

Electrocardiographic Patterns of Normal and Thiamine-Deficient Baby Pigs.* (22902)

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Electrocardiographic (ECG) studies of normal and thiamine-deficient individuals in man and several animal species have been made and are well reviewed by Lepeschkin(1). Studies with a limited number of animals(2-4) have dealt with ECG changes in thiamine-deficient pigs beyond weaning age. The thiamine requirement of the baby pig has been reported by the present workers(5). Electrocardiograms were obtained but were not reported. We have noted no communications in which the ECG pattern of either normal or thiamine-deficient baby pigs has been submitted. The purpose of the present paper is to present such patterns and to submit a summary of duration data for various electrocardial intervals.

Methods. Electrocardiograms were made weekly on 35 baby pigs which were taken from the sow when 3 or 4 days of age and placed in individual cages where they received a synthetic milk diet. These pigs were used during the second and third replications of the thiamine requirement study(5). Diet and controlled environment have been described previously(5,6). Seven pigs received no thiamine in the diet and developed acute thiamine deficiency. Fourteen pigs received 0.5 to 1.0 mg thiamine/kg of dietary solids. These animals developed milder deficiency symptoms. The remaining 14 baby pigs received milk containing 1.5 to 2.0 mg thiamine/kg of solids in the diet and these pigs were quite normal in all respects. To obtain valid ECG data the pigs were suspended in a canvas carrier device. With some training the pigs learned to lie still for a considerable period of time. Recordings were not made until the

pigs had remained still for a period of 3 minutes or more. The electrocardiograph employed was a 4 channel, model 67 Sanborn. Five leads were connected to electrodes situated on the 4 legs and the chest. Recordings were made from the 3 standard dipolar leads, the unipolar AVR, AVL, and AVF leads and the unipolar chest lead. A comparison of

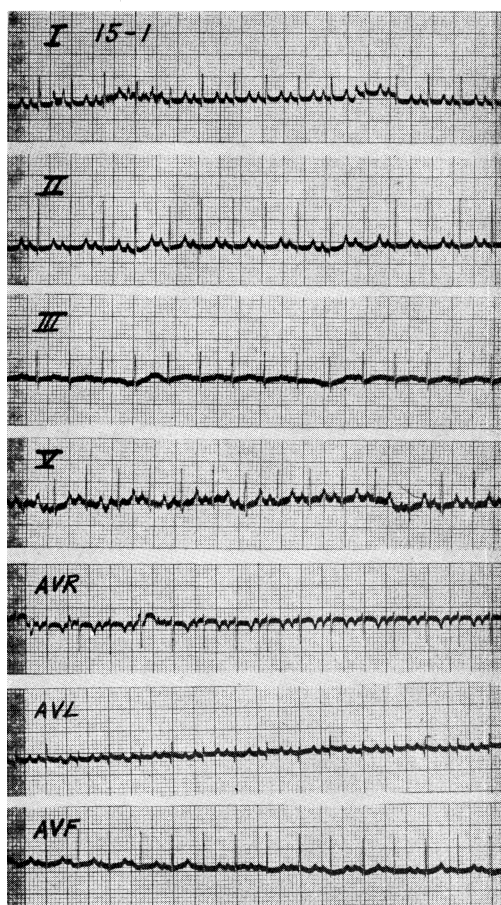


FIG. 1. Seven lead recordings made on all electrocardiograms. This ECG is from one control pig during fifth week. Heart cycle length is uniform, heart rate is 190 bpm, PR time is 0.08 sec. and QRST duration is 0.20 sec.

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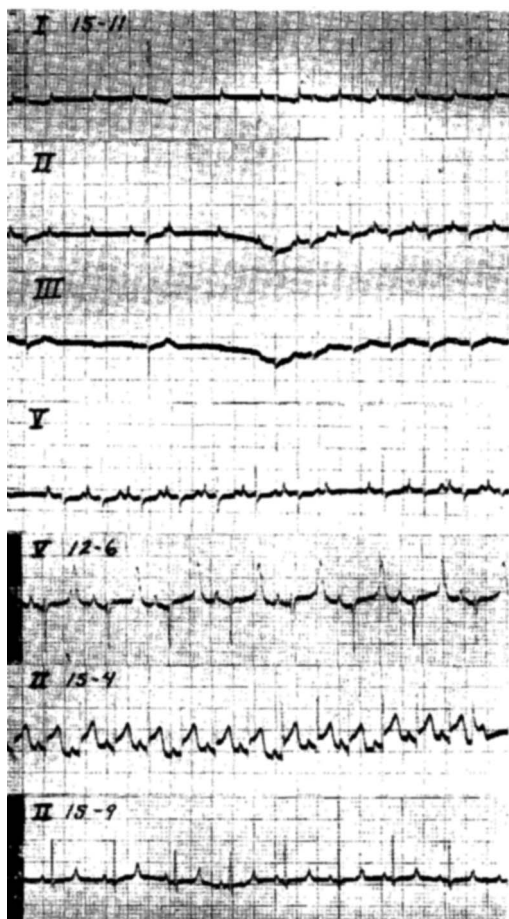


FIG. 2. These tracings from thiamine deficient pigs reveal varying degrees of bradycardia in all pigs. A marked sinus arrhythmia is exhibited by pigs 15-11 and 15-4. First degree AV block is apparent in pig 12-6 and second degree AV block is exhibited by pig 15-11. Duration of QRST interval is excessive in all pigs except 15-4 and PR time is excessive in pigs 12-6 and 15-11. ST segment is greatly elevated in pig 15-4 and T wave potential is abnormally high in pigs 12-6, 15-9, and 15-4.

duration of ECG intervals between normal and thiamine-deficient animals was made. These data were taken from tracings which were made during the fifth week of age or from the ECG last obtained before death in case of deficient animals which died. These data were statistically analyzed using the method for single classification variance(7).

Results. Electrocardiograms from normal animals usually showed positive P, R and T waves in the standard leads although T was sometimes inverted in all of these leads and very often inverted or small in lead I and

often barely perceptible in lead III. P was often barely discernible and sometimes inverted in lead III. The S wave was usually not present in lead I. There were no particular changes in this pattern from birth to 5 weeks of age. There appeared to be no consistent differences between normal and thiamine-deficient animals in the direction of any waves in the standard leads (Fig. 1 and 2) although in several of the acutely deficient pigs the T wave voltage greatly exceeded that found in normal pigs. T wave voltage was normally less than 0.2 millivolt in all leads.

The P, R, and T waves were usually all inverted in the AVR unipolar lead. In the AVL lead T was usually inverted and both P and T were often small or not perceptible. T was occasionally inverted in the AVF lead. T was usually of greater magnitude from the unipolar chest lead than on any other lead. Again, no consistent changes in unipolar lead tracings, either in wave magnitude or direction were effected by advancing age or thiamine deficiency.

Duration of heart cycle in control pigs was usually uniform although a slight degree of sinus arrhythmia appeared not to be abnormal. A marked sinus arrhythmia was observed in most of the deficient pigs. Bradycardia was exhibited by all pigs which developed an acute thiamine deficiency.

A summary of duration of ECG intervals is presented in Table I. The PR interval was significantly lengthened in acutely deficient pigs. In one of these pigs (Fig. 2) this interval was 0.14 second which probably indicates first degree auriculoventricular (AV) block. The QRS interval was not lengthened in thiamine-deficient pigs and was consistently 0.04 second in duration. The period of electrical systole (QT interval) was significantly lengthened in both chronically and acutely deficient pigs. In one of the acutely deficient pigs (Fig. 2) the ventricular phase of the cycle was occasionally absent probably because of second degree AV block. A comparison of Bazett's constant(8) reveals that the systolic portion of the cycle constituted a relatively greater amount of the cycle duration in the deficient pigs.

TABLE I. Duration* of Electrocardial Intervals in Normal and Thiamine-Deficient Baby Pigs.†

	Normal	Acute thiamine deficiency	Chronic thiamine deficiency
No. of pigs	14	7	14
PR interval	.08 ± .00‡	.10 ± .01¶	.08 ± .00
QRS	.04 ± .00	.04 ± .00	.04 ± .00
ST	.10 ± .01	.16 ± .02	.12 ± .01
QT	.20 ± .01	.27 ± .01¶	.23 ± .01
RR	.33 ± .01	.48 ± .04¶	.35 ± .01
Bazett's constant§	.35 ± .01	.39 ± .02	.39 ± .01

* Interval time durations expressed in sec.

† Data for normal pigs was taken from ECG made at 5 wk of age. Data for deficient pigs was obtained at similar age or from ECG just preceding death in the case of those which died.

‡ Stand. error of mean.

$$\S \frac{QT}{\sqrt{RR}}$$

|| Significantly greater than for normal pigs (P = 0.05), and ¶ (P = 0.01).

Duration of heart cycle and each electrical interval was increased somewhat in normal pigs as their age advanced. Heart rates dropped from average of 266 bpm for the first week to average of 189 bpm by the second week and then reduced only gradually thereafter to average of 180 bpm at 5 weeks of age. The PR interval increased from 0.06 second shortly after birth to 0.08 second at 5 weeks of age. The ST interval increased from 0.06 second to 0.10 second and the QT was increased from 0.14 second to 0.20 second over the same period. The QRS interval and the interval of the T wave remained quite constant in duration over this age period and were 0.04 second and 0.06 second respectively.

Three pigs in the group receiving no dietary thiamine died suddenly during third and fourth week after having exhibited severe degree of anorexia and depressed growth rate. The remaining 4 pigs from this group also showed these acute symptoms and 2 of these were sacrificed *in extremis* during the fifth week. The other 2 pigs from this group recovered following intraperitoneal injections of

thiamine hydrochloride. Although the effect on dietary intake and growth depression was not nearly so great in pigs receiving 0.5 mg or 1.0 mg of thiamine/kg of dietary solids, 3 of these pigs died during the fifth week and analysis of heart weight data from animals which were sacrificed at this time indicates that a greater degree of cardiac hypertrophy had occurred in this group than in pigs from the group receiving no thiamine. The ECG pattern of the lead II tracing for pig 15-4 of this group is shown in Fig. 2.

Summary. Electrocardiograms were made weekly from birth through 5 weeks of age on 35 baby pigs receiving various subminimal and adequate levels of thiamine in the diet. Typical ECG patterns of normal and thiamine-deficient baby pigs are presented and described. Statistically significant increases in PR time, QT time and cycle length occurred in deficient animals. Thiamine-deficient pigs consistently exhibited sinus arrhythmia. First and second degree auriculo-ventricular block were manifested. Evidence of cardiac hypertrophy occurred in deficient animals.

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