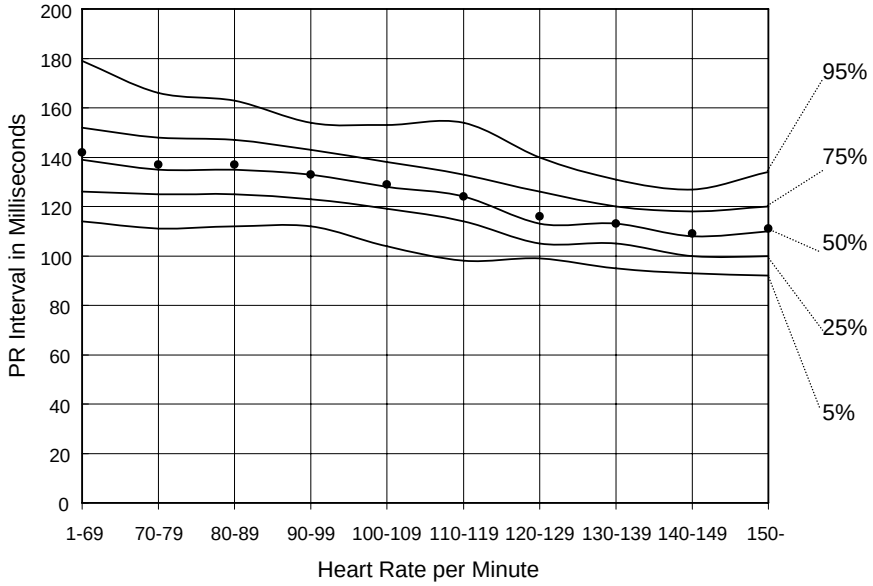

Figure 1.3 PR Interval by heart rate, each curve corresponding to the indicated percentile level (• = mean). The PR interval decreases slightly along with increasing heart rate during the entire pediatric ages.

Heart rate	*1–69*	*70–79*	*80–89*	*90–99*	*100–109*	*110–119*	*120–129*	*130–139*	*140–149*	*150–*
95%	179	166	163	154	153	154	140	131	127	134
Mean	**142**	**137**	**137**	**133**	**129**	**124**	**116**	**113**	**109**	**111**
(±SD)	**21.54**	**18.53**	**15.96**	**13.71**	**14.91**	**17.48**	**14.94**	**0.00**	**0.00**	**0.00**
5%	114	111	112	112	104	98	99	95	93	92
(N)	143	206	274	247	178	127	174	200	158	177

CHAPTER 1.4

QT interval by age

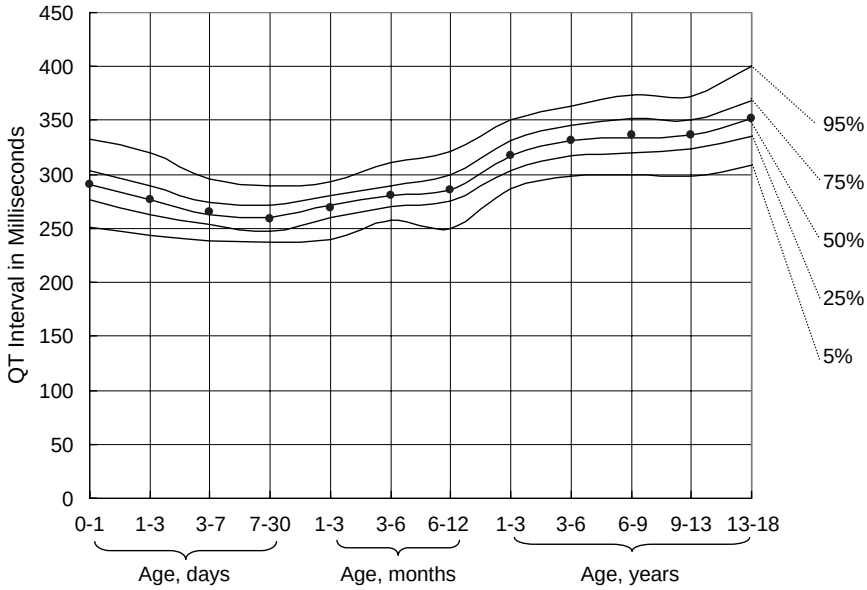

Figure 1.4 QT interval by age, each curve corresponding to the indicated percentile level (• = mean). The QT interval decreases slightly after birth, reaching the lowest at age 7–30 days. From that age forward, the QT interval increases along with increasing age up to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	333	320	296	289	293	311	321	350	363	373	372	400
Mean	**291**	**277**	**265**	**259**	**269**	**281**	**285**	**318**	**331**	**336**	**337**	**352**
(±SD)	**26.63**	**23.09**	**17.92**	**17.85**	**18.90**	**15.95**	**23.81**	**21.69**	**21.11**	**23.41**	**26.02**	**27.00**
5%	251	244	239	237	240	258	249	287	298	300	298	309
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 1.5

QT interval by heart rate

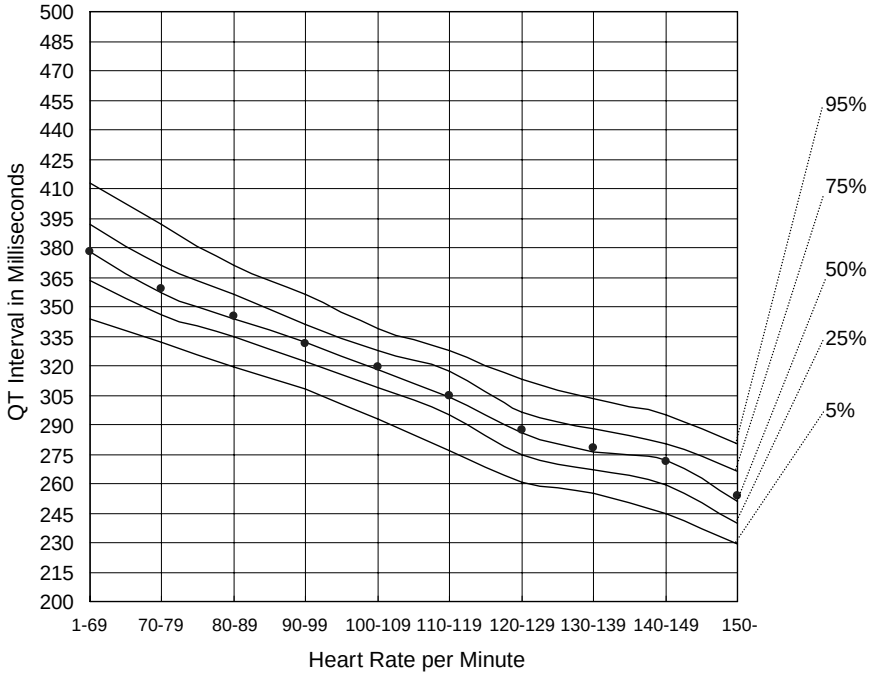

Figure 1.5 QT interval by heart rate, each curve corresponding to the indicated percentile level (• = mean). The QT interval decreases in striking accordance with the increasing heart rate.

Heart rate	*1–69*	*70–79*	*80–89*	*90–99*	*100–109*	*110–119*	*120–129*	*130–139*	*140–149*	*150–*
95%	413	392	371	356	339	328	313	303	295	280
Mean	**378**	**359**	**345**	**331**	**319**	**305**	**287**	**278**	**271**	**254**
(±SD)	**21.54**	**17.50**	**15.46**	**14.51**	**15.18**	**16.39**	**15.61**	**0.00**	**0.00**	**0.00**
5%	344	332	319	308	293	277	261	255	245	229
(N)	143	206	274	247	178	127	174	200	158	177

QTc interval by age

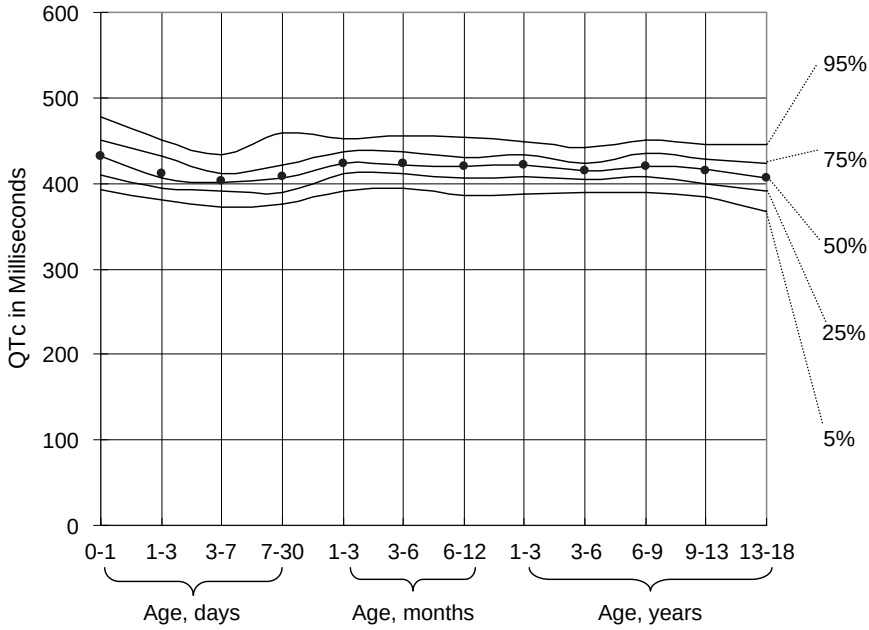

Figure 1.6 QTc interval by age, each curve corresponding to the indicated percentile level (• = mean). The corrected QT interval decreases slightly after birth, and returns to the previous level by age 1–3 months, then remains unchanged until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	478	451	434	459	452	455	453	449	442	450	445	446
Mean	**431**	**412**	**402**	**408**	**423**	**424**	**419**	**421**	**415**	**420**	**415**	**407**
(±SD)	**26.44**	**23.09**	**19.15**	**25.15**	**20.56**	**17.50**	**20.17**	**16.27**	**15.83**	**18.09**	**17.35**	**23.52**
5%	392	380	372	375	391	395	386	388	389	390	384	367
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 1.7

QTc interval by heart rate

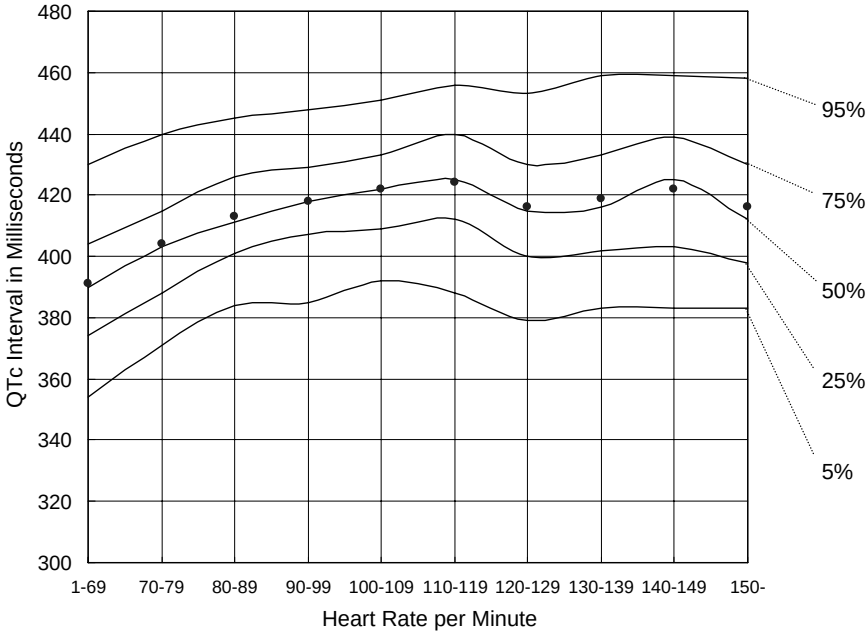

Figure 1.7 QTc interval by heart rate, each curve corresponding to the indicated percentile level (• = mean). The corrected QT interval increases slightly and steadily with increasing heart rate up to a rate of 110–119 per minute, then remains little or unchanged.

Heart rate	*1–69*	*70–79*	*80–89*	*90–99*	*100–109*	*110–119*	*120–129*	*130–139*	*140–149*	*150–*
95%	430	440	445	448	451	456	453	459	459	458
Mean	**391**	**404**	**413**	**418**	**422**	**424**	**416**	**419**	**422**	**416**
(±SD)	**22.76**	**19.70**	**17.90**	**18.44**	**19.74**	**22.19**	**21.81**	**0.00**	**0.00**	**0.00**
5%	354	371	384	385	392	388	379	383	383	383
(N)	143	206	274	247	178	127	174	200	158	177

CHAPTER 1.8

QRS duration by age

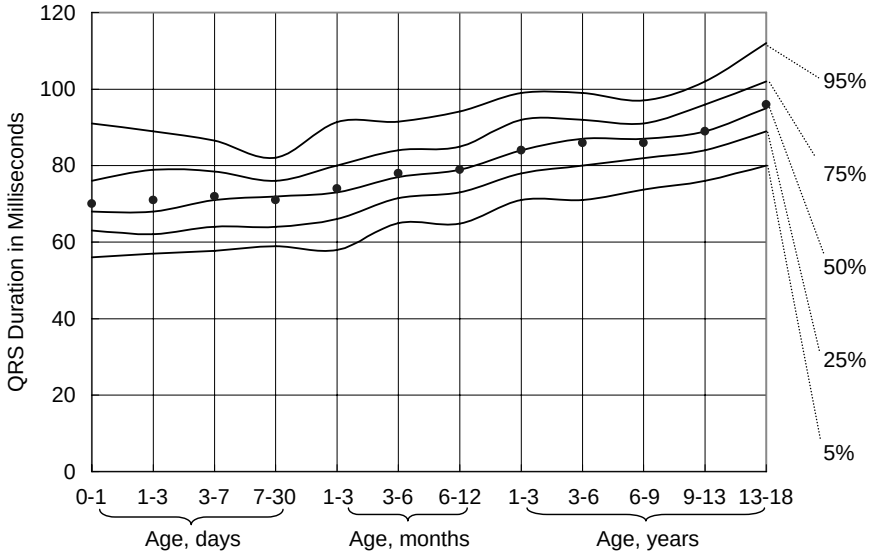

Figure 1.8 QRS duration by age, each curve corresponding to the indicated percentile level (• = mean). QRS duration steadily and gradually increases with increasing age, from birth to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	91	89	87	82	91	92	94	99	99	97	102	112
Mean	**70**	**71**	**72**	**71**	**74**	**78**	**79**	**84**	**86**	**86**	**89**	**96**
(±SD)	**10.65**	**11.54**	**9.44**	8.06	**10.55**	**8.31**	**9.04**	**10.85**	**10.56**	**7.53**	**8.67**	**9.85**
5%	56	57	58	59	58	65	65	71	71	74	76	80
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 1.9

RR interval by age

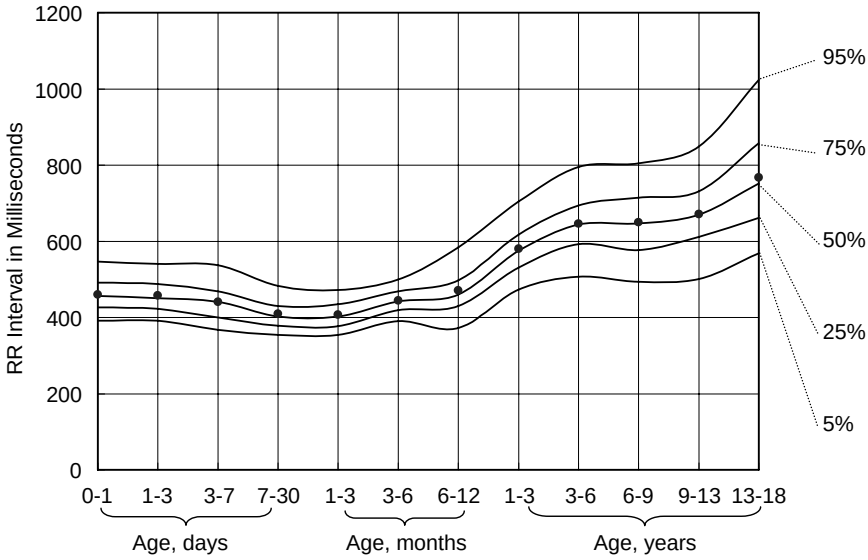

Figure 1.9 RR interval by age, each curve corresponding to the indicated percentile level (• = mean). The RR interval decreases slightly from birth to ages 7–30 days and 1–3 months. From that age forward, the RR interval increases with a wider range along with increasing age until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	547	541	537	483	472	500	583	705	795	805	849	1023
Mean	**460**	**458**	**441**	**410**	**407**	**445**	**471**	**580**	**646**	**650**	**672**	**767**
(±SD)	**47.94**	**46.18**	**53.46**	**48.33**	**40.57**	**37.92**	**71.09**	**75.93**	**79.16**	**96.94**	**95.41**	**138.81**
5%	391	391	368	354	354	390	372	473	507	494	501	568
(N)	109	128	95	100	120	92	97	113	107	100	289	514

PART 2

Frontal plane P-QRS-T axis by age

CHAPTER 2.1

Frontal plane P axis by age

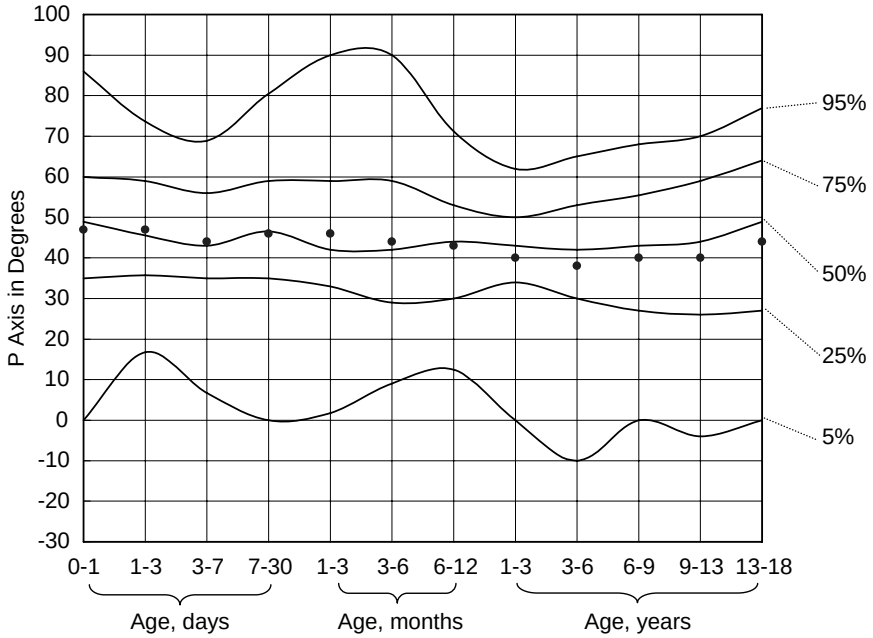

Figure 2.1 Frontal plane P axis by age, each curve corresponding to the indicated percentile level (• = mean). From newborn to adolescence, the frontal plane P axes, as in adults, direct constantly to the left and inferiorly between zero and 90 degrees.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	86	74	69	81	90	90	71	62	65	68	70	77
Mean	**47**	**47**	**44**	**46**	**46**	**44**	**43**	**40**	**38**	**40**	**40**	**44**
(±SD)	**22.24**	**17.05**	**18.15**	**24.79**	**25.13**	**27.16**	**18.67**	**16.27**	**21.11**	**21.02**	**26.02**	**26.88**
5%	0	17	7	0	2	9	12	0	−10	0	−4	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 2.2

Frontal plane QRS axis by age

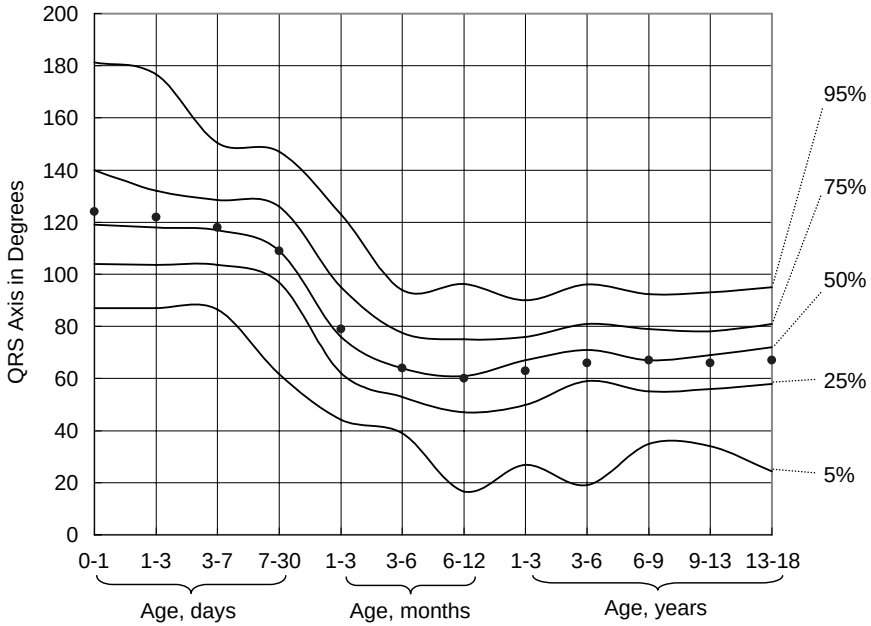

Figure 2.2 Frontal plane QRS axis by age, each curve corresponding to the indicated percentile level (• = mean). The frontal QRS axis following progresses from the right-hand axis, a following newborn pattern: slowly after birth, then changing abruptly by age 7 days, to a more adult pattern within the first year of life.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	181	177	150	147	123	94	96	90	96	92	93	95
Mean	**124**	**122**	**118**	**109**	**79**	**64**	**60**	**63**	**66**	**67**	**66**	**67**
(±SD)	**28.56**	**27.59**	**20.62**	**26.35**	**25.80**	**18.53**	**24.49**	**21.69**	**21.11**	**18.60**	**17.35**	**21.48**
5%	87	87	87	62	44	39	17	27	19	35	34	24
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 2.3

Frontal plane T axis by age

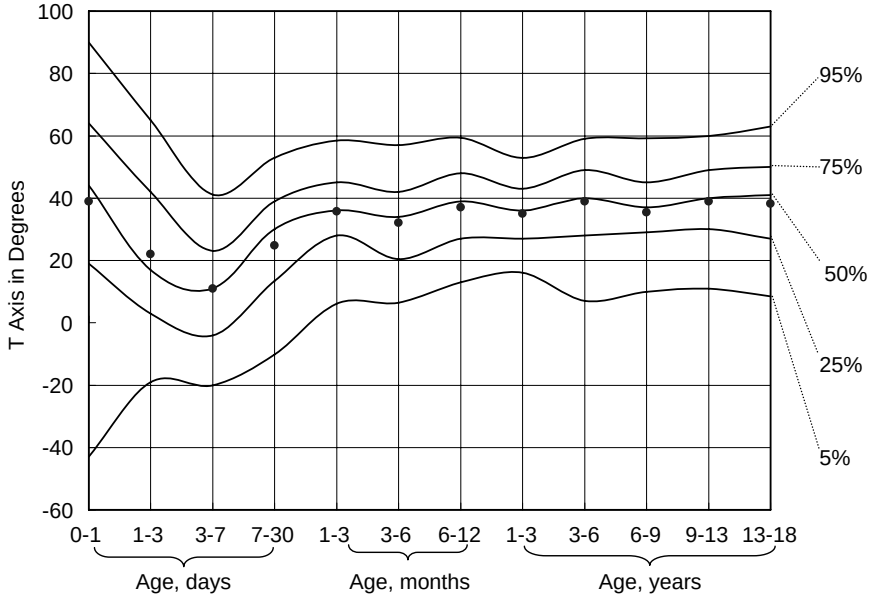

Figure 2.3 Frontal plane T axis by age, each curve corresponding to the indicated percentile level (• = mean). The frontal plane T wave axis abruptly changes from a wide range of T axis after birth, to a narrower range at age 3–7 days. The T axis moves back to the previous levels during the subsequent days, then reaching the adult pattern by age 3–6 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	90	65	41	53	58	57	59	53	59	59	60	63
Mean	**39**	**22**	**11**	**25**	**36**	**32**	**37**	**35**	**39**	**35**	**39**	**38**
(±SD)	**42.61**	**23.09**	**19.98**	**20.20**	**14.82**	**16.01**	**16.61**	**10.85**	**15.83**	**15.94**	**17.35**	**17.09**
5%	−43	−19	−20	−10	6	7	13	16	7	10	11	8
(N)	109	128	95	100	113	91	97	113	107	99	289	510

PART 3

P-QRS-T amplitude by age

CHAPTER 3.1

P amplitude by age in lead II

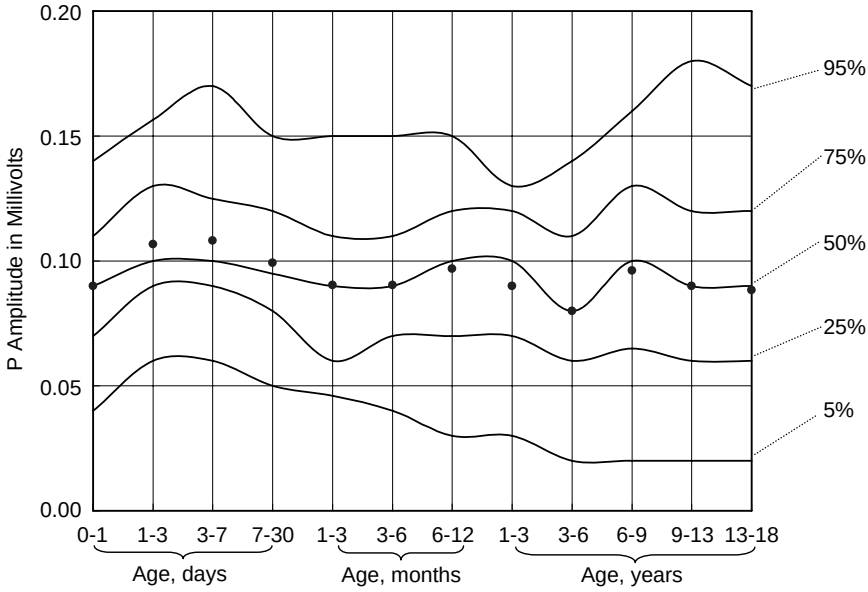

Figure 3.1 P amplitude by age in lead II, each curve corresponding to the indicated percentile level (• = mean). The mean of the P wave amplitudes in lead II of newborns to adolescents stays little changed, but a wider range of amplitudes is noted after the first year of life.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.14	0.16	0.17	0.15	0.15	0.15	0.15	0.13	0.14	0.16	0.18	0.17
Mean	**0.09**	**0.11**	**0.11**	**0.10**	**0.09**	**0.09**	**0.10**	**0.09**	**0.08**	**0.10**	**0.09**	**0.09**
(±SD)	**0.05**	**0.03**	**0.03**	**0.03**	**0.03**	**0.04**	**0.04**	**0.05**	**0.05**	**0.04**	**0.09**	**0.05**
5%	0.04	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.2

Q amplitude by age in lead I

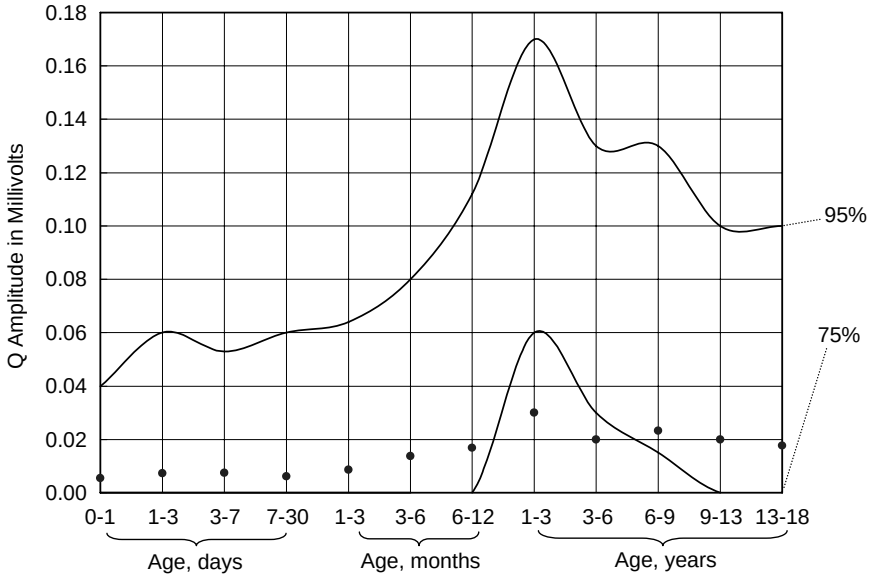

Figure 3.2 Q amplitude by age in lead I, each curve corresponding to the indicated percentile level (• = mean). Q waves in lead I are absent or small during infancy.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.04	0.06	0.05	0.06	0.06	0.08	0.11	0.17	0.13	0.13	0.10	0.10
Mean	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.03**	**0.02**	**0.02**	**0.02**	**0.02**
(±SD)	**0.02**	**0.03**	**0.02**	**0.02**	**0.02**	**0.03**	**0.04**	**0.05**	**0.05**	**0.05**	**0.00**	**0.04**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.3

Q amplitude by age in lead II

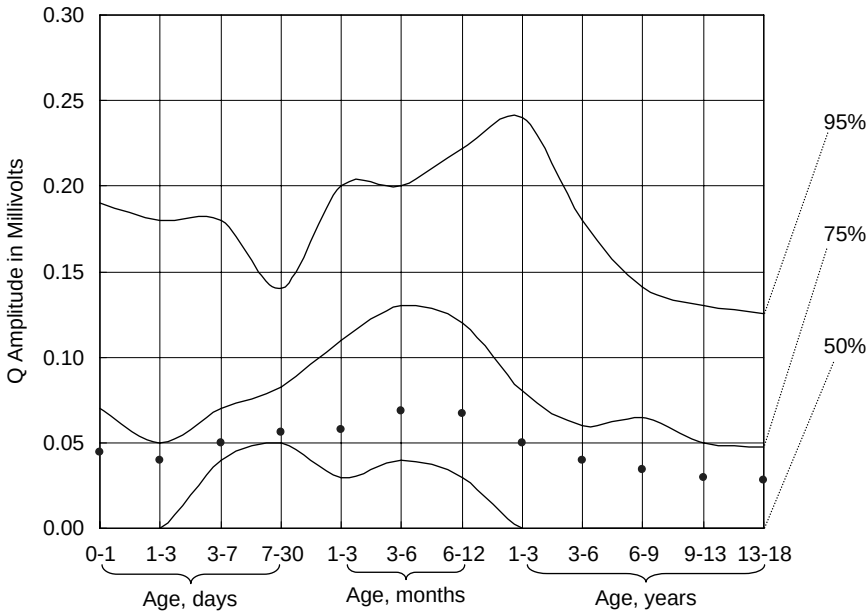

Figure 3.3 Q amplitude by age in lead II, each curve corresponding to the indicated percentile level (• = mean). Q waves in lead II are generally small or absent. The amplitude is relatively larger during ages 1–3 months, 3–6 months, 6–12 months and 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.19	0.18	0.18	0.14	0.20	0.20	0.22	0.24	0.18	0.14	0.13	0.13
Mean	**0.04**	**0.04**	**0.05**	**0.06**	**0.06**	**0.07**	**0.07**	**0.05**	**0.04**	**0.03**	**0.03**	**0.03**
(±SD)	**0.07**	**0.06**	**0.06**	**0.06**	**0.07**	**0.08**	**0.08**	**0.11**	**0.05**	**0.05**	**0.09**	**0.05**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.4

Q amplitude by age in lead III

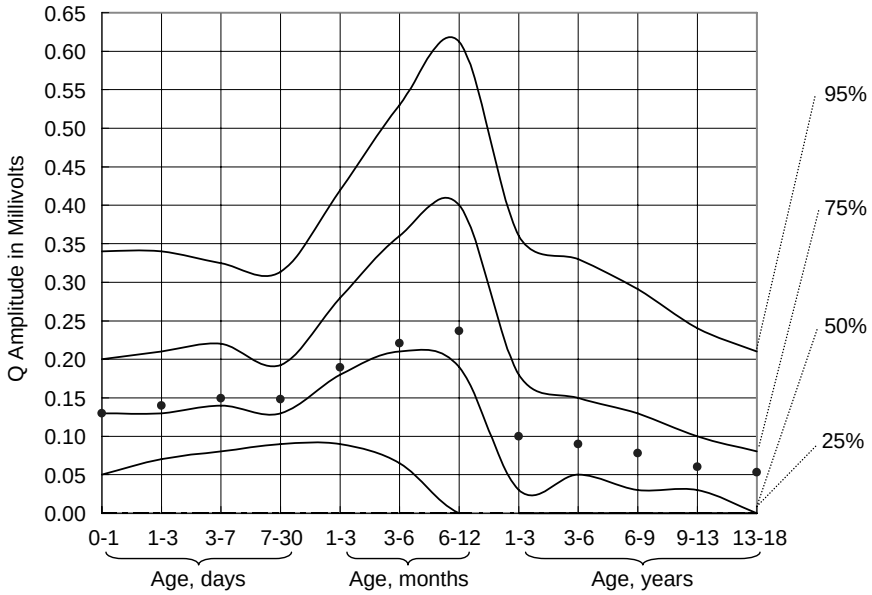

Figure 3.4 Q amplitude by age in lead III, each curve corresponding to the indicated percentile level (• = mean). Q waves in lead III are more prominent at ages 1–3 months, 3–6 months, and 6–12 months, with a deflection up to 6.1 mm.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.34	0.34	0.33	0.31	0.42	0.53	0.61	0.36	0.33	0.29	0.24	0.21
Mean	**0.13**	**0.14**	**0.15**	**0.15**	**0.19**	**0.22**	**0.24**	**0.1**	**0.09**	**0.08**	**0.06**	**0.05**
(±SD)	**0.11**	**0.12**	**0.10**	**0.10**	**0.14**	**0.17**	**0.22**	**0.11**	**0.11**	**0.11**	**0.09**	**0.07**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.5

Q amplitude by age in lead aVR

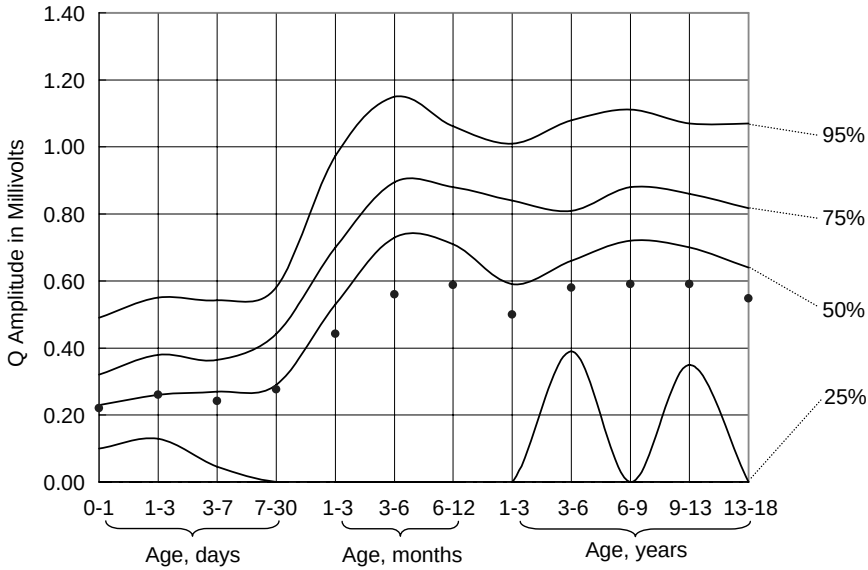

Figure 3.5 Q amplitude by age in lead aVR, each curve corresponding to the indicated percentile level (• = mean). Q waves recorded in aVR are absent, small or prominent. The Q wave amplitude produced becomes larger with a wider range after 1 month of age and thereafter.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.49	0.55	0.54	0.58	0.97	1.15	1.06	1.01	1.08	1.11	1.07	1.07
Mean	**0.22**	**0.26**	**0.24**	**0.28**	**0.44**	**0.56**	**0.59**	**0.5**	**0.58**	**0.59**	**0.59**	**0.55**
(±SD)	**0.16**	**0.17**	**0.18**	**0.21**	**0.34**	**0.43**	**0.40**	**0.38**	**0.37**	**0.41**	**0.35**	**0.37**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.6

Q amplitude by age in lead aVL

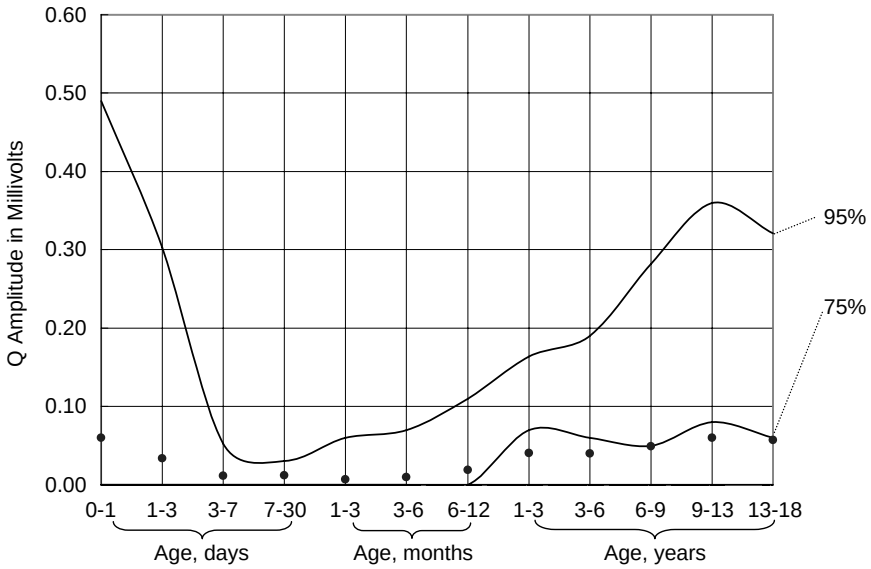

Figure 3.6 Q amplitude by age in lead aVL, each curve corresponding to the indicated percentile level (• = mean). Q waves in lead aVL are absent or small during infancy. The Q wave deflections can be large, up to 4.9 mm, immediately and 1–3 days after birth, and up to 3.6 mm also after age 3–6 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.49	0.30	0.05	0.03	0.06	0.07	0.11	0.16	0.19	0.28	0.36	0.32
Mean	**0.06**	**0.03**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.04**	**0.04**	**0.05**	**0.06**	**0.06**
(±SD)	**0.16**	**0.12**	**0.05**	**0.07**	**0.03**	**0.03**	**0.04**	**0.06**	**0.05**	**0.10**	**0.09**	**0.12**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.7

Q amplitude by age in lead aVF

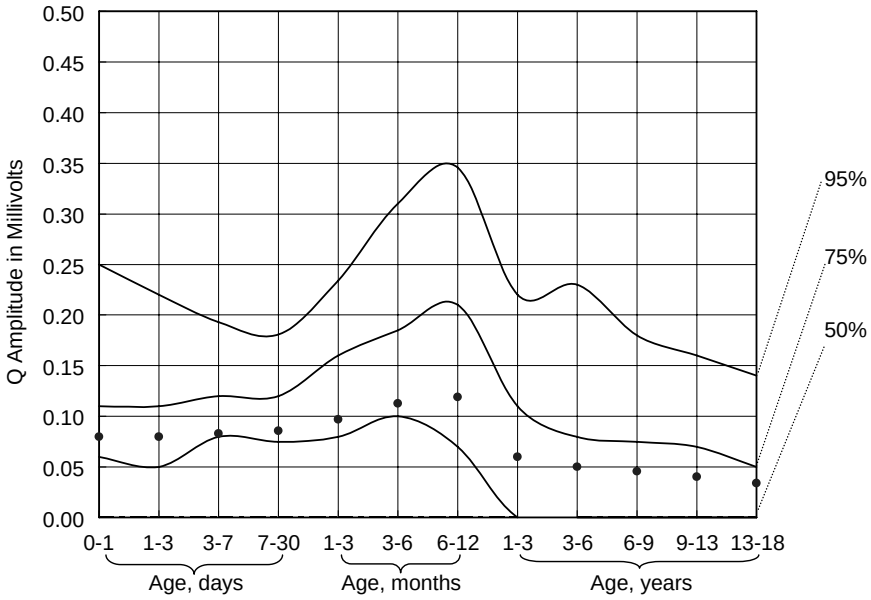

Figure 3.7 Q amplitude by age in lead aVF, each curve corresponding to the indicated percentile level (• = mean). Q waves in aVF are absent of small deflections.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.25	0.22	0.19	0.18	0.23	0.31	0.35	0.22	0.23	0.18	0.16	0.14
Mean	**0.08**	**0.08**	**0.08**	**0.09**	**0.10**	**0.11**	**0.12**	**0.06**	**0.05**	**0.05**	**0.04**	**0.03**
(±SD)	**0.05**	**0.06**	**0.07**	**0.07**	**0.09**	**0.11**	**0.13**	**0.11**	**0.05**	**0.07**	**0.09**	**0.05**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.8

Q amplitude by age in lead V4

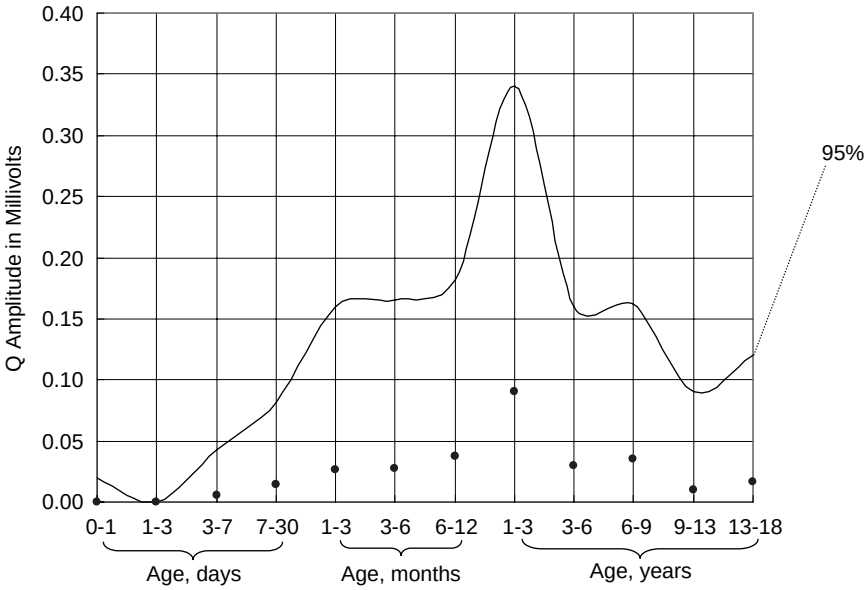

Figure 3.8 Q amplitude by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). Q waves in V4 are absent or small, relatively prominent at age 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.02	0.00	0.04	0.08	0.16	0.17	0.18	0.34	0.16	0.16	0.09	0.12
Mean	**0**	**0**	**0.01**	**0.01**	**0.03**	**0.03**	**0.04**	**0.09**	**0.03**	**0.03**	**0.01**	**0.02**
(±SD)	**0.00**	**0.00**	**0.02**	**0.04**	**0.06**	**0.06**	**0.08**	**0.11**	**0.05**	**0.08**	**0.00**	**0.05**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.9

Q amplitude by age in lead V5

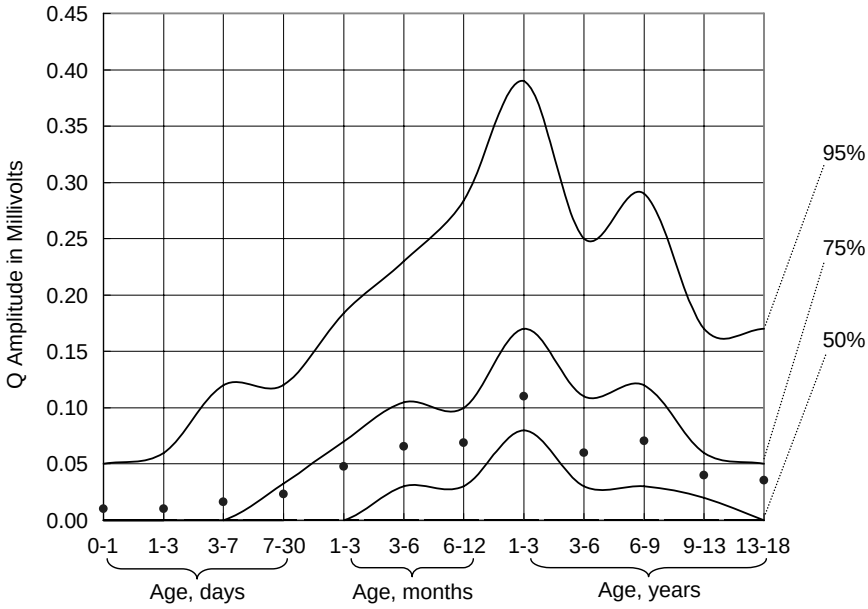

Figure 3.9 Q amplitude by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). Q waves in V5 are generally absent or small during infancy. The Q amplitudes can be large, up to 3.9 mm, at age 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.05	0.06	0.12	0.12	0.18	0.23	0.28	0.39	0.25	0.29	0.17	0.17
Mean	**0.01**	**0.01**	**0.02**	**0.02**	**0.05**	**0.07**	**0.07**	**0.11**	**0.06**	**0.07**	**0.04**	**0.04**
(±SD)	**0.00**	**0.00**	**0.04**	**0.05**	**0.07**	**0.08**	**0.10**	**0.11**	**0.11**	**0.10**	**0.09**	**0.06**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.10

Q amplitude by age in lead V6

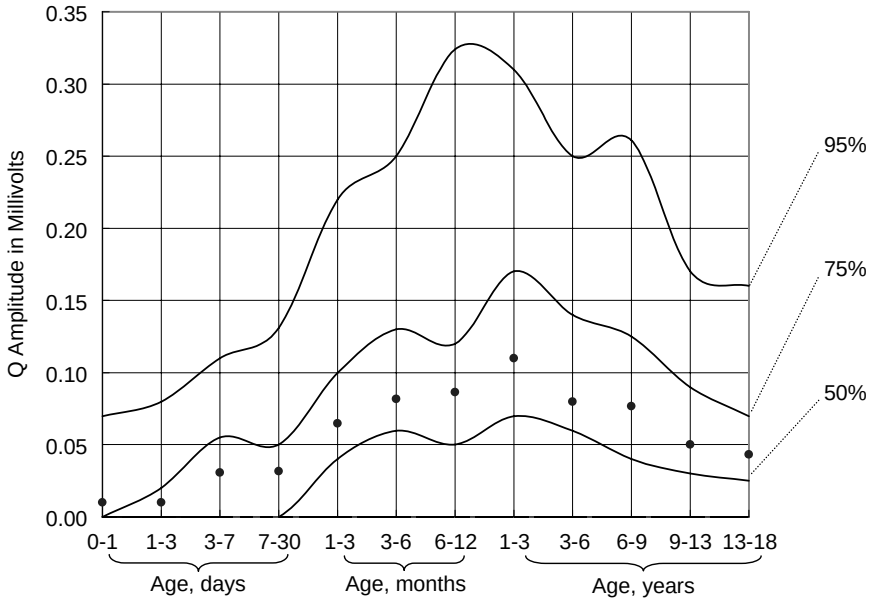

Figure 3.10 Q amplitude by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). Q waves in V6 are absent or small throughout newborn to adolescence. The deflections can be large, up to 3.2 mm, in late infancy and early childhood.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.07	0.08	0.11	0.13	0.22	0.25	0.32	0.31	0.25	0.26	0.17	0.16
Mean	**0.01**	**0.01**	**0.03**	**0.03**	**0.06**	**0.08**	**0.09**	**0.11**	**0.08**	**0.08**	**0.05**	**0.04**
(±SD)	**0.05**	**0.06**	**0.05**	**0.05**	**0.08**	**0.08**	**0.11**	**0.11**	**0.11**	**0.10**	**0.09**	**0.06**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.11

R amplitude by age in lead aVR

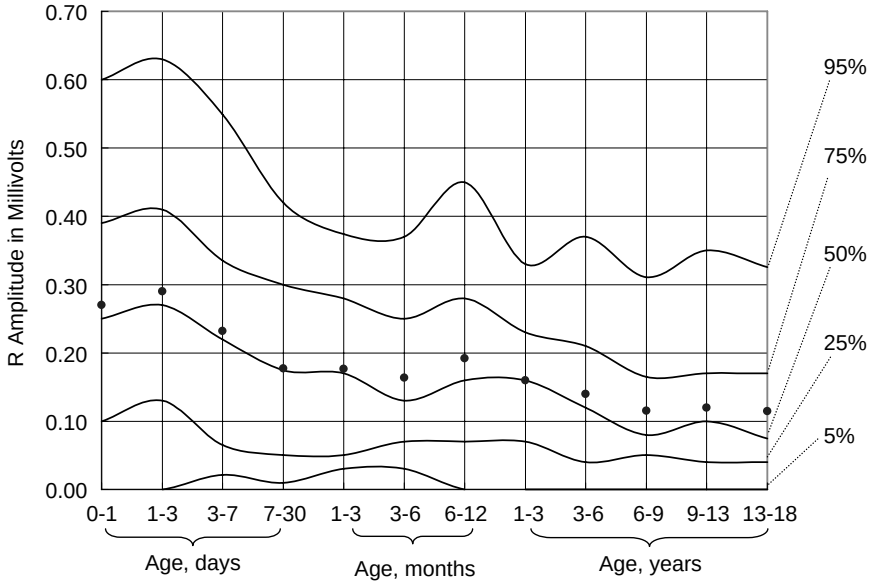

Figure 3.11 R amplitude by age in lead aVR, each curve corresponding to the indicated percentile level (• = mean). R waves in aVR are prominent from birth to late infancy. The R wave amplitude increases in the first 3 days, then decreases strikingly thereafter, reaching a plateau by age 6–9 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.60	0.63	0.55	0.42	0.37	0.37	0.45	0.33	0.37	0.31	0.35	0.33
Mean	**0.27**	**0.29**	**0.23**	**0.18**	**0.18**	**0.16**	**0.19**	**0.16**	**0.14**	**0.12**	**0.12**	**0.11**
(±SD)	**0.21**	**0.17**	**0.17**	**0.14**	**0.12**	**0.13**	**0.15**	**0.11**	**0.11**	**0.10**	**0.09**	**0.11**
5%	0.00	0.00	0.02	0.01	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.12

R amplitude by age in lead V1

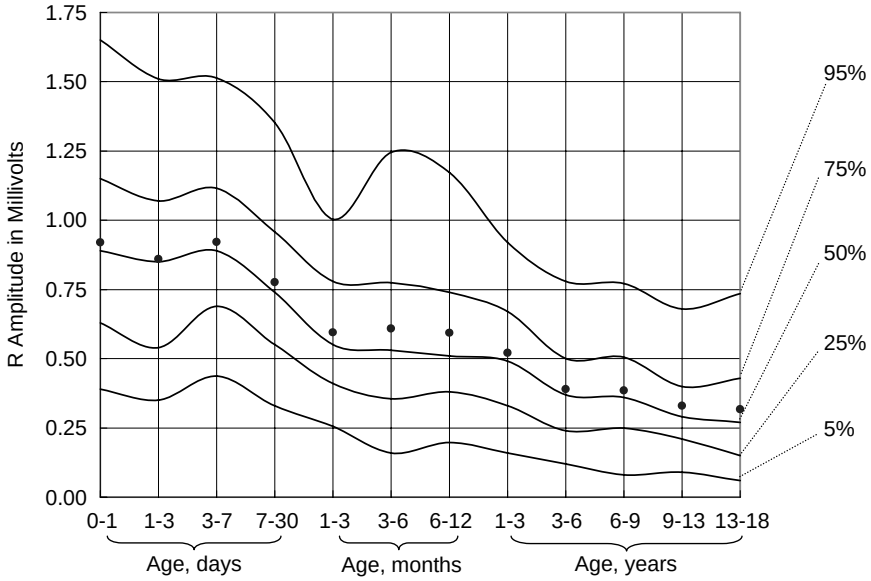

Figure 3.12 R amplitude by age in lead V1, each curve corresponding to the indicated percentile level (• = mean). R waves amplitude in V1 declines strikingly then gradually from birth to adolescence. An R wave in V1 of 16.5 mm can be normal in term newborns.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.65	1.51	1.51	1.35	1.00	1.25	1.17	0.92	0.78	0.77	0.68	0.74
Mean	**0.92**	**0.86**	**0.92**	**0.78**	**0.60**	**0.61**	**0.59**	**0.52**	**0.39**	**0.38**	**0.33**	**0.32**
(±SD)	**0.37**	**0.35**	**0.32**	**0.32**	**0.24**	**0.33**	**0.32**	**0.27**	**0.21**	**0.20**	**0.17**	**0.22**
5%	0.39	0.35	0.44	0.33	0.26	0.16	0.20	0.16	0.12	0.08	0.09	0.06
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.13

R amplitude by age in lead V2

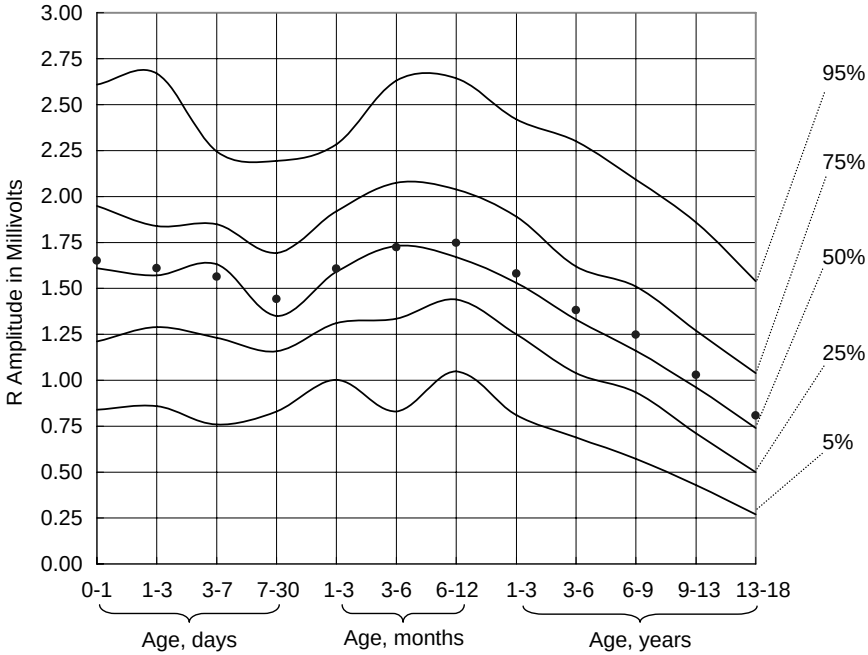

Figure 3.13 R amplitude by age in lead V2, each curve corresponding to the indicated percentile level (• = mean). R waves in V2 are most prominent. The amplitude can be high, up to 26.7 mm, after birth. It decreases strikingly with increasing age throughout early childhood to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	2.61	2.67	2.25	2.19	2.28	2.63	2.64	2.42	2.30	2.09	1.86	1.54
Mean	**1.65**	**1.61**	**1.56**	**1.44**	**1.61**	**1.72**	**1.75**	**1.58**	**1.38**	**1.25**	**1.03**	**0.81**
(±SD)	**0.53**	**0.52**	**0.45**	**0.43**	**0.42**	**0.55**	**0.50**	**0.49**	**0.47**	**0.50**	**0.43**	**0.40**
5%	0.84	0.86	0.76	0.83	1.00	0.83	1.05	0.81	0.69	0.57	0.43	0.27
(N)	109	128	95	100	113	91	97	113	107	99	289	510

R amplitude by age in lead V4

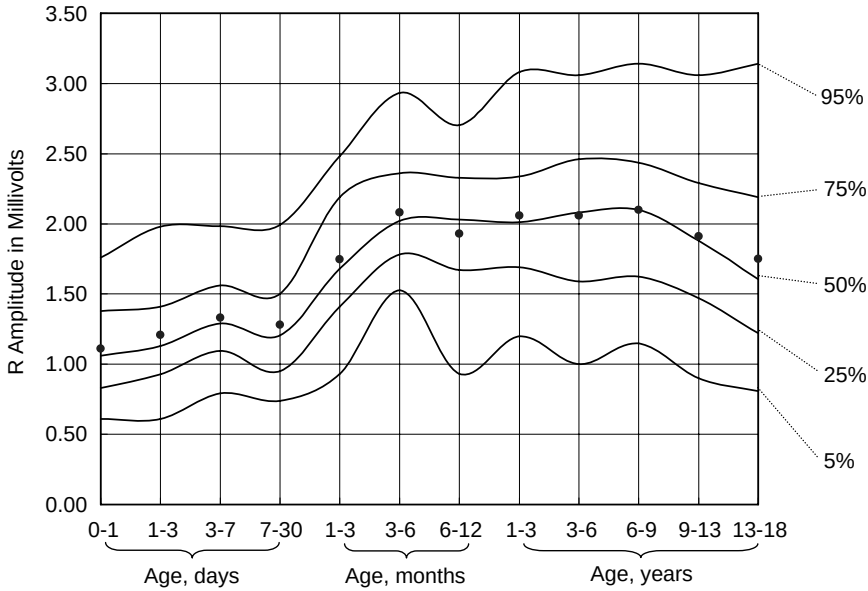

Figure 3.14 R amplitude by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). The R wave amplitude in V4 increases strikingly after age 1–3 months, reaching a plateau by age 6–12 months, and starts to decline by age 9–13 years and thereafter.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.76	1.98	1.98	1.99	2.48	2.94	2.70	3.08	3.06	3.14	3.06	3.14
Mean	**1.11**	**1.21**	**1.33**	**1.28**	**1.75**	**2.08**	**1.93**	**2.06**	**2.06**	**2.10**	**1.91**	**1.75**
(±SD)	**0.37**	**0.40**	**0.39**	**0.44**	**0.51**	**0.50**	**0.60**	**0.54**	**0.63**	**0.63**	**0.69**	**0.73**
5%	0.61	0.61	0.79	0.74	0.93	1.53	0.93	1.20	1.00	1.15	0.90	0.81
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.15

R amplitude by age in lead V5

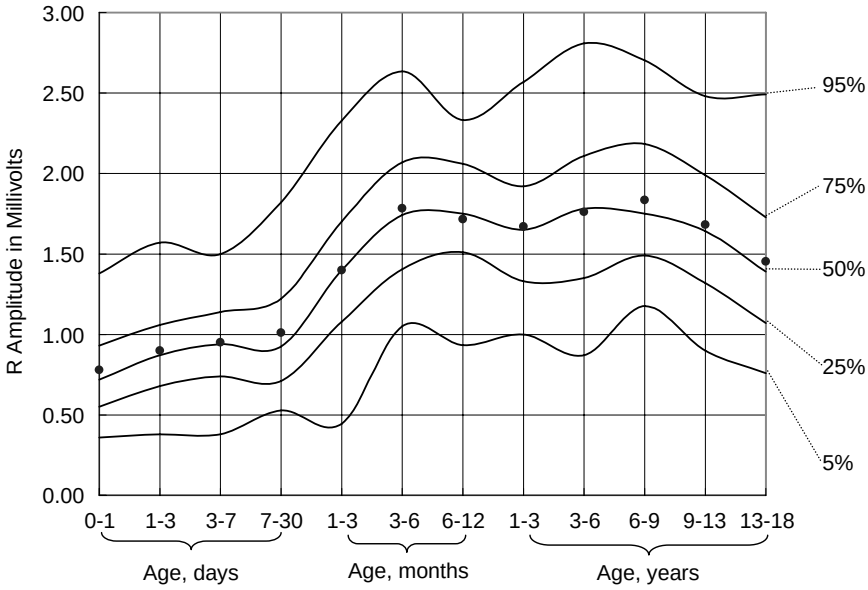

Figure 3.15 R amplitude by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). The amplitude of R wave in V5 strikingly increases at age 1–3 months, reaching a plateau by age 3–6 months, and starts declining by age 9–13 years and thereafter. The normal highest amplitude can be up to 28.1 mm at age 3–6 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.38	1.57	1.50	1.82	2.33	2.64	2.33	2.57	2.81	2.70	2.48	2.49
Mean	**0.78**	**0.9**	**0.95**	**1.01**	**1.40**	**1.78**	**1.72**	**1.67**	**1.76**	**1.84**	**1.68**	**1.45**
(±SD)	**0.32**	**0.35**	**0.33**	**0.42**	**0.54**	**0.49**	**0.44**	**0.49**	**0.58**	**0.51**	**0.52**	**0.53**
5%	0.36	0.38	0.38	0.53	0.44	1.05	0.93	1.00	0.87	1.18	0.90	0.76
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.16

R amplitude by age in lead V6

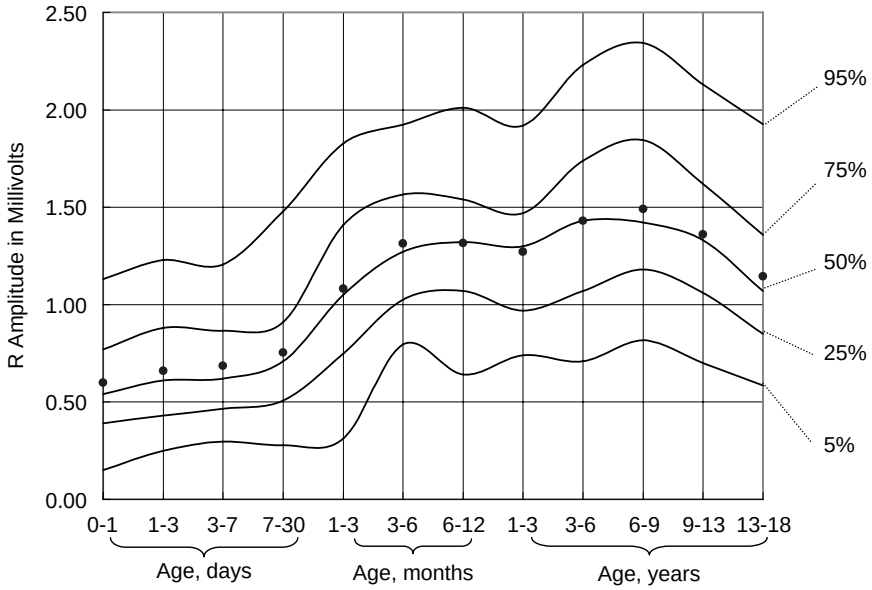

Figure 3.16 R amplitude by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). A typical progression of R amplitude changes from birth to adolescence is seen here. The R amplitude in V6 increases gradually after birth, rapidly from age 1–3 months, reaching a plateau by age 3–6 months, increases again from 3–6 years up to 6–9 years of age, followed by a decrease at 9–13 years until 13–18 years of age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.13	1.23	1.21	1.48	1.83	1.93	2.01	1.92	2.23	2.34	2.13	1.93
Mean	**0.6**	**0.66**	**0.69**	**0.75**	**1.08**	**1.31**	**1.32**	**1.27**	**1.43**	**1.49**	**1.36**	**1.15**
(±SD)	**0.32**	**0.29**	**0.30**	**0.35**	**0.46**	**0.38**	**0.41**	**0.38**	**0.47**	**0.49**	**0.43**	**0.41**
5%	0.15	0.25	0.30	0.28	0.31	0.80	0.64	0.74	0.71	0.82	0.70	0.58
(N)	109	128	95	100	113	91	97	113	107	99	289	510

S amplitude by age in lead I

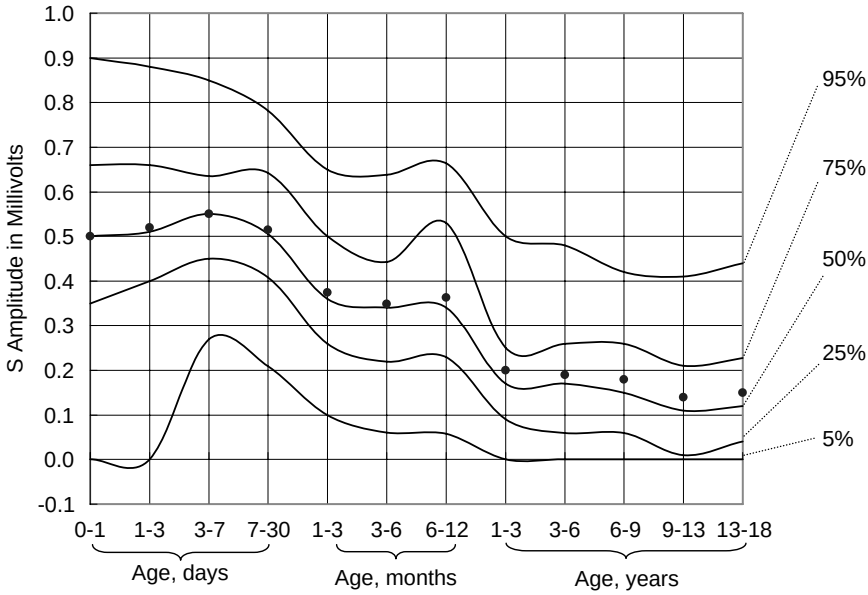

Figure 3.17 S amplitude by age in lead I, each curve corresponding to the indicated percentile level (• = mean). S waves in lead I are prominent after birth. The S wave deflection becomes shallow after age 7–30 days, becoming smaller or absent after age 1–3 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.9	0.9	0.8	0.8	0.7	0.6	0.7	0.5	0.5	0.4	0.4	0.4
Mean	**0.5**	**0.52**	**0.55**	**0.51**	**0.37**	**0.35**	**0.36**	**0.2**	**0.19**	**0.18**	**0.14**	**0.15**
(±SD)	**0.27**	**0.23**	**0.17**	**0.19**	**0.17**	**0.20**	**0.20**	**0.16**	**0.16**	**0.15**	**0.17**	**0.14**
5%	0.0	0.0	0.3	0.2	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead II

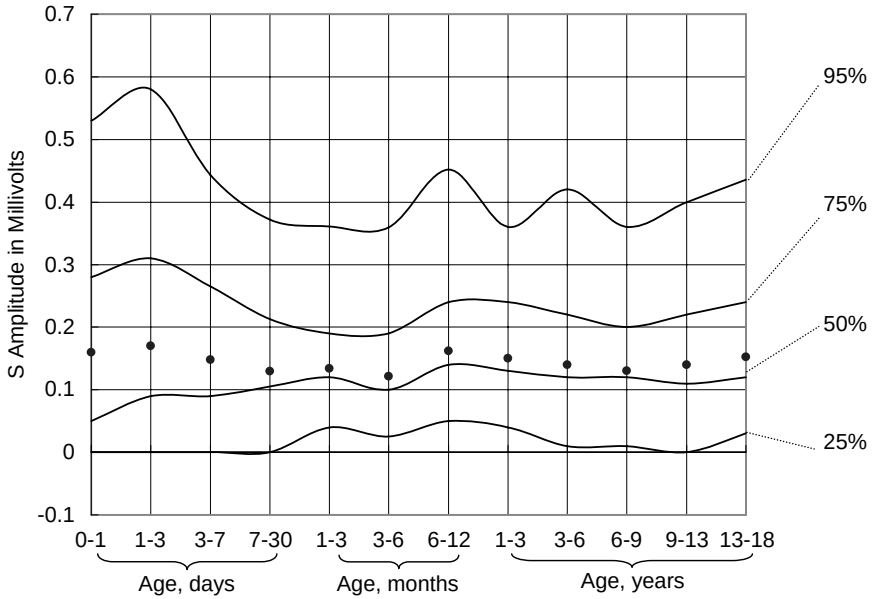

Figure 3.18 S amplitude by age in lead II, each curve corresponding to the indicated percentile level (• = mean). S waves in II are relatively shallow or absent, and change little during the entire pediatric ages.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.53	0.58	0.44	0.37	0.36	0.36	0.45	0.36	0.42	0.36	0.40	0.44
Mean	**0.16**	**0.17**	**0.15**	**0.13**	**0.13**	**0.12**	**0.16**	**0.15**	**0.14**	**0.13**	**0.14**	**0.15**
(±SD)	**0.21**	**0.17**	**0.17**	**0.14**	**0.12**	**0.12**	**0.14**	**0.11**	**0.16**	**0.10**	**0.17**	**0.15**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.19

S amplitude by age in lead III

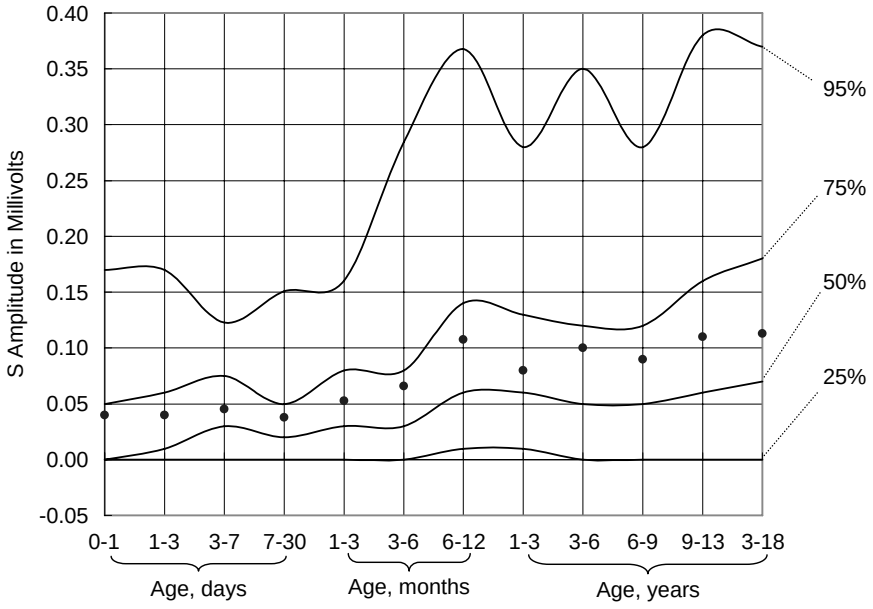

Figure 3.19 S amplitude by age in lead III, each curve corresponding to the indicated percentile level (• = mean). S waves in lead III are shallow or absent after birth, becoming more prominent after age 3–6 months, reaching the adult pattern by age 9–13 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.17	0.17	0.12	0.15	0.16	0.28	0.37	0.28	0.35	0.28	0.38	0.37
Mean	**0.04**	**0.04**	**0.05**	**0.04**	**0.05**	**0.07**	**0.11**	**0.08**	**0.1**	**0.09**	**0.11**	**0.11**
(±SD)	**0.05**	**0.06**	**0.05**	**0.06**	**0.06**	**0.11**	**0.14**	**0.11**	**0.16**	**0.10**	**0.09**	**0.13**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead aVL

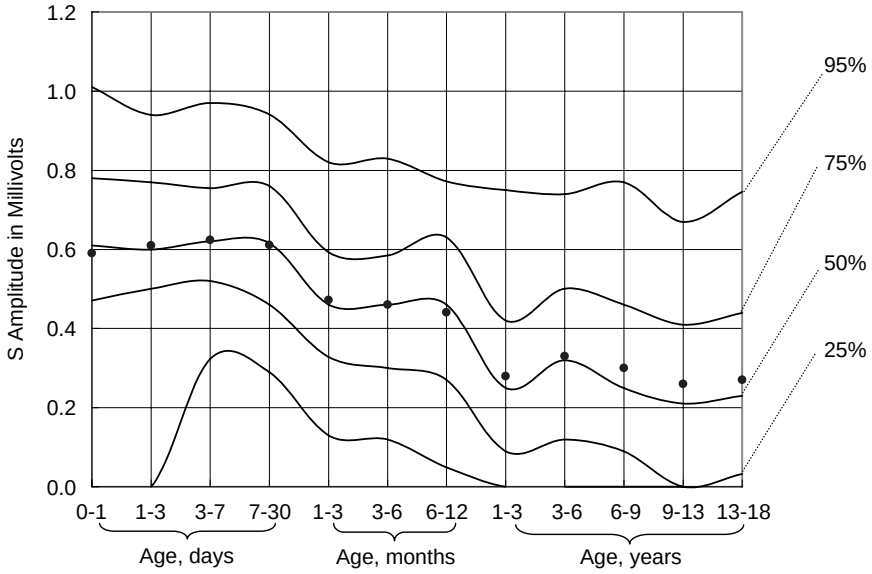

Figure 3.20 S amplitude by age in lead aVL, each curve corresponding to the indicated percentile level (• = mean). S waves in aVL can be deep or absent during the neonatal period. The S deflection decreases gradually and steadily after age 7–3 days, becoming adult pattern by 9–13 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.0	0.9	1.0	0.9	0.8	0.8	0.8	0.8	0.7	0.8	0.7	0.7
Mean	**0.59**	**0.61**	**0.62**	**0.61**	**0.47**	**0.46**	**0.44**	**0.28**	**0.33**	**0.3**	**0.26**	**0.27**
(±SD)	**0.27**	**0.23**	**0.21**	**0.21**	**0.21**	**0.23**	**0.24**	**0.22**	**0.26**	**0.26**	**0.26**	**0.25**
5%	0.0	0.0	0.3	0.3	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.21

S amplitude by age in lead aVF

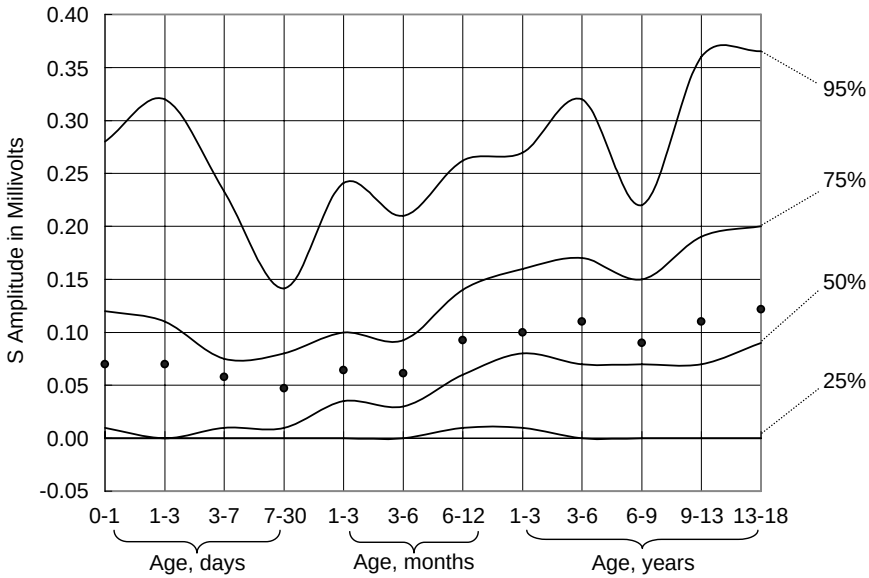

Figure 3.21 S amplitude by age in lead aVF, each curve corresponding to the indicated percentile level (• = mean). S waves in aVF are small or absent. The S amplitude increases little, however, after age 1–3 months until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.28	0.32	0.23	0.14	0.24	0.21	0.26	0.27	0.32	0.22	0.36	0.37
Mean	**0.07**	**0.07**	**0.06**	**0.05**	**0.06**	**0.06**	**0.09**	**0.1**	**0.11**	**0.09**	**0.11**	**0.12**
(±SD)	**0.11**	**0.12**	**0.09**	**0.07**	**0.08**	**0.08**	**0.10**	**0.11**	**0.11**	**0.10**	**0.09**	**0.13**
5%	0	0	0	0	0	0	0	0	0	0	0	0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead V1

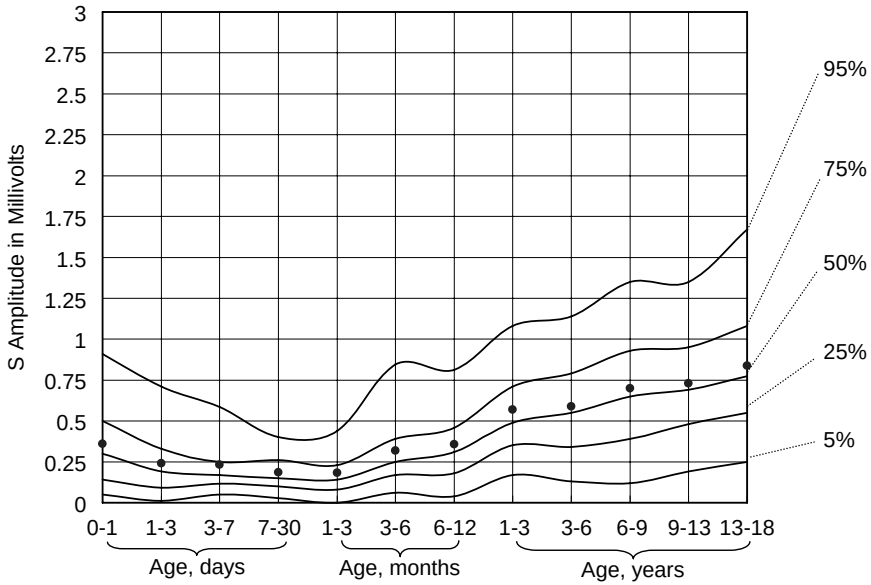

Figure 3.22 S amplitude by age in lead V1, each curve corresponding to the indicated percentile level (• = mean). S waves in lead V1 are small or absent after birth, increasing their depth little during infancy, then are more prominent thereafter until age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.91	0.71	0.59	0.40	0.44	0.85	0.81	1.08	1.14	1.35	1.35	1.67
Mean	**0.36**	**0.24**	**0.23**	**0.19**	**0.18**	**0.32**	**0.36**	**0.57**	**0.59**	**0.7**	**0.73**	**0.84**
(±SD)	**0.32**	**0.17**	**0.21**	**0.14**	**0.16**	**0.23**	**0.28**	**0.33**	**0.32**	**0.41**	**0.35**	**0.44**
5%	0.1	0.0	0.1	0.0	0.0	0.1	0.0	0.2	0.1	0.1	0.2	0.2
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead V2

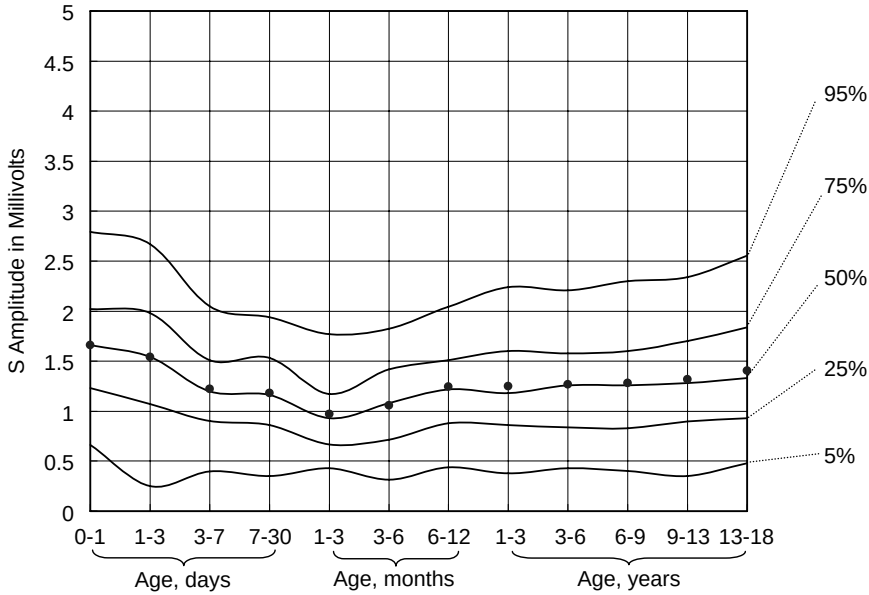

Figure 3.23 S amplitude by age in lead V2, each curve corresponding to the indicated percentile level (• = mean). S waves deflection in V2 decreases slightly after birth until age 1–3 months. From this age on, the deflection increases, but very little, until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	2.79	2.67	2.05	1.94	1.77	1.83	2.04	2.24	2.21	2.30	2.34	2.56
Mean	**1.66**	**1.54**	**1.22**	**1.18**	**0.97**	**1.06**	**1.25**	**1.25**	**1.27**	**1.28**	**1.32**	**1.41**
(±SD)	**0.59**	**0.69**	**0.47**	**0.49**	**0.41**	**0.48**	**0.57**	**0.60**	**0.63**	**0.56**	**0.61**	**0.64**
5%	0.66	0.25	0.40	0.35	0.43	0.32	0.44	0.38	0.43	0.40	0.35	0.48
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead V4

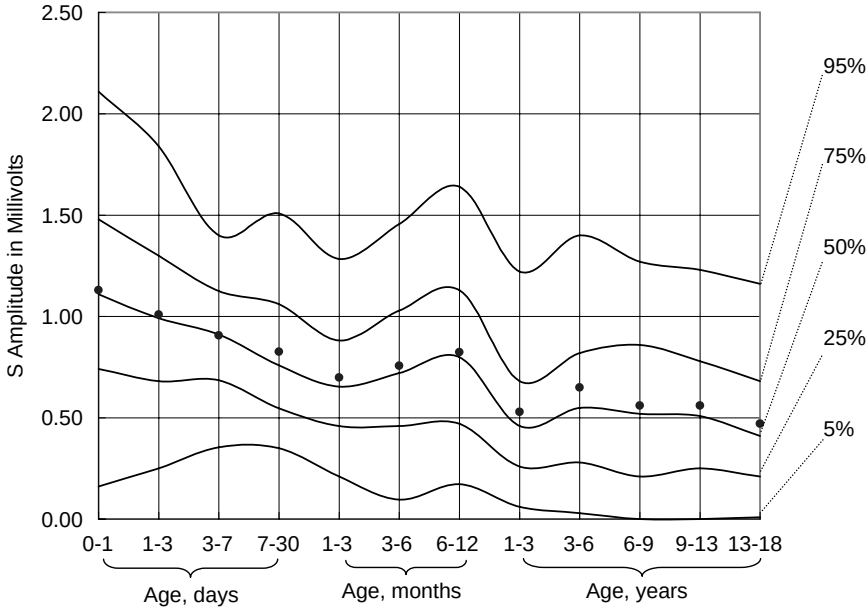

Figure 3.24 S amplitude by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). S waves in V4 are prominent after birth, and become shallower and less prominent thereafter until age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	2.11	1.84	1.40	1.51	1.28	1.46	1.64	1.22	1.40	1.27	1.23	1.16
Mean	**1.13**	**1.01**	**0.91**	**0.83**	**0.70**	**0.76**	**0.82**	**0.53**	**0.65**	**0.56**	**0.56**	**0.47**
(±SD)	**0.59**	**0.46**	**0.37**	**0.36**	**0.34**	**0.47**	**0.49**	**0.38**	**0.58**	**0.41**	**0.43**	**0.35**
5%	0.16	0.25	0.35	0.35	0.21	0.10	0.17	0.06	0.03	0.00	0.00	0.01
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.25

S amplitude by age in lead V5

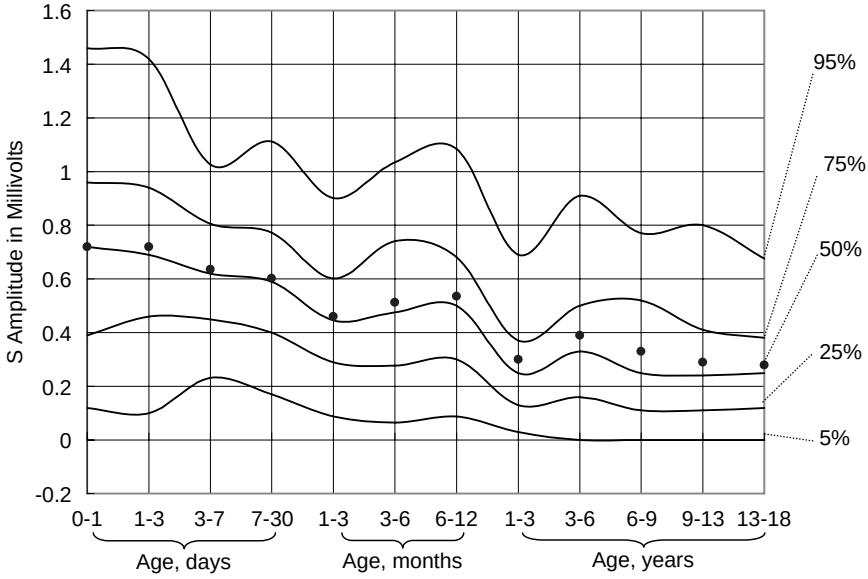

Figure 3.25 S amplitude by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). S waves are present after birth, becoming shallower gradually thereafter until adolescence. The changing patterns are quite comparable to those of lead V4.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.46	1.42	1.03	1.11	0.90	1.03	1.08	0.69	0.91	0.77	0.80	0.68
Mean	**0.72**	**0.72**	**0.63**	**0.60**	**0.46**	**0.51**	**0.53**	**0.3**	**0.39**	**0.33**	**0.29**	**0.28**
(±SD)	**0.43**	**0.40**	**0.28**	**0.28**	**0.25**	**0.35**	**0.33**	**0.22**	**0.37**	**0.26**	**0.26**	**0.22**
5%	0.12	0.10	0.23	0.17	0.09	0.07	0.09	0.03	0.00	0.00	0.00	0.00
(N)	109	128	95	100	120	92	97	113	107	100	289	510

S amplitude by age in lead V6

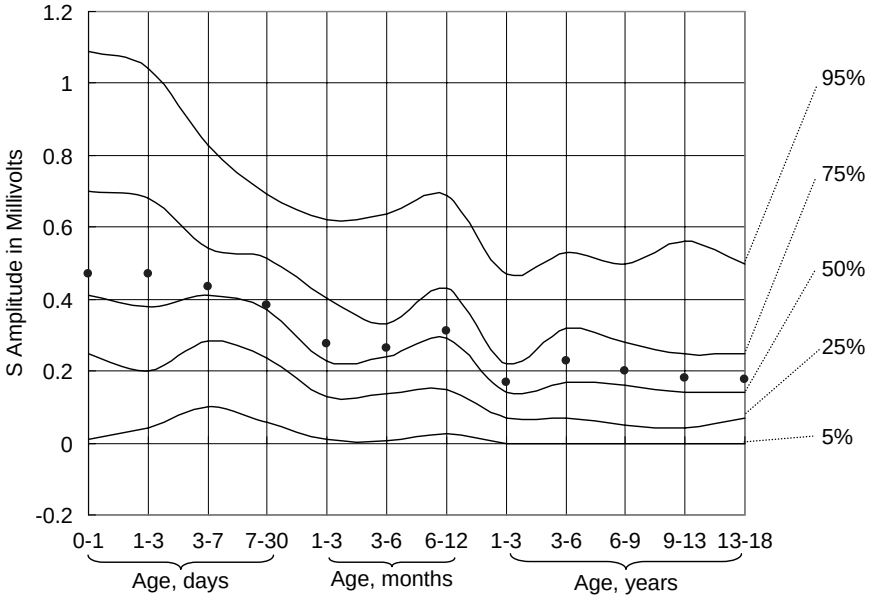

Figure 3.26 S amplitude by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). S waves in V6 are prominent after birth, and their amplitude decreases gradually along with increasing age until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.09	1.04	0.83	0.69	0.62	0.64	0.69	0.47	0.53	0.50	0.56	0.50
Mean	**0.47**	**0.47**	**0.43**	**0.38**	**0.27**	**0.26**	**0.31**	**0.17**	**0.23**	**0.2**	**0.18**	**0.18**
(±SD)	**0.32**	**0.35**	**0.23**	**0.21**	**0.20**	**0.21**	**0.23**	**0.16**	**0.26**	**0.15**	**0.17**	**0.16**
5%	0.01	0.04	0.10	0.06	0.01	0.01	0.03	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	120	92	97	113	107	100	289	510

T amplitude by age in lead I

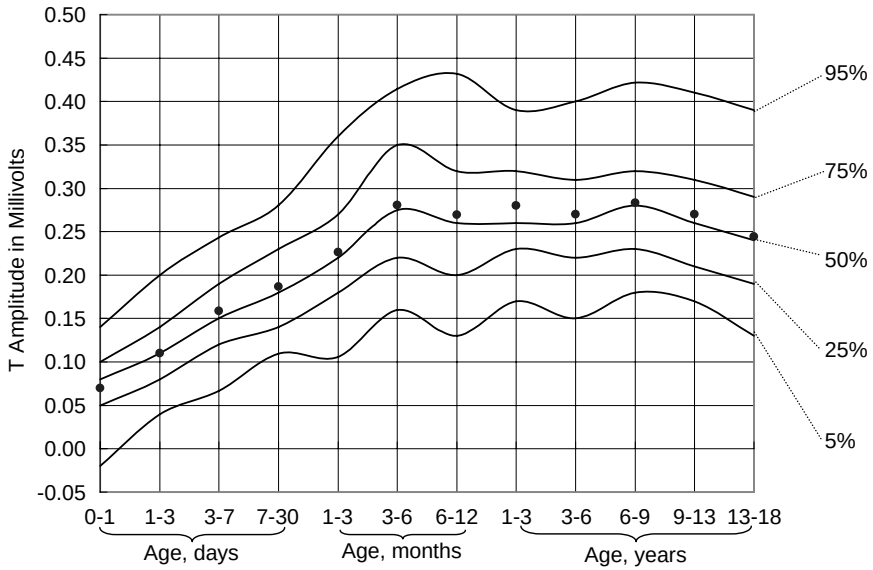

Figure 3.27 T amplitude by age in lead I, each curve corresponding to the indicated percentile level (• = mean). T waves in lead I are small, absent, or even negative, shortly after birth and their amplitude increases gradually, reaching a plateau by age 3–6 months, and stays little changed until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.14	0.20	0.24	0.28	0.36	0.41	0.43	0.39	0.40	0.42	0.41	0.39
Mean	**0.07**	**0.11**	**0.16**	**0.19**	**0.23**	**0.28**	**0.27**	**0.28**	**0.27**	**0.28**	**0.27**	**0.24**
(±SD)	**0.05**	**0.06**	**0.07**	**0.06**	**0.07**	**0.08**	**0.10**	**0.05**	**0.05**	**0.08**	**0.09**	**0.08**
5%	−0.02	0.04	0.07	0.11	0.11	0.16	0.13	0.17	0.15	0.18	0.17	0.13
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.28

T amplitude by age in lead II

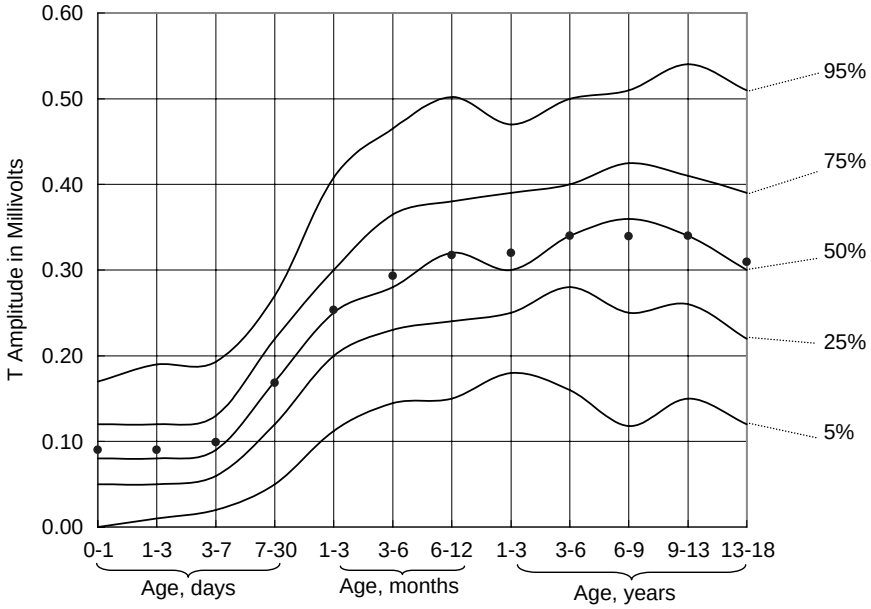

Figure 3.28 T amplitude by age in lead II, each curve corresponding to the indicated percentile level (• = mean). T waves are small after birth. The T waves amplitude increases rapidly after age 3–7 days to age 3–6 months, then gradually thereafter up to 3–6 years of age. It decreases slightly after age 9–13 years until age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.17	0.19	0.19	0.27	0.41	0.47	0.50	0.47	0.50	0.51	0.54	0.51
Mean	**0.09**	**0.09**	**0.10**	**0.17**	**0.25**	**0.29**	**0.32**	**0.32**	**0.34**	**0.34**	**0.34**	**0.31**
(±SD)	**0.05**	**0.06**	**0.06**	**0.07**	**0.09**	**0.11**	**0.12**	**0.11**	**0.11**	**0.12**	**0.09**	**0.12**
5%	0.00	0.01	0.02	0.05	0.11	0.15	0.15	0.18	0.16	0.12	0.15	0.12
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 3.29

T amplitude by age in lead III

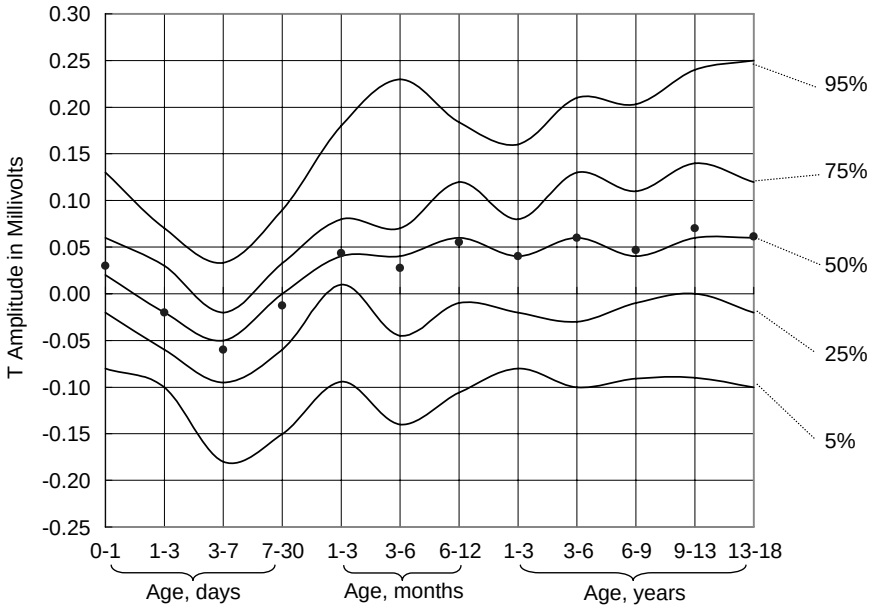

Figure 3.29 T amplitude by age in lead III, each curve corresponding to the indicated percentile level (• = mean). T waves changes in lead III during the newborn period are very characteristic. The T amplitude decreases even becomes negative, reaching a nadir at age 3–7 days. It increases thereafter, up to a plateau by age 6–12 months until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.13	0.07	0.03	0.09	0.18	0.23	0.18	0.16	0.21	0.20	0.24	0.25
Mean	**0.03**	**−0.02**	**−0.06**	**−0.01**	**0.04**	**0.03**	**0.06**	**0.04**	**0.06**	**0.05**	**0.07**	**0.06**
(±SD)	**0.05**	**0.06**	**0.07**	**0.07**	**0.07**	**0.11**	**0.09**	**0.05**	**0.11**	**0.10**	**0.09**	**0.11**
5%	−0.08	−0.10	−0.18	−0.15	−0.09	−0.14	−0.11	−0.08	−0.10	−0.09	−0.09	−0.10
(N)	109	128	95	100	113	91	97	113	107	99	289	510

T amplitude by age in lead aVR

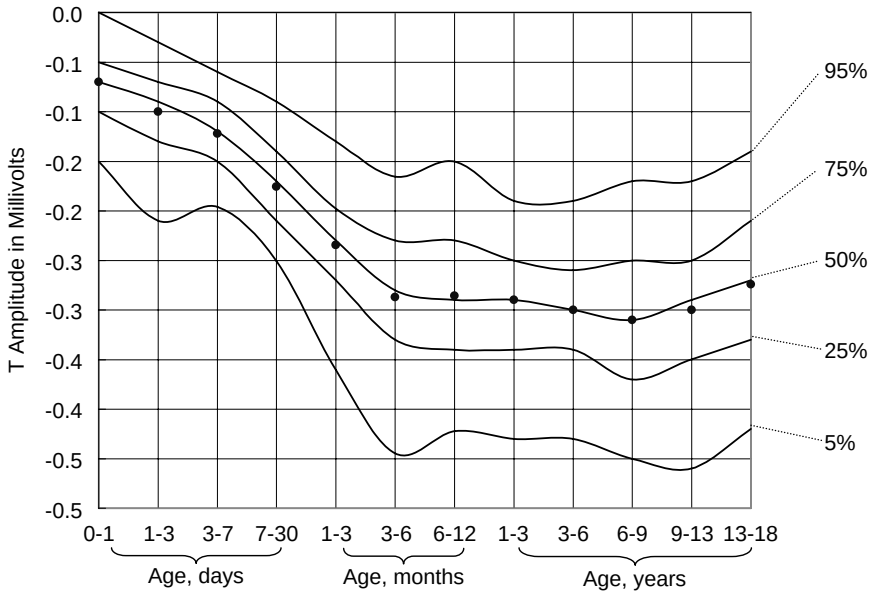

Figure 3.30 T amplitude by age in lead aVR, each curve corresponding to the indicated percentile level (• = mean). The T waves in lead aVR are always inverted. The depth of the T waves steadily increases after birth until age 3–6 months, and stays unchanged afterward until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.0	0.0	−0.1	−0.1	−0.1	−0.2	−0.2	−0.2	−0.2	−0.2	−0.2	−0.1
Mean	**−0.07**	**−0.1**	**−0.12**	**−0.18**	**−0.23**	**−0.29**	**−0.29**	**−0.29**	**−0.3**	**−0.31**	**−0.3**	**−0.27**
(±SD)	**0.05**	**0.06**	**0.05**	**0.05**	**0.07**	**0.08**	**0.09**	**0.05**	**0.05**	**0.10**	**0.09**	**0.09**
5%	−0.2	−0.2	−0.2	−0.3	−0.4	−0.4	−0.4	−0.4	−0.4	−0.5	−0.5	−0.4
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.31

T amplitude by age in lead aVL

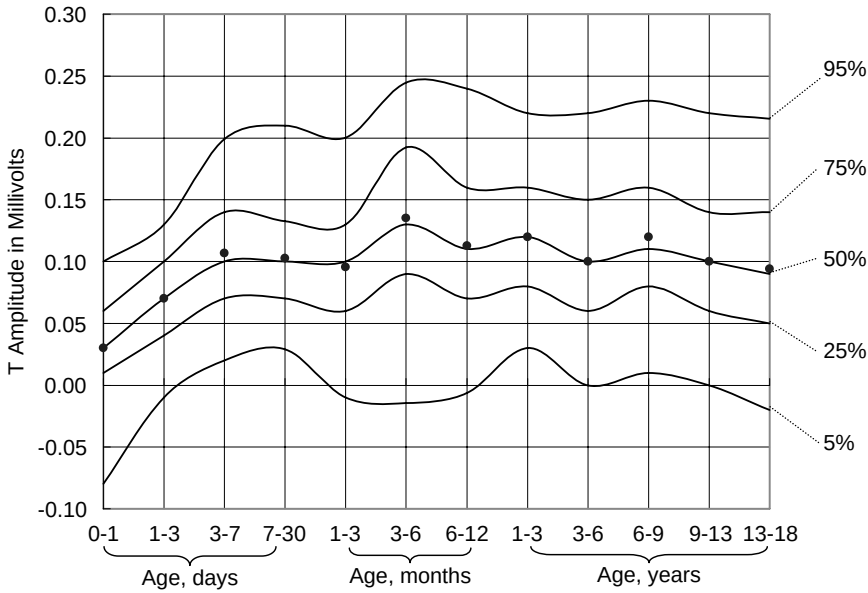

Figure 3.31 T amplitude by age in lead aVL, each curve corresponding to the indicated percentile level (• = mean). The T waves amplitude in aVL increases after birth reaching a plateau at age 3–7 days, then increases slightly with a wider range, at age 3–6 months and thereafter.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.10	0.13	0.20	0.21	0.20	0.24	0.24	0.22	0.22	0.23	0.22	0.22
Mean	**0.03**	**0.07**	**0.11**	**0.10**	**0.10**	**0.14**	**0.11**	**0.12**	**0.1**	**0.12**	**0.1**	**0.09**
(±SD)	**0.05**	**0.06**	**0.06**	**0.05**	**0.07**	**0.08**	**0.08**	**0.05**	**0.05**	**0.05**	**0.09**	**0.07**
5%	−0.08	−0.01	0.02	0.03	−0.01	−0.01	−0.01	0.03	0.00	0.01	0.00	−0.02
(N)	109	128	95	100	120	92	97	113	107	100	289	510

T amplitude by age in lead aVF

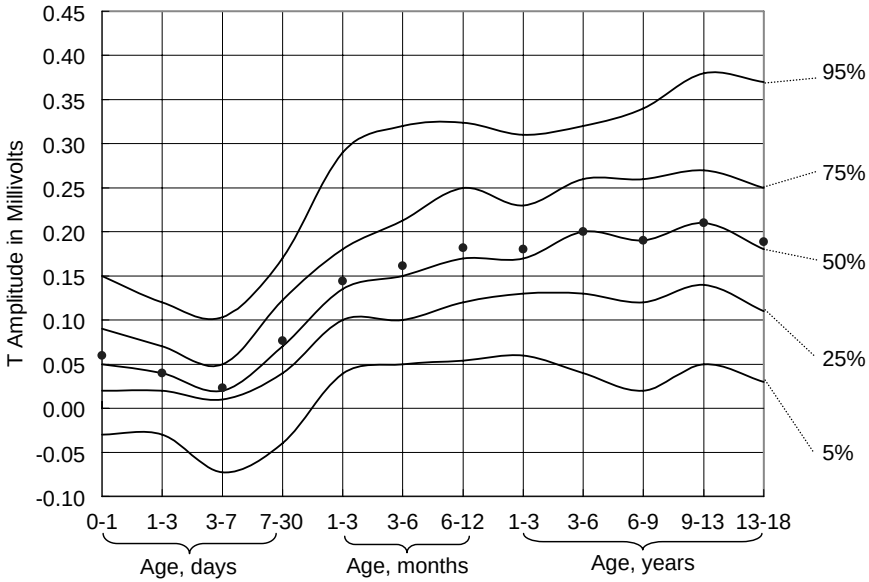

Figure 3.32 T amplitude by age in lead aVF, each curve corresponding to the indicated percentile level (• = mean). The T waves in aVF are low, flat or inverted at birth. The T waves amplitude decreases during the first days of life, followed by a rapid increase until age 1–3 months, then steady and gradual increase until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.15	0.12	0.10	0.17	0.29	0.32	0.32	0.31	0.32	0.34	0.38	0.37
Mean	**0.06**	**0.04**	**0.02**	**0.08**	**0.14**	**0.16**	**0.18**	**0.18**	**0.2**	**0.19**	**0.21**	**0.19**
(±SD)	**0.05**	**0.06**	**0.06**	**0.06**	**0.07**	**0.10**	**0.09**	**0.05**	**0.11**	**0.10**	**0.09**	**0.11**
5%	−0.03	−0.03	−0.07	−0.04	0.04	0.05	0.05	0.06	0.04	0.02	0.05	0.03
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.33

T amplitude by age in lead V1

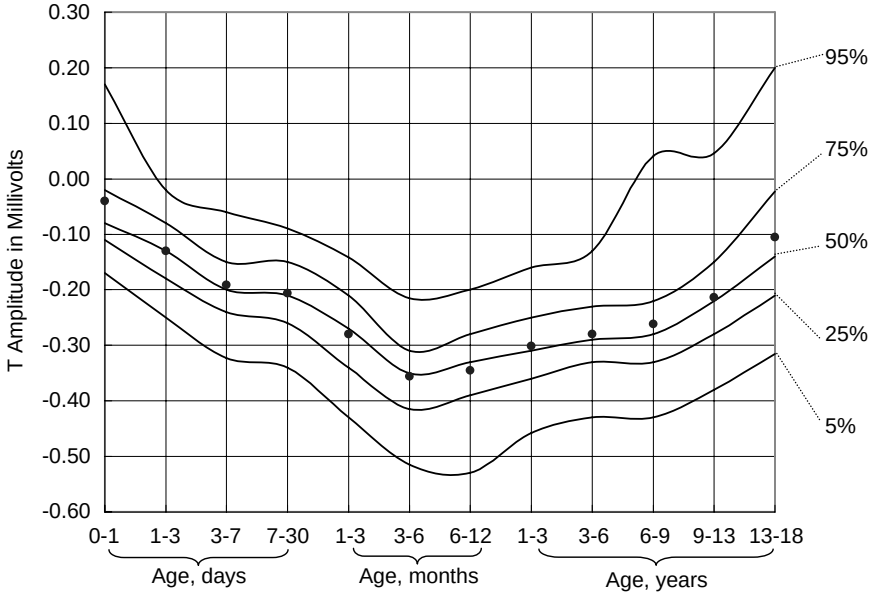

Figure 3.33 T amplitude by age in lead V1, each curve corresponding to the indicated percentile level (• = mean). T waves in V1 are characteristically upright, low or only slightly inverted during the first day of life. They all become inverted with increased depth until age 3–6 months, then turning to be less inverted or even upright thereafter along with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.17	−0.02	−0.06	−0.09	−0.14	−0.22	−0.20	−0.16	−0.13	0.04	0.05	0.20
Mean	**−0.04**	**−0.13**	**−0.19**	**−0.21**	**−0.28**	**−0.36**	**−0.35**	**−0.30**	**−0.28**	**−0.26**	**−0.21**	**−0.11**
(±SD)	**0.11**	**0.06**	**0.08**	**0.08**	**0.09**	**0.11**	**0.12**	**0.10**	**0.11**	**0.12**	**0.12**	**0.16**
5%	−0.17	−0.25	−0.32	−0.34	−0.43	−0.52	−0.53	−0.46	−0.43	−0.43	−0.38	−0.32
(N)	109	128	95	100	113	91	97	113	107	99	289	510

T amplitude by age in lead V2

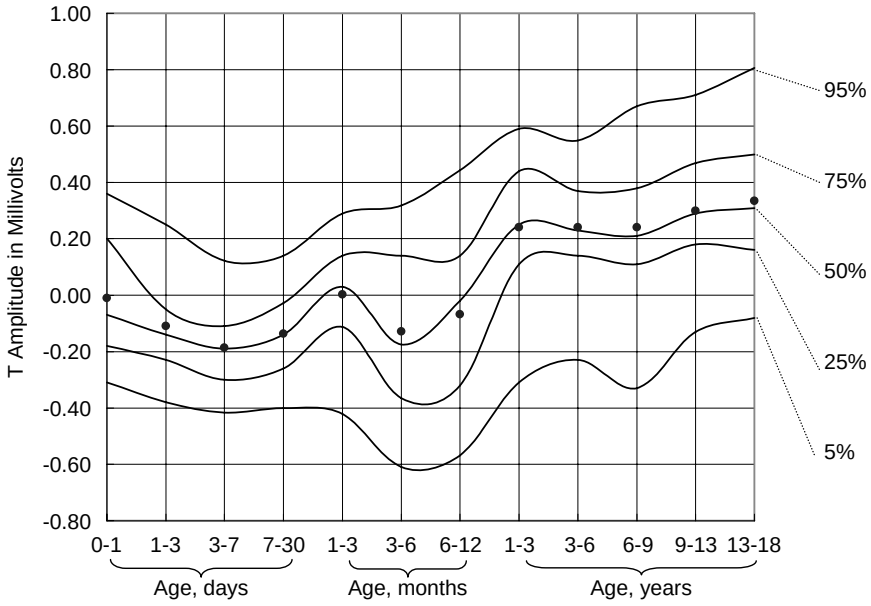

Figure 3.34 T amplitude by age in lead V2, each curve corresponding to the indicated percentile level (• = mean). T wave changes by age in lead V2 are not as spectacular and characteristic as those registered in lead V1.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.36	0.25	0.12	0.14	0.29	0.32	0.44	0.59	0.55	0.67	0.71	0.81
Mean	**−0.01**	**−0.11**	**−0.19**	**−0.14**	**0.00**	**−0.13**	**−0.07**	**0.24**	**0.24**	**0.24**	**0.3**	**0.34**
(±SD)	**0.21**	**0.17**	**0.18**	**0.17**	**0.21**	**0.32**	**0.35**	**0.27**	**0.21**	**0.26**	**0.26**	**0.26**
5%	−0.31	−0.38	−0.42	−0.40	−0.42	−0.61	−0.57	−0.31	−0.23	−0.33	−0.13	−0.08
(N)	109	128	95	100	120	92	97	113	107	100	289	510

T amplitude by age in lead V4

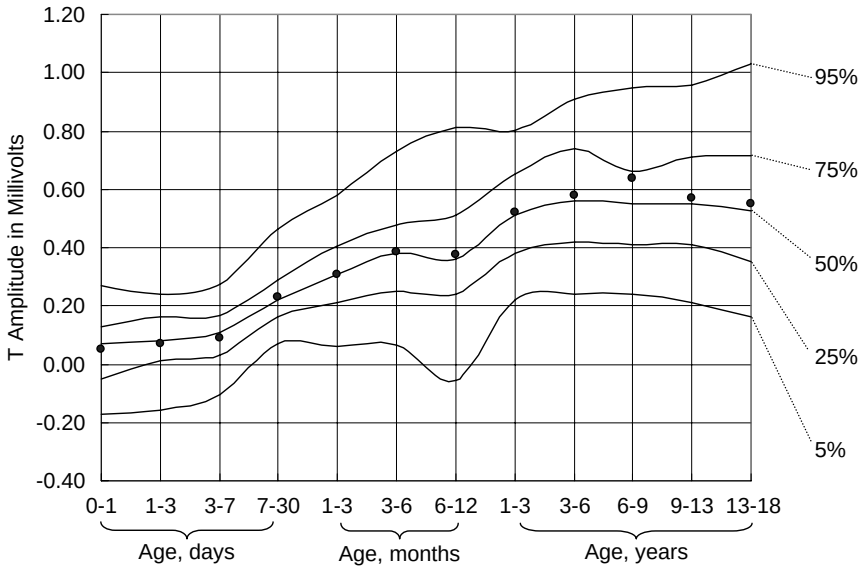

Figure 3.35 T amplitude by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). T waves registered in V4 during the first week of life are low, flat or slightly inverted. They turn upright and taller from age 7–30 days and thereafter with a wider range along with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.27	0.24	0.28	0.46	0.58	0.73	0.81	0.80	0.91	0.95	0.96	1.03
Mean	**0.05**	**0.07**	**0.09**	**0.23**	**0.31**	**0.39**	**0.37**	**0.52**	**0.58**	**0.64**	**0.57**	**0.55**
(±SD)	**0.11**	**0.12**	**0.14**	**0.12**	**0.16**	**0.22**	**0.26**	**0.16**	**0.21**	**0.87**	**0.26**	**0.28**
5%	−0.17	−0.16	−0.10	0.07	0.06	0.07	−0.06	0.22	0.24	0.24	0.21	0.16
(N)	109	128	95	100	120	92	97	113	107	100	289	510

T amplitude by age in lead V5

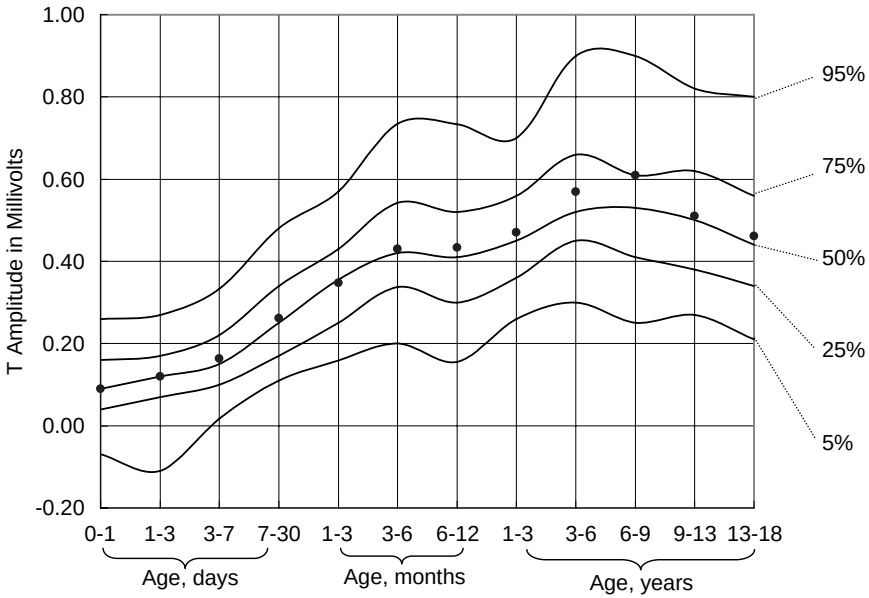

Figure 3.36 T amplitude by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). The T waves changes recorded in V5 from birth to adolescence are similar to those recorded in V4, except that the decrease of the T waves amplitude after age 9–13 years are more prominent.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.26	0.27	0.33	0.48	0.57	0.73	0.73	0.70	0.90	0.90	0.82	0.80
Mean	**0.09**	**0.12**	**0.16**	**0.26**	**0.35**	**0.43**	**0.43**	**0.47**	**0.57**	**0.61**	**0.51**	**0.46**
(±SD)	**0.11**	**0.12**	**0.11**	**0.11**	**0.14**	**0.19**	**0.18**	**0.11**	**0.16**	**0.82**	**0.17**	**0.18**
5%	−0.07	−0.11	0.02	0.11	0.16	0.20	0.16	0.26	0.30	0.25	0.27	0.21
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 3.37

T amplitude by age in lead V6

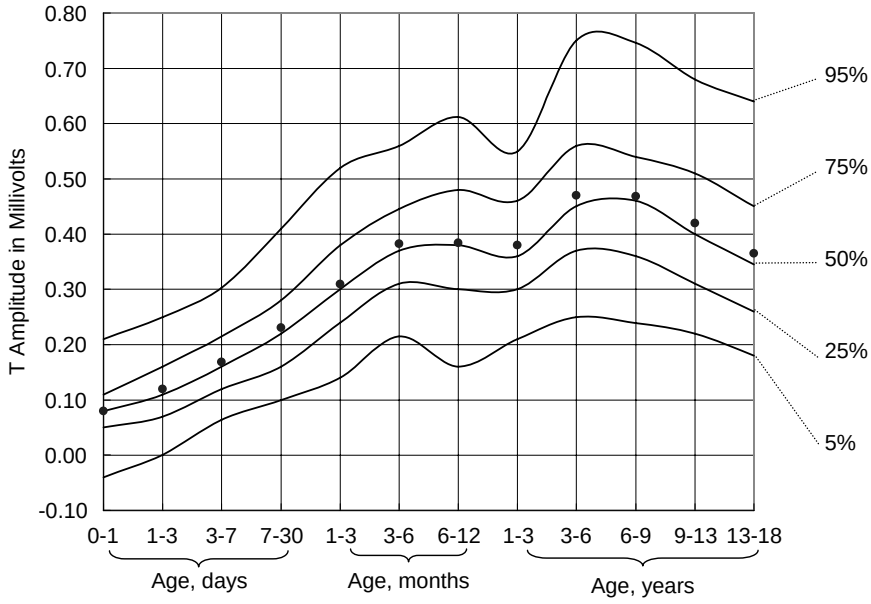

Figure 3.37 T amplitude by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). Normal T wave changes registered in lead V6 are more striking and characteristic than those registered in V5.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.21	0.25	0.30	0.41	0.52	0.56	0.61	0.55	0.75	0.75	0.68	0.64
Mean	**0.08**	**0.12**	**0.17**	**0.23**	**0.31**	**0.38**	**0.38**	**0.38**	**0.47**	**0.47**	**0.42**	**0.37**
(±SD)	**0.05**	**0.06**	**0.09**	**0.09**	**0.11**	**0.12**	**0.14**	**0.11**	**0.16**	**0.19**	**0.17**	**0.15**
5%	−0.04	0.00	0.06	0.10	0.14	0.22	0.16	0.21	0.25	0.24	0.22	0.18
(N)	109	128	95	100	113	91	97	113	107	99	289	510

PART 4

Calculated values on RS amplitude and ventricular activation time by age

CHAPTER 4.1

R/S amplitude ratio by age in lead I

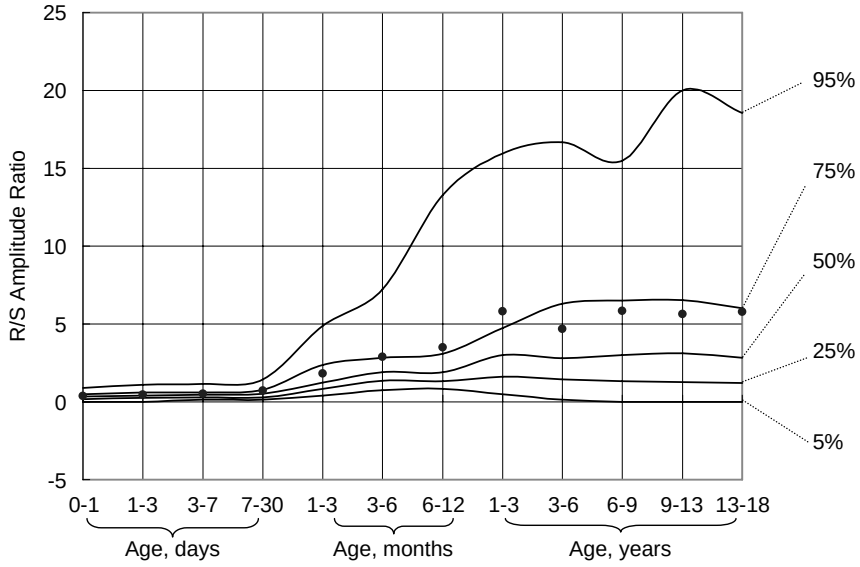

Figure 4.1 R/S amplitude ratio by age in lead I, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio of lead I is small from birth to age 7–30 days. From that age on, the ratio increases steadily and gradually with dominant R waves until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.9	1.1	1.2	1.4	4.9	7.2	13.3	16.0	16.7	15.5	20.0	18.6
Mean	**0.36**	**0.47**	**0.51**	**0.73**	**1.81**	**2.90**	**3.48**	**5.81**	**4.68**	**5.84**	**5.63**	**5.78**
(±SD)	**0.34**	**0.41**	**0.34**	**1.00**	**1.62**	**3.81**	**5.04**	**12.51**	**5.29**	**10.45**	**8.43**	**10.50**
5%	0.00	0.00	0.15	0.15	0.40	0.74	0.85	0.50	0.16	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.2

R/S amplitude ratio by age in lead II

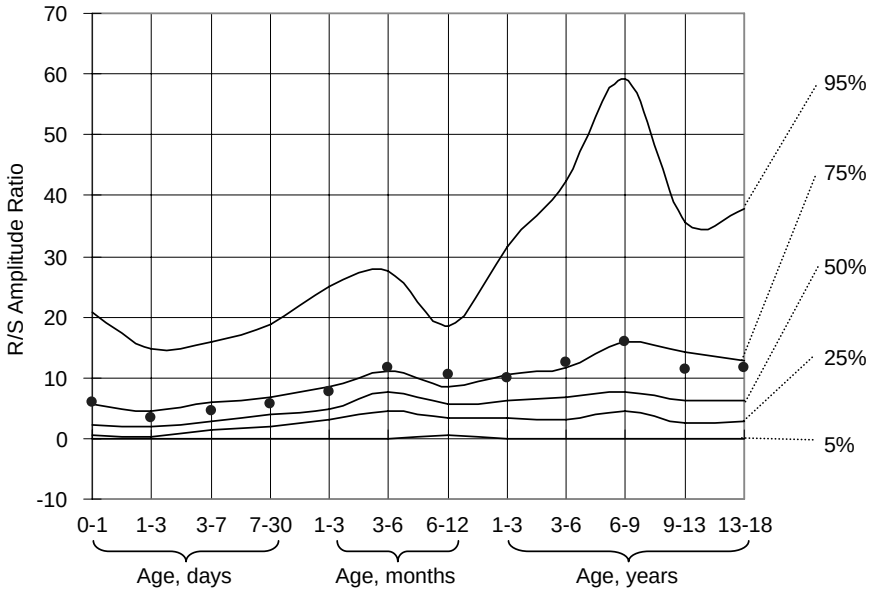

Figure 4.2 R/S amplitude ratio by age in lead II, each curve corresponding to the indicated percentile level (• = mean). The R/S ratio in II decreases slightly after birth, followed by gradual and steady increase from age 1–3 days and thereafter until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	20.67	14.67	15.82	18.68	25.02	27.46	18.50	31.66	42.33	59.10	35.50	37.89
Mean	**5.82**	**3.45**	**4.39**	**5.76**	**7.61**	**11.67**	**10.49**	**9.92**	**12.36**	**15.94**	**11.45**	**11.50**
(±SD)	**12.37**	**5.32**	**5.09**	**6.17**	**9.22**	**21.21**	**22.85**	**14.67**	**21.35**	**24.90**	**16.48**	**19.71**
5%	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.3

R/S amplitude ratio by age in lead III

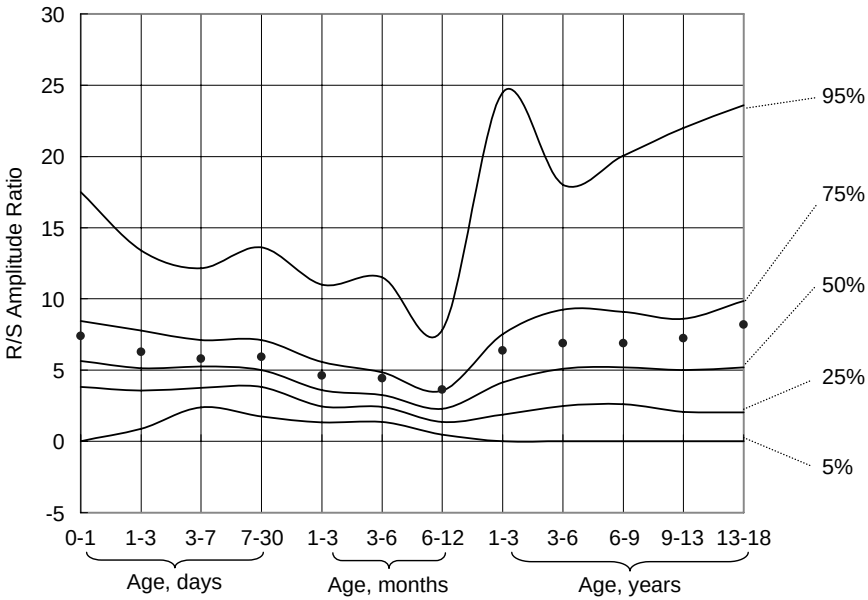

Figure 4.3 R/S amplitude ratio by age in lead III, each curve corresponding to the indicated percentile level (• = mean). Dominant R waves are registered in lead III throughout the pediatric ages.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	17.50	13.40	12.15	13.61	11.00	11.50	7.80	24.50	18.00	20.07	22.00	23.59
Mean	**7.41**	**6.30**	**5.80**	**5.94**	**4.62**	**4.45**	**3.63**	**6.39**	**6.90**	**6.89**	**7.25**	**8.19**
(±SD)	**9.17**	**4.72**	**3.08**	**3.68**	**3.28**	**4.38**	**7.88**	**7.65**	**7.12**	**6.63**	**9.76**	**12.52**
5%	0.00	0.91	2.41	1.76	1.34	1.39	0.50	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.4

R/S amplitude ratio by age in lead aVR

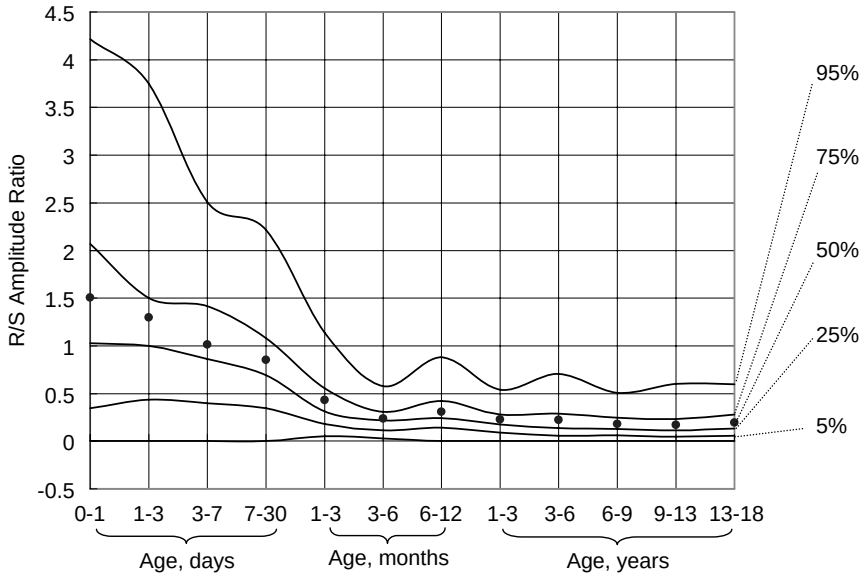

Figure 4.4 R/S amplitude ratio by age in lead aVR, each curve corresponding to the indicated percentile level (• = mean). Dominant R waves are registered in aVR from birth until age 3–6 months. The R/S ratio stays little changed thereafter until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	4.21	3.75	2.51	2.22	1.14	0.58	0.88	0.54	0.71	0.51	0.60	0.60
Mean	**1.50**	**1.30**	**1.01**	**0.85**	**0.43**	**0.24**	**0.31**	**0.23**	**0.22**	**0.18**	**0.17**	**0.20**
(±SD)	**1.67**	**1.34**	**0.83**	**0.86**	**0.48**	**0.18**	**0.24**	**0.20**	**0.27**	**0.17**	**0.18**	**0.19**
5%	0.00	0.00	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.5

R/S amplitude ratio by age in lead aVL

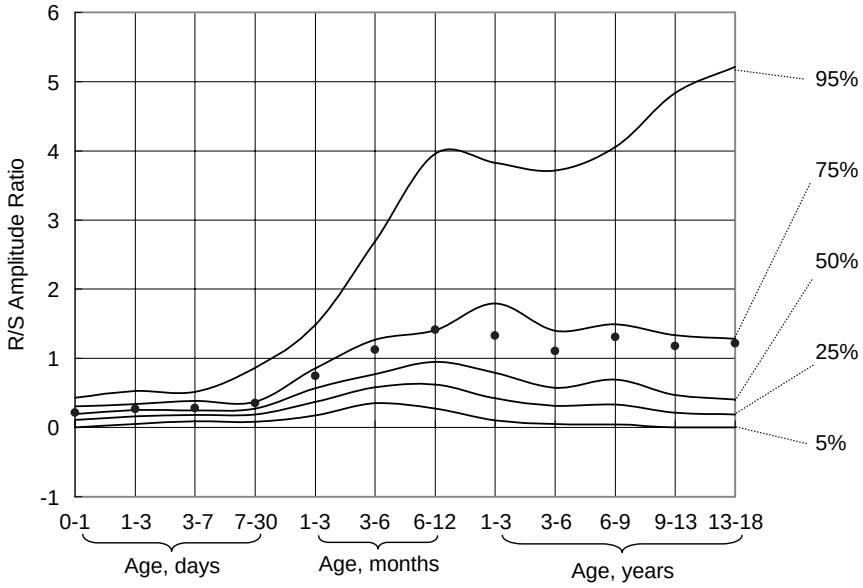

Figure 4.5 R/S amplitude ratio by age in lead aVL, each curve corresponding to the indicated percentile level (• = mean). The R/S ratio of aVL is small after birth until age 7–30 days, then increases typically with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	0.43	0.53	0.52	0.86	1.49	2.69	3.96	3.83	3.71	4.06	4.83	5.21
Mean	**0.22**	**0.27**	**0.28**	**0.35**	**0.75**	**1.13**	**1.41**	**1.33**	**1.11**	**1.31**	**1.18**	**1.22**
(±SD)	**0.13**	**0.16**	**0.14**	**0.39**	**0.71**	**1.07**	**1.85**	**1.71**	**1.39**	**2.01**	**2.01**	**2.13**
5%	0.00	0.05	0.09	0.09	0.18	0.36	0.28	0.11	0.05	0.05	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.6

R/S amplitude ratio by age in lead aVF

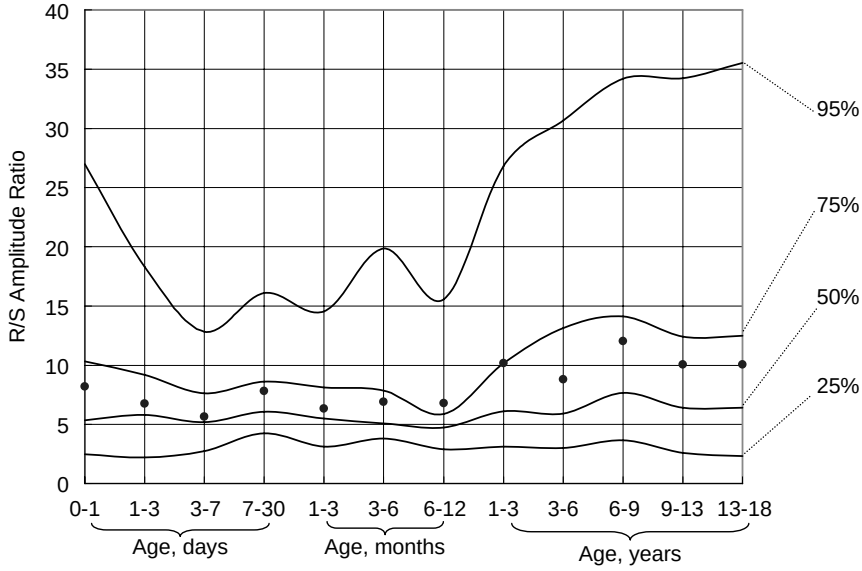

Figure 4.6 R/S amplitude ratio by age in lead aVF, each curve corresponding to the indicated percentile level (• = mean). The R waves in aVF stay dominant through birth to adolescence. The R/S ratio increases substantially after age 6–12 months until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	27.00	18.29	12.83	16.08	14.52	19.85	15.56	26.85	30.67	34.20	34.25	35.53
Mean	**8.20**	**6.77**	**5.66**	**7.84**	**6.36**	**6.91**	**6.79**	**10.17**	**8.80**	**12.03**	**10.07**	**10.07**
(±SD)	**10.81**	**6.73**	**5.98**	**10.38**	**6.14**	**8.08**	**12.44**	**17.53**	**8.82**	**16.35**	**14.70**	**14.30**
5%	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.7

R/S amplitude ratio by age in lead V1

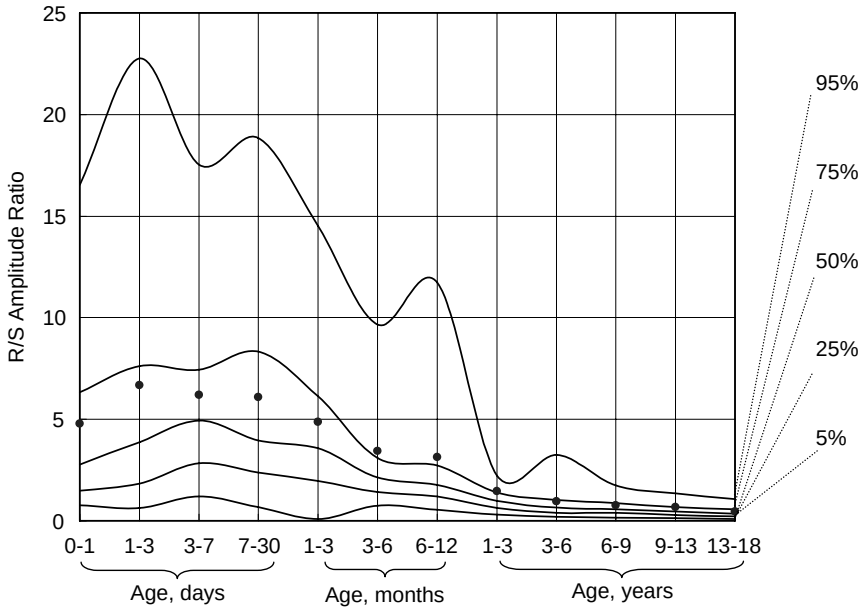

Figure 4.7 R/S amplitude ratio by age in lead V1, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio in V1 reflects the structural changes of the heart occurring from birth to adolescence. The ratio increases slightly after birth, then decreases strikingly throughout infancy, childhood and adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	16.55	22.75	17.53	18.83	14.51	9.67	11.72	2.23	3.25	1.74	1.34	1.06
Mean	**4.79**	**6.69**	**6.20**	**6.10**	**4.88**	**3.44**	**3.14**	**1.45**	**0.95**	**0.77**	**0.67**	**0.47**
(±SD)	**5.11**	**9.09**	**5.30**	**5.82**	**4.91**	**6.06**	**4.82**	**4.10**	**1.05**	**0.96**	**1.56**	**0.48**
5%	0.75	0.64	1.20	0.68	0.09	0.75	0.55	0.31	0.20	0.15	0.12	0.09
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.8

R/S amplitude ratio by age in lead V2

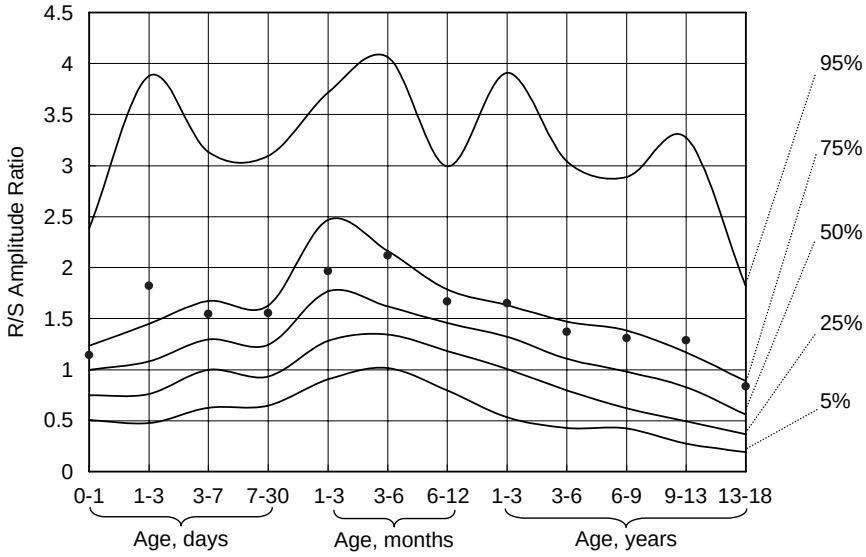

Figure 4.8 R/S amplitude ratio by age in lead V2, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio registered in V2 changes little during the entire pediatric age. R wave deflections are always dominant.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	2.39	3.88	3.14	3.10	3.71	4.06	3.00	3.91	3.04	2.89	3.28	1.82
Mean	**1.14**	**1.82**	**1.55**	**1.56**	**1.96**	**2.12**	**1.67**	**1.65**	**1.37**	**1.31**	**1.29**	**0.84**
(±SD)	**0.67**	**4.01**	**1.05**	**1.57**	**0.93**	**2.32**	**1.03**	**1.51**	**1.14**	**1.39**	**3.19**	**1.79**
5%	0.51	0.48	0.63	0.65	0.90	1.02	0.80	0.54	0.43	0.43	0.28	0.19
(N)	109	128	95	100	113	91	97	113	107	99	289	510

R/S amplitude ratio by age in lead V3

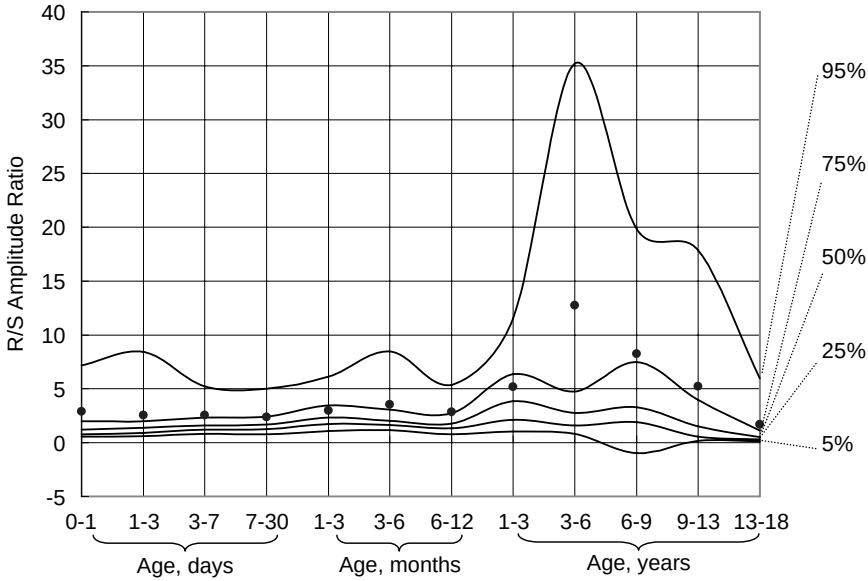

Figure 4.9 R/S amplitude ratio by age in lead V3, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio remains unchanged during infancy. It starts to increase by age 1 year and forward, followed by a decrease after age 6–9 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	7.20	8.43	5.23	5.04	6.12	8.47	5.37	11.54	35.19	19.84	17.86	5.96
Mean	**2.90**	**2.55**	**2.54**	**2.39**	**2.98**	**3.53**	**2.84**	**5.18**	**12.73**	**8.24**	**5.22**	**1.70**
(±SD)	**7.16**	**4.73**	**5.15**	**2.81**	**2.26**	**5.41**	**6.73**	**5.68**	**51.57**	**25.30**	**14.97**	**4.65**
5%	0.58	0.62	0.82	0.80	1.10	1.19	0.80	1.06	0.85	−1.00	0.17	0.14
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.10

R/S amplitude ratio by age in lead V4

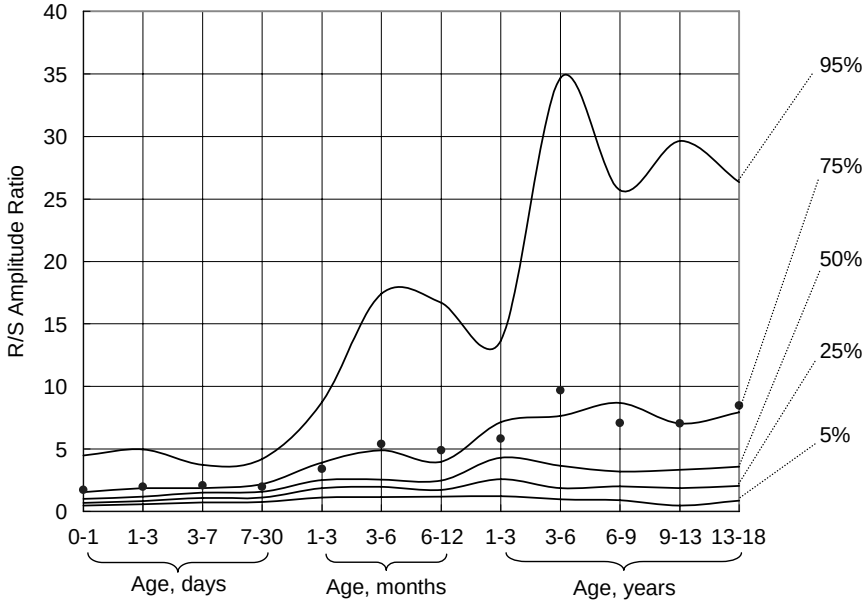

Figure 4.10 R/S amplitude ratio by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio in V4 stays unchanged after birth until age 7–30 days. From that age forward, it increases steadily until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	4.47	4.95	3.73	4.20	8.77	17.40	16.69	13.67	34.67	25.70	29.64	26.34
Mean	**1.72**	**1.95**	**2.06**	**1.98**	**3.40**	**5.38**	**4.90**	**5.84**	**9.70**	**7.09**	**7.05**	**8.46**
(±SD)	**2.88**	**3.76**	**3.70**	**2.06**	**2.79**	**7.97**	**8.92**	**5.44**	**21.99**	**11.43**	**13.00**	**19.77**
5%	0.48	0.57	0.73	0.75	1.11	1.15	1.18	1.20	0.98	0.91	0.46	0.86
(N)	109	128	95	100	113	91	97	113	107	99	289	510

R/S amplitude ratio by age in lead V5

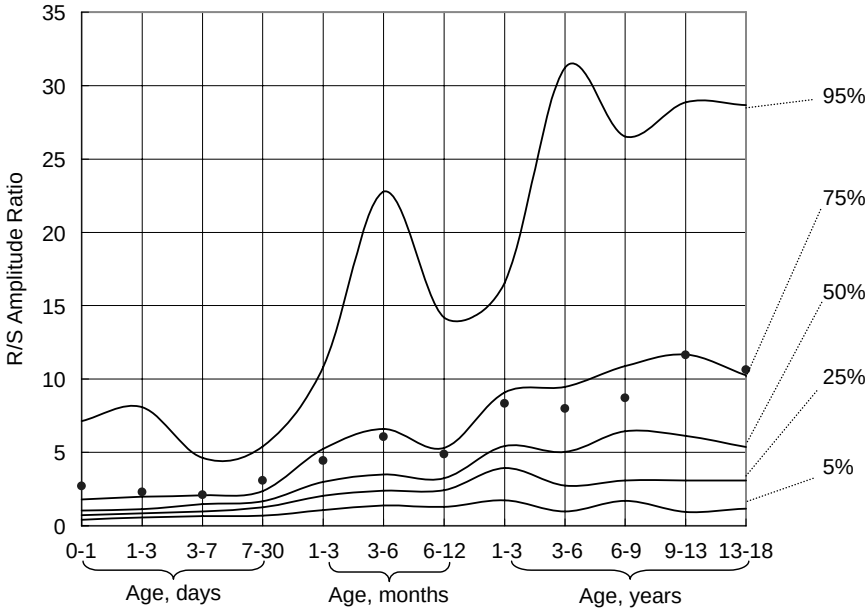

Figure 4.11 R/S amplitude ratio by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). R/S amplitude ratio in V5 stays little changed after birth. It starts to increase from 7–30 days of age until age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	7.14	8.09	4.62	5.42	10.83	22.79	14.19	16.56	31.22	26.52	28.88	28.66
Mean	**2.72**	**2.28**	**2.09**	**3.07**	**4.44**	**6.07**	**4.89**	**8.35**	**8.01**	**8.72**	**11.66**	**10.63**
(±SD)	**8.24**	**3.54**	**2.63**	**10.39**	**4.26**	**6.36**	**4.76**	**15.03**	**8.35**	**9.13**	**22.88**	**22.24**
5%	0.41	0.56	0.67	0.70	1.08	1.38	1.29	1.73	0.99	1.70	0.94	1.16
(N)	109	128	95	100	113	91	97	113	107	99	289	510

R/S amplitude ratio by age in lead V6

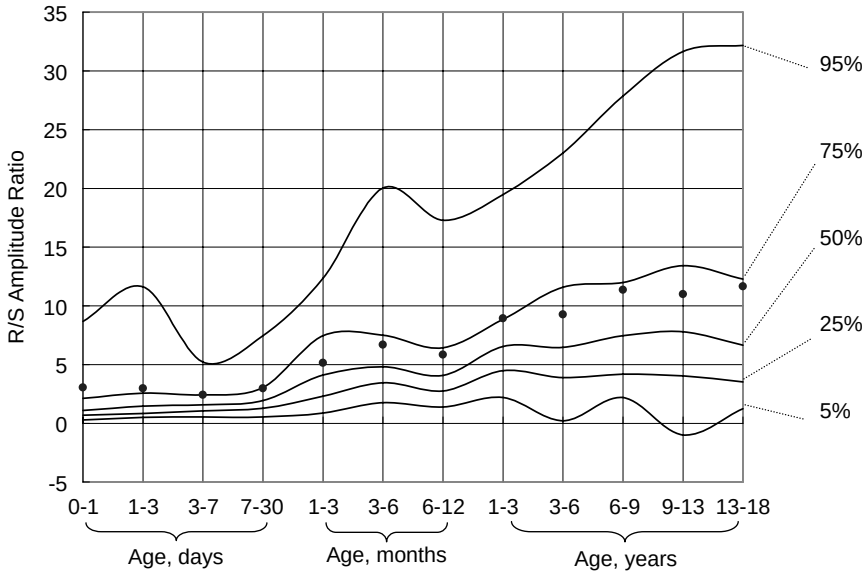

Figure 4.12 R/S amplitude ratio by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). The progress of R/S amplitude ratio in lead V6 is striking. The ratio stays little changed after birth, then increases from age 1 month, then continues to increase forward until age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	8.69	11.60	5.21	7.48	12.35	20.03	17.29	19.50	23.00	27.86	31.67	32.17
Mean	**3.06**	**2.97**	**2.42**	**2.98**	**5.16**	**6.69**	**5.85**	**8.93**	**9.27**	**11.35**	**11.00**	**11.66**
(±SD)	**8.34**	**4.21**	**3.77**	**4.25**	**4.19**	**6.43**	**5.59**	**11.62**	**11.92**	**16.37**	**13.29**	**19.18**
5%	0.29	0.52	0.57	0.56	0.90	1.75	1.39	2.21	0.21	2.20	−1.00	1.27
(N)	109	128	95	100	113	91	97	113	107	99	289	510

CHAPTER 4.13

R amplitude in lead V3 + S amplitude in lead V3 by age

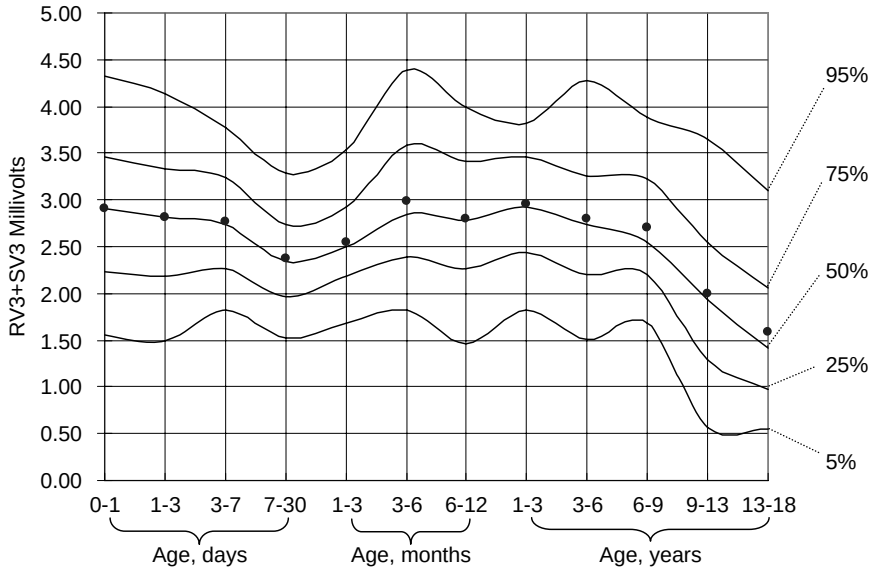

Figure 4.13 R amplitude in lead V3+ S amplitude in lead V3 by age, each curve corresponding to the indicated percentile level (• = mean). The sum of R wave amplitude in lead V3 and S wave amplitude in V3 decreases slightly after birth. It increases after age 7–30 days, reaching the highest value at ages 3–6 months and 1–3 years, then decreases thereafter up to age 13–18 years.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	4.32	4.13	3.77	3.28	3.54	4.38	4.00	3.82	4.28	3.88	3.65	3.10
Mean	**2.91**	**2.81**	**2.77**	**2.38**	**2.55**	**2.99**	**2.80**	**2.95**	**2.8**	**2.7**	**1.99**	**1.59**
(±SD)	**0.91**	**0.81**	**0.67**	**0.62**	**0.60**	**0.79**	**0.85**	**0.65**	**0.90**	**0.71**	**0.95**	**0.81**
5%	1.55	1.50	1.83	1.53	1.69	1.83	1.47	1.83	1.51	1.69	0.56	0.55
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.14

R amplitude in lead V6 + S amplitude in lead V1 by age

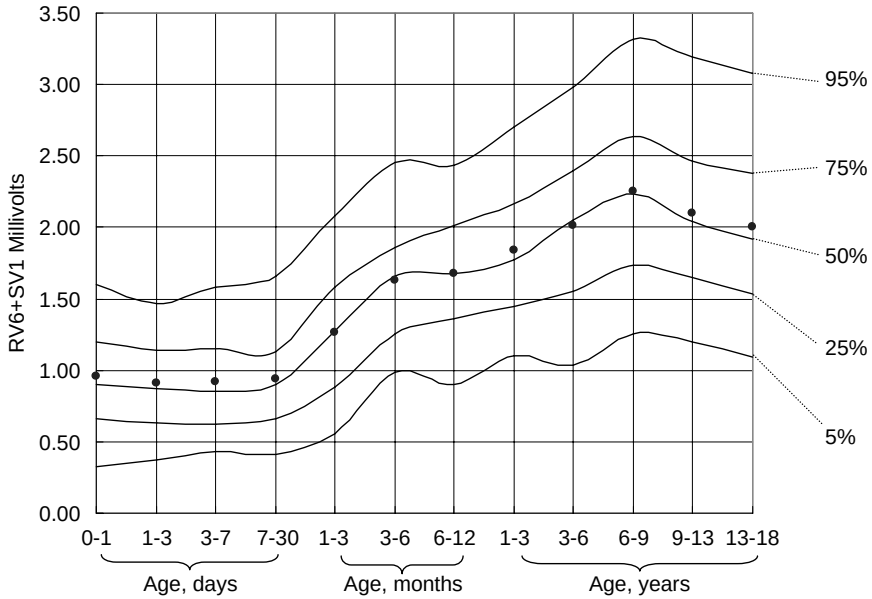

Figure 4.14 R amplitude in lead V6 + S amplitude in Lead V1 by age, each curve corresponding to the indicated percentile level (• = mean). The sum of R wave amplitude in V6 and S wave amplitude in V1 stays almost unchanged in the first week of life. From that age forward, it increases rapidly to age 3–6 months, then gradually up to age 6–9 years, followed by a decrease up to 13–18 years of age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	1.60	1.47	1.58	1.66	2.08	2.45	2.43	2.70	2.98	3.32	3.19	3.08
Mean	**0.96**	**0.91**	**0.92**	**0.94**	**1.27**	**1.63**	**1.68**	**1.84**	**2.01**	**2.25**	**2.1**	**2.00**
(±SD)	**0.43**	**0.35**	**0.39**	**0.37**	**0.49**	**0.47**	**0.50**	**0.49**	**0.58**	**0.71**	**0.61**	**0.63**
5%	0.33	0.37	0.43	0.41	0.56	0.99	0.90	1.10	1.04	1.26	1.20	1.09
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.15

R amplitude in lead V6 + S amplitude in lead V2 by age

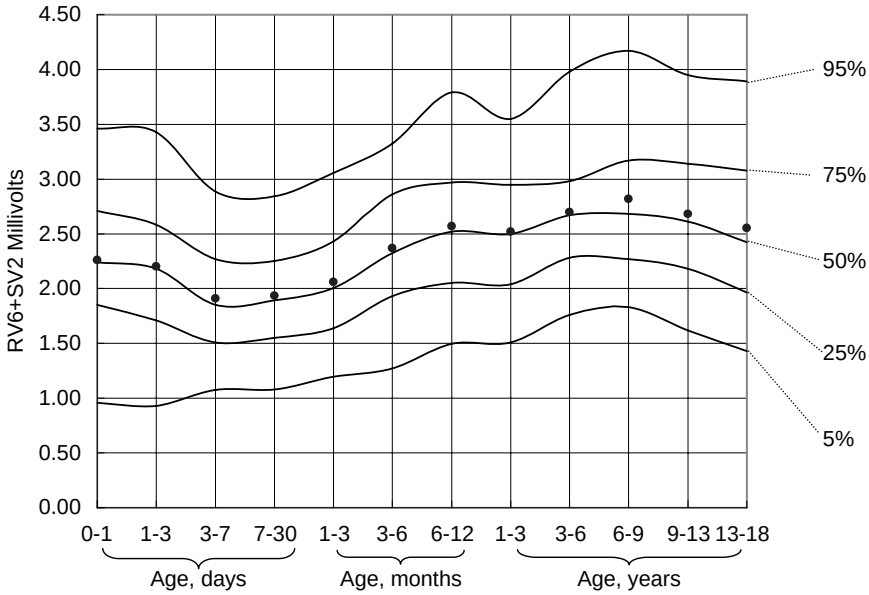

Figure 4.15 R amplitude in lead V6 + S amplitude in lead V2 by age, each curve corresponding to the indicated percentile level (• = mean). The sum of R wave amplitude in lead V6 and S wave amplitude in lead V2 decreases slightly from birth to 7 days of age. From that age forward, it increases gradually from age 1–3 years until age 6–9 years, followed by a decrease thereafter.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	3.46	3.43	2.89	2.85	3.06	3.32	3.79	3.55	3.98	4.17	3.95	3.89
Mean	**2.26**	**2.2**	**1.91**	**1.94**	**2.06**	**2.37**	**2.57**	**2.52**	**2.7**	**2.82**	**2.68**	**2.55**
(±SD)	**0.75**	**0.75**	**0.55**	**0.55**	**0.59**	**0.62**	**0.73**	**0.65**	**0.63**	**0.77**	**0.69**	**0.79**
5%	0.96	0.93	1.08	1.08	1.20	1.27	1.50	1.51	1.76	1.83	1.62	1.43
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.16

Ventricular activation time by age in lead I

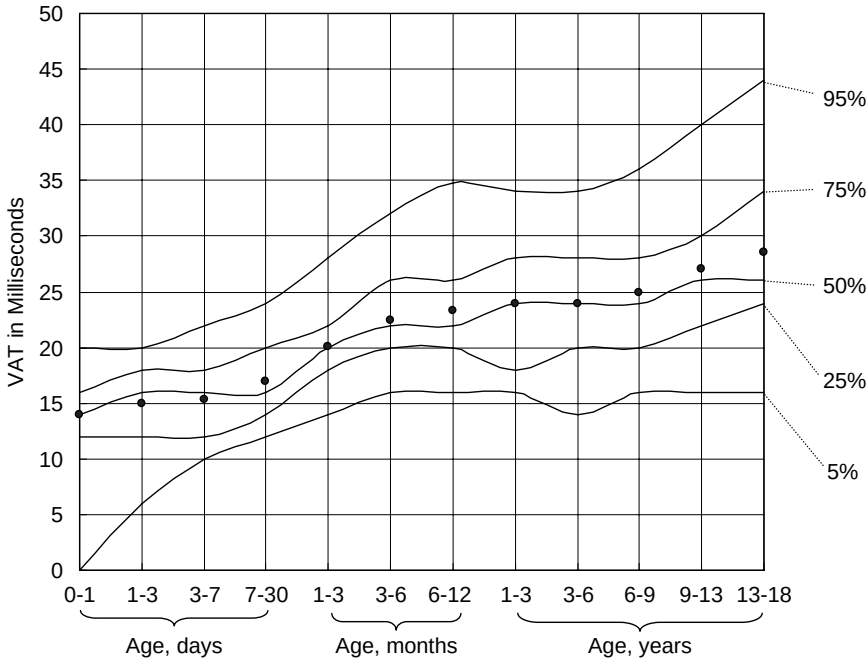

Figure 4.16 Ventricular activation time by age in lead I, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time recorded in lead I becomes longer with increasing age, more strikingly during infancy and adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	20	20	22	24	28	32	35	34	34	36	40	44
Mean	**14**	**15**	**15**	**17**	**20**	**22**	**23**	**24**	**24**	**25**	**27**	**29**
(±SD)	**5.33**	**5.77**	**3.87**	**4.86**	**4.72**	**5.45**	**6.00**	**5.42**	**5.28**	**10.20**	**8.67**	**8.26**
5%	0	6	10	12	14	16	16	16	14	16	16	16
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.17

Ventricular activation time by age in lead II

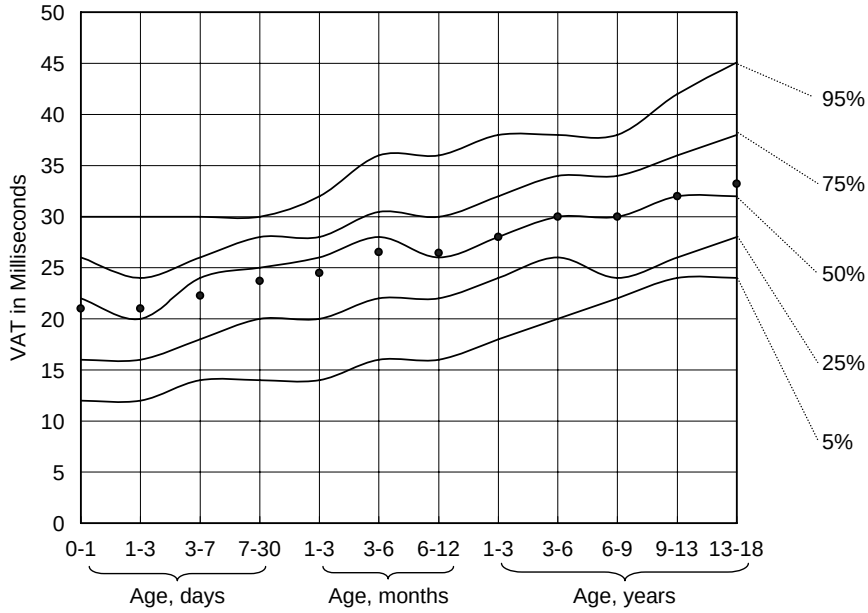

Figure 4.17 Ventricular activation time by age in lead II, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time registered in lead II becomes longer gradually and steadily with increasing age from birth to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	30	30	30	30	32	36	36	38	38	38	42	45
Mean	**21**	**21**	**22**	**24**	**24**	**27**	**26**	**28**	**30**	**30**	**32**	**33**
(±SD)	**5.33**	**5.77**	**5.44**	**5.00**	**5.59**	**6.94**	**7.05**	**5.42**	**5.28**	**5.10**	**8.67**	**7.11**
5%	12	12	14	14	14	16	16	18	20	22	24	24
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.18

Ventricular activation time by age in lead III

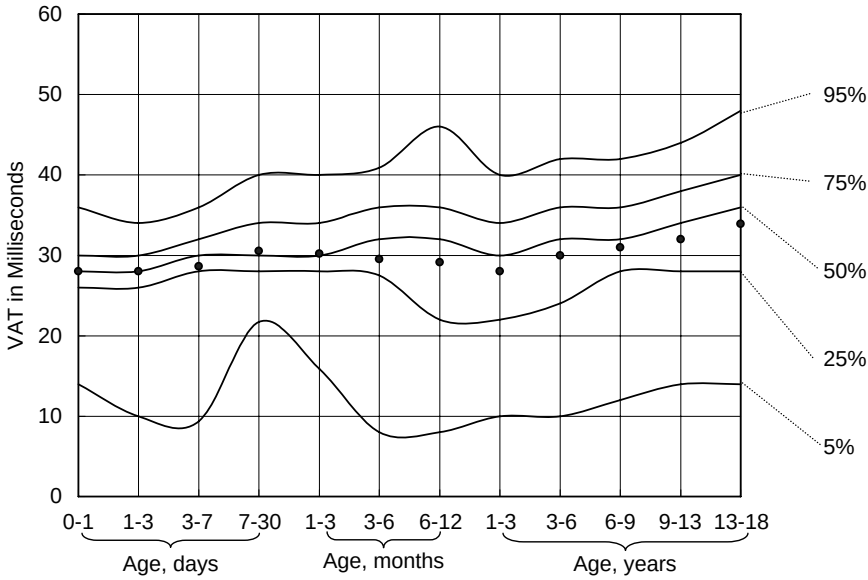

Figure 4.18 Ventricular Activation time by age in lead III, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time recorded in lead III becomes longer, but not as strikingly as in lead II.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	36	34	36	40	40	41	46	40	42	42	44	48
Mean	**28**	**28**	**29**	**31**	**30**	**30**	**29**	**28**	**30**	**31**	**32**	**34**
(±SD)	**5.33**	**5.77**	**6.95**	**6.38**	**7.23**	**9.83**	**11.76**	**10.85**	**10.56**	**10.20**	**8.67**	**10.26**
5%	14	10	9	22	16	8	8	10	10	12	14	14
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.19

Ventricular activation time by age in lead aVR

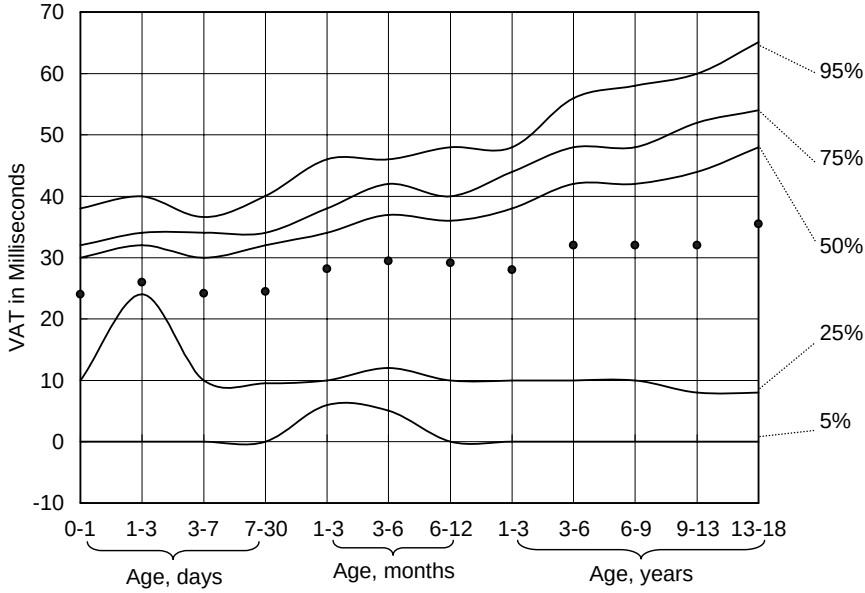

Figure 4.19 Ventricular activation time by age in lead aVR, each curve corresponding to the indicated percentile level (• = mean). Ventricular activation time recorded in lead aVR becomes longer with a wider range along with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	38	40	37	40	46	46	48	48	56	58	60	65
Mean	**24**	**26**	**24**	**24**	**28**	**29**	**29**	**28**	**32**	**32**	**32**	**35**
(±SD)	**10.65**	**11.54**	**12.15**	**13.82**	**14.46**	**15.47**	**16.31**	**16.27**	**21.11**	**20.41**	**26.02**	**24.61**
5%	0	0	0	0	6	5	0	0	0	0	0	0
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.20

Ventricular activation time by age in lead aVL

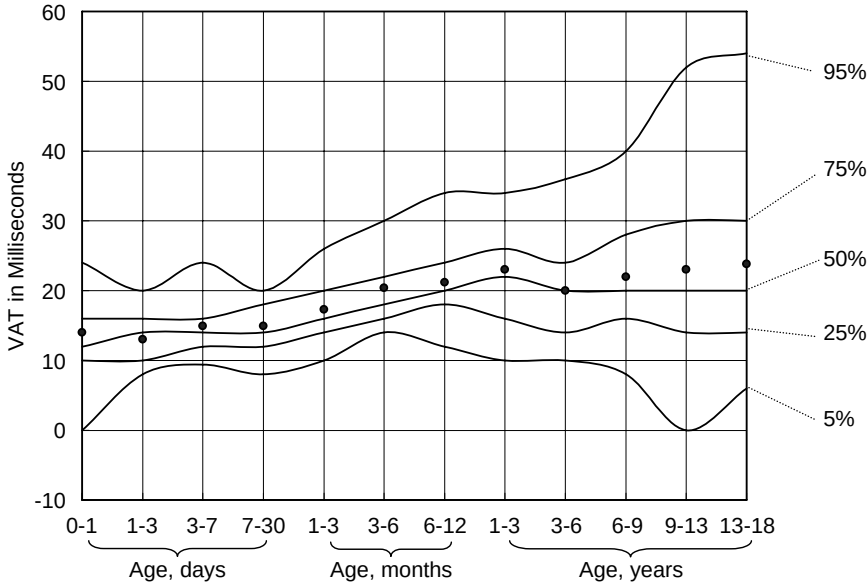

Figure 4.20 Ventricular activation time by age in lead aVL, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time interval increases with a wider range from birth to adolescence, particularly during late adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	24	20	24	20	26	30	34	34	36	40	52	54
Mean	**14**	**13**	**15**	**15**	**17**	**20**	**21**	**23**	**20**	**22**	**23**	**24**
(±SD)	**10.65**	**5.77**	**6.68**	**4.96**	**6.35**	**7.54**	**6.73**	**10.85**	**10.56**	**10.20**	**17.35**	**15.37**
5%	0	8	9	8	10	14	12	10	10	8	0	6
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.21

Ventricular activation time by age in lead aVF

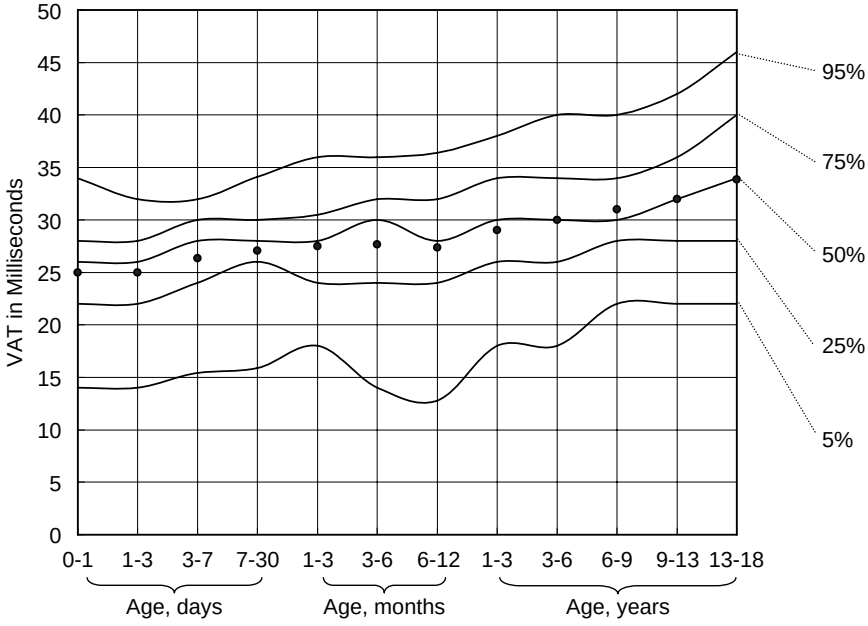

Figure 4.21 Ventricular activation time by age in lead aVF, each curve corresponding to the indicated percentile level (• = mean). The lengthening of ventricular activation time recorded in aVF is gradual and steady during aging from birth to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	34	32	32	34	36	36	36	38	40	40	42	46
Mean	**25**	**25**	**26**	**27**	**27**	**28**	**27**	**29**	**30**	**31**	**32**	**34**
(±SD)	**5.33**	**5.77**	**5.77**	**5.79**	**5.37**	**7.17**	**7.96**	**5.42**	**5.28**	**5.10**	**8.67**	**7.30**
5%	14	14	15	16	18	14	13	18	18	22	22	22
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.22

Ventricular activation time by age in lead V1

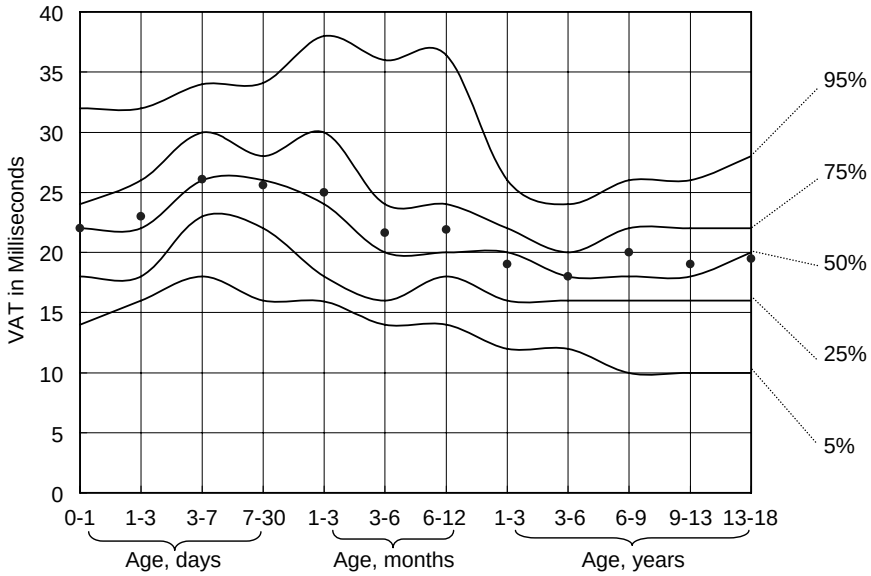

Figure 4.22 Ventricular activation time by age in lead V1, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time interval recorded in lead V1 increases after birth up to age 3–7 days, then decreases during infancy, reaching a plateau level by age 1–3 years, until adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	32	32	34	34	38	36	36	26	24	26	26	28
Mean	**22**	**23**	**26**	**26**	**25**	**22**	**22**	**19**	**18**	**20**	**19**	**19**
(±SD)	**5.33**	**5.77**	**4.90**	**5.67**	**8.52**	**6.56**	**6.99**	**5.42**	**5.28**	**5.10**	**8.67**	**6.87**
5%	14	16	18	16	16	14	14	12	12	10	10	10
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.23

Ventricular activation time by age in lead V2

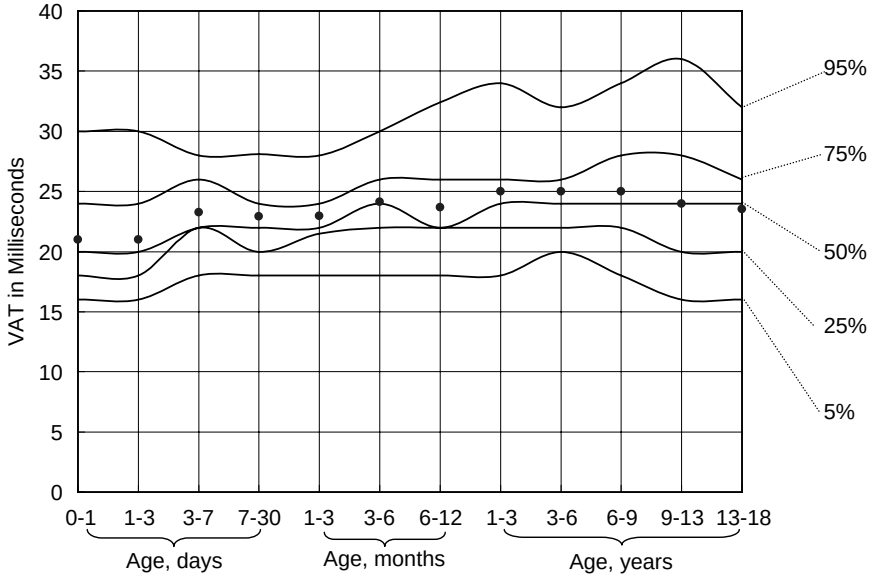

Figure 4.23 Ventricular activation time by age in lead V2, each curve corresponding to the indicated percentile level (• = mean). The average ventricular activation time registered in lead V2 varies little throughout the pediatric age from birth to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	30	30	28	28	28	30	32	34	32	34	36	32
Mean	**21**	**21**	**23**	**23**	**23**	**24**	**24**	**25**	**25**	**25**	**24**	**24**
(±SD)	**5.33**	**5.77**	**4.54**	**3.15**	**2.97**	**4.16**	**4.26**	**5.42**	**5.28**	**5.10**	**8.67**	**5.15**
5%	16	16	18	18	18	18	18	18	20	18	16	16
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.24

Ventricular activation time by age in lead V4

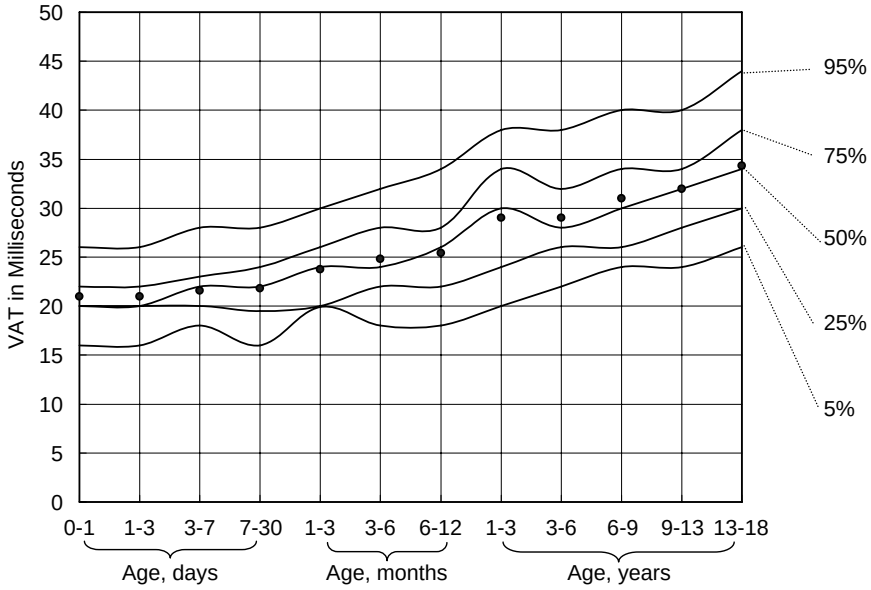

Figure 4.24 Ventricular activation time by age in lead V4, each curve corresponding to the indicated percentile level (• = mean). Lengthening of the ventricular activation time recorded in lead V4 is gradual and strikingly steady from birth to adolescence.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	26	26	28	28	30	32	34	38	38	40	40	44
Mean	**21**	**21**	**21.56**	**21.8**	**23.73**	**24.83**	**25.4**	**29**	**29**	**31**	**32**	**34.34**
(±SD)	**5.33**	**5.77**	**3.06**	**4.29**	**3.63**	**5.41**	**6.02**	**5.42**	**5.28**	**5.10**	**8.67**	**6.00**
5%	16	16	18	16	20	18	18	20	22	24	24	26
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.25

Ventricular activation time by age in lead V5

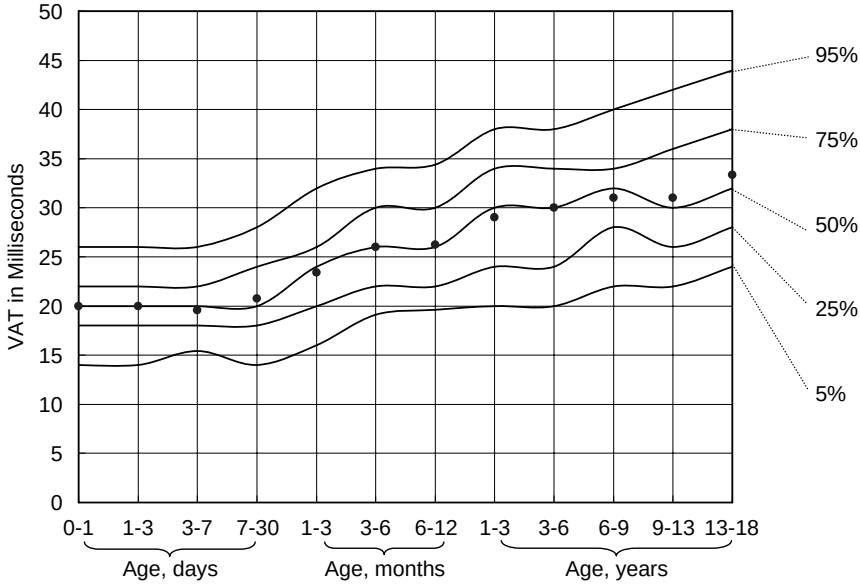

Figure 4.25 Ventricular activation time by age in lead V5, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time registered in V5 stays unchanged during the first 7 days after birth. From that age forward, the ventricular activation time becomes longer along with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	26	26	26	28	32	34	34	38	38	40	42	44
Mean	**20**	**20**	**19.56**	**20.74**	**23.4**	**26**	**26.23**	**29**	**30**	**31**	**31**	**33.34**
(±SD)	**5.33**	**5.77**	**3.70**	**4.08**	**5.16**	**5.11**	**5.36**	**5.42**	**5.28**	**5.10**	**8.67**	**6.26**
5%	14	14	15	14	16	19	20	20	20	22	22	24
(N)	109	128	95	100	120	92	97	113	107	100	289	510

CHAPTER 4.26

Ventricular activation time by age in lead V6

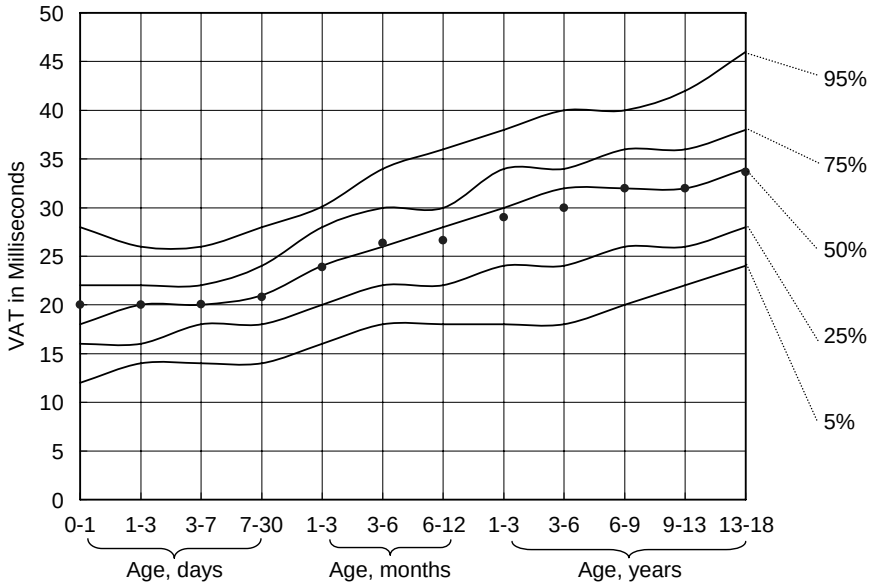

Figure 4.26 Ventricular activation time by age in lead V6, each curve corresponding to the indicated percentile level (• = mean). The ventricular activation time recorded in lead V6 varies little within the first 7 days of life. From that age forward, the time prolongs gradually and steadily along with increasing age.

	Days				*Months*			*Years*				
Age	*0–1*	*1–3*	*3–7*	*7–30*	*1–3*	*3–6*	*6–12*	*1–3*	*3–6*	*6–9*	*9–13*	*13–18*
95%	28	26	26	28	30	34	36	38	40	40	42	46
Mean	**20**	**20**	**20**	**21**	**24**	**26**	**27**	**29**	**30**	**32**	**32**	**34**
(±SD)	**5.33**	**5.77**	**4.25**	**4.62**	**4.80**	**4.75**	**6.17**	**5.42**	**5.28**	**10.20**	**8.67**	**6.99**
5%	12	14	14	14	16	18	18	18	18	20	22	24
(N)	109	128	95	100	120	92	97	113	107	100	289	510