Electrocardiographic Notching in Rats Deficient in Essential Fatty Acids

Abstract. *A notch has been seen in the electrocardiograms of rats who were fed diets deficient in essential fatty acids. This notching occurs consistently at a point 37 percent through the* QRS-*complex. It can be prevented by the addition of small amounts of linoleate, linolenate, or arachidonate to the diet of these rats.*

An interest in the relationship between heart disease and essential fatty acid (EFA) nutrition led to this study of the changes in the electrocardiogram of rats maintained on EFA-free diets.

In one of our experiments, 75 male rats who weighed from 35 to 50 grams each, were fed a fat-free diet for 10 weeks. The diet contained 18 percent casein, 74 percent sucrose, 4 percent cellulose (Alfacell), 4 percent Wesson Salt Mixture, and a complete vitamin mixture (*1*). As a control, 10 other rats were placed on a similar diet which contained 5 percent corn oil in place of an equal weight of sucrose. By the end of eight weeks, rats on the fat-free diet had developed a dermatitis of the paws, tail, and coat [total dermatitis score = 3 to 5 (*2*)] and they weighed an average 230 grams as compared with 290 grams for the controls.

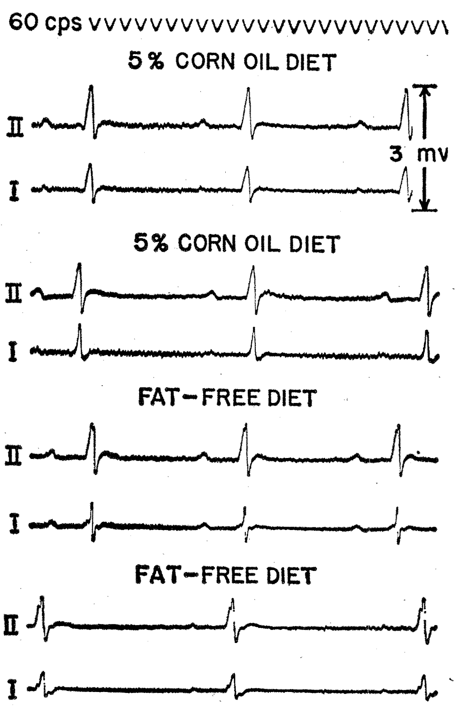

Fig. 1. Typical electrocardiograms of two normal and two EFA-deficient rats.

Each 3 weeks during the depletion period electrocardiograms were recorded on all animals. For this, each rat was anesthetized with an intraperitoneal dose of 40 mg of Nembutal per kilogram of body weight. Ether was not used since it is highly toxic to EFA-deficient animals. Electrocardiograms were recorded with a Honeywell Visicorder with a T-1500 galvanometer (response essentially flat to 900 cy/second) which was driven by a Tektronix (type 122) preamplifier and a transistorized power amplifier which was designed to provide an essentially flat frequency response from 0.2 cy/second to the upper frequency limit of the galvanometer.

Figure 1 shows a typical electrocardiogram for both the normal and the EFA-deficient rat. The time tracing, which marks each one-sixtieth of a second, was taken from the power line. The tracings marked I and II represent lead I (between right and left forelimbs) and lead II (right upper forelimb to left hind limb) as used previously (*3*).

This same experiment, with slight variations, has been repeated so that over one hundred EFA-deficient animals have been observed and their electrocardiograms have been studied. The one consistent change noted in the electrocardiogram of every one of the EFA-deficient animals was a notching in the *QRS*-complex. Similar notching has not been seen in the record of any control animal (*4*) either in this experiment or in previous work (*5*).

As measured from the start of the *Q*-wave, the notch appears typically at 37 percent (S.D. = 5 percent) of the horizontal distance (time) through the *QRS*-complex and it may have an amplitude of as much as 10 percent of the vertical distance from *R* to *S*. The horizontal position of the notch is highly consistent, but the amplitude of the notch in any single lead varies. This makes quantitation of the degree of notching difficult.

In general, this *QRS*-notching, which points to an alternation in ventricular conduction, appeared before the rats developed dermatitis, and it disappeared more rapidly when linoleate was administered than when other substances were used. In 30 to 60 percent of the rats, administration of a single dose of 200 mg of linoleate, 100 mg of linolenate, or 50 mg of arachidonate returned the electrocardiogram to normal within four days. *QRS*-notching thus provides a sensitive indicator of essential fatty acid deficiency in the rat (*6*).

W. O. CASTER
PHILIP AHN
Department of Physiological Chemistry, University of Minnesota, St. Paul

References and Notes

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3. W. O. Caster, W. D. Armstrong, and E. Simonson, *Am. J. Physiol.* **188**, 169 (1957).
4. In one control rat (5 percent corn oil), notching was seen at a point 59 percent of the way through the *QRS*-complex. Since this point was more than 4 standard deviations away from the position in the *QRS*-complex described in this report, the record was excluded.
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6. This work was supported in part by grants from the Graduate School of the University of Minnesota, the General Research Support Grant of the College of Medical Sciences, University of Minnesota, and U.S. Public Health Service grant HE 03662-05.

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Psychophysics of Perceived Intensity: A Theoretical Basis for Fechner's and Stevens' Laws

Abstract. *A "matching-response" model of psychophysical judgment is proposed, in terms of which power-law relationships would be expected between perceived intensity and stimulus strength, even though receptors had logarithmic response characteristics. On this model, observed differences in exponent for various modalities would reflect differences in coupling coefficients, rather than in transducer mechanisms.*

Fechner's famous contention (*1*), that the "strength of sensation" is logarithmically related to the stimulus intensity, has recently been challenged by Stevens (*2–4*), who adduces convincing experimental evidence for a "power law" of the general form

$$\psi = a(I - I_0)^{\beta} \qquad (1)$$

Here ψ is the perceived intensity, I the physical intensity, and a, I_0, and β are constants.

Some authors have regarded Fechner's law as a reflection of the logarithmic relation between the frequency of nerve impulses from sensory receptors and the intensity of stimulation. With the advent of Stevens' law (Eq. 1), the question is then raised whether a closer look at receptor firing-frequencies might