Case Report Section

Electrocardiographic Changes in Undernutrition

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The number of people in our world who are chronically undernourished is phenomenal. This number was greatly increased and expanded during World War II and shortly thereafter. General undernutrition is probably the most common metabolic abnormality in the populations of many parts of the world. Although there is a great deal of literature dealing with the problems of undernutrition, especially in the semi-starvation form, as exhibited in the famines of India, China and in the period of World War I and World War II and their aftermath, comparatively few detailed electrocardiographic studies have resulted. Fewer yet are the number that include adequate precordial and limb leads in addition to the standard leads. Naturally the main reason for this deficiency lies in the fact that most of the studies were conducted under adverse conditions and just prior to the popular development of the more recent limb and precordial leads.

Recently the occasion presented itself to observe a patient with severe undernutrition. As far as can be determined from the literature, the electrocardiographic pattern exhibited by this patient had not been previously described.

Case Report

History: A 45 year old white, single, school teacher, entered the hospital complaining of weakness and weight loss. She had been undernourished as a child, and weighed only 98 pounds as a student in high school. During the years 1938 to 1944 she averaged 87 pounds. Her highest weight—120 pounds—was obtained between 1944 and 1946 while in military service. Following discharge her weight once more began to decline and in 1951 she was down to 75 pounds. She had continued to lose weight from then until her admission to the hospital in January 1955. She presented a long-standing history of poor dietary habits. During recent months she experienced episodes of semi-starvation alternating with periods of increased carbohydrate intake. The latter consisted of intermittently (about once every two weeks) gorging herself with carbohydrates usually in the form of about ½ to 1 pound of sugar. This carbohydrate orgy was usually followed by self-induced vomiting and purging. She has had swelling of her feet off and on for about five to eight years. At times she has noted pain in her ankles and legs and more recently has had difficulty in walking due to weakness. Her daily diet consisted of a hot drink for breakfast; a piece of fruit, lettuce, one half cup of milk and cheese for lunch. Vegetables, one piece of toast, and another half cup of milk comprised her dinner. She rounded out the day with an apple and a small amount of cereal in the evening. She had not eaten meat for months and only occasionally did she add an egg to her diet. According to this diet it has been calculated that she averaged 800 to 1,000 calories per day with 45 to 50 grams of protein, 15 to 25 grams of fat, and 90 to 130 grams of carbohydrates. Her diet also contained about 1800 to 2400 Vitamin A units, 0.22 mgs. of thiamine, 1.08 mgs. of riboflavin, 4.63 mgs. niacin and 81 mgs. of ascorbic acids, as well as about 400 units of Vitamin D, about 660 mgs. of calcium, 800 mgs. of phosphorus and 17.1 mgs. of iron. She was having irregular bowel movements with alternating periods of constipation and diarrhea. She attributed this to the fact that she had been having frequent doses of castor oil whenever she felt that she was “overeating.” Her past history revealed that she had numerous colds and pneumonia on five or six occasions. Her menstruation began at age 14, was regular for a number of years, and became grossly irregular 15 years ago. During the past seven years she had failed to menstruate.

Physical Findings: On admission, she weighed 68 lbs. with a height of 62". She was poorly developed, emaciated, pale, almost cadaverous-appearing but in no acute distress.

From the Medical Service, Veterans Administration Hospital.
Mentally she was clear and cooperative. The oral temperature was 96.6°F, a resting heart rate of 72 per minute, and respiratory rate of 18 per minute. The blood pressure was 100/68. The head, neck, abdomen, heart, lungs were normal. There was 4 plus pitting edema of both lower extremities extending from the knees downward. Her skin was cool, dry and atrophic.

All pertinent laboratory tests and x-ray films of the chest were essentially negative. A gastro-intestinal series including small bowel study revealed only hypomotility. An electrocardiogram on admission as noted in Figure 1 exhibited QS complexes in leads V-4 through V-7. A clinical diagnosis of anorexia nervosa with secondary severe undernutrition was made.

Course in the Hospital: She early exhibited marked sensitivity to cold. She kept herself constantly bundled in numerous layers of clothing with windows and doors in her room shut. Her temperature during the first two days of hospitalization ranged between 96.4 and 98°F, and then gradually reached normal and remained so for the remainder of her period of observation. During her early days in the hospital her heart rate ranged between 70-80 per minute. Her weight gradually increased reaching a total of 84 lbs. at the end of eight weeks of hospitalization. The leg and ankle edema cleared and she became less sensitive to cold. The glucose tolerance curve during the ninth week of hospitalization revealed a fasting glucose of 85 mgms. per cent, 155 mgms. per cent at the end of one hour, 135 mgs. per cent at the end of two hours, and 95 mgms. per cent at the end of three hours. She was placed on a course of estrogenic therapy and began to menstruate six days after the drug was discontinued. An electrocardiogram taken at the end of eight weeks of

![ECG leads](image)
hospitalization is shown in Figure 2, and records R waves present in the precordial leads and the tracing is within normal limits. This tracing like the original one (Figure 1) was taken in the usual recumbent position. The degree of emphysema and the position of the diaphragm at this time was unchanged from that noted at the time of admission.

**DISCUSSION**

In anorexia nervosa the weight loss frequently is as great and sometimes greater than that seen in the non-fatal cases of starvation. War-time starvation and famines present similar pictures of undernutrition. Tur,1 during the siege of Leningrad (1941-1942) noted sinus bradycardia, right axis deviation and low QRS voltage in patients with severe malnutrition. The T waves were abnormally large in the standard leads, but low or negative in the apical leads. In deteriorating patients, there was a progressive lowering of the T wave amplitude in the standard leads. In another study of 24 cachectic women he noted that the majority had subnormal T wave amplitude in one or more leads, usually in lead 1. The QRS amplitude was subnormal in 12 patients. Out of 15 patients in a better state of nutrition none had right axis deviation and 11 had low QRS and T voltages. During rehabilitation the increase of the T wave amplitude paralleled the clinical improvement and was considered to be of prognostic significance. Cardozo and Eggink2 found low voltage and sinus bradycardia in 29 cases of severe undernutrition. In addition, the duration of the QR interval was prolonged, absolutely, as well as in relation to their cycle length. Ellis3 studied the ECG changes in four American prisoners of war, immediately after liberation and during rehabilitation for a period of three weeks. All were severely undernourished and one was almost moribund, having lost about 45 per cent of his body weight. The most prominent feature was a prolongation of the QT interval. He suggested that this prolongation might be due to a prominent U wave which disappeared during the improvement. He also claimed ST segment depression in two patients which in one was associated with an inversion of T2 and T3. All four appeared to show right axis shift which was still in evidence after three weeks of rehabilitation. At this point, however, there was complete disappearance of the QT prolongation, the ST depression, and the T wave changes. Hellerstein,4 looking at this problem from another point of

FIGURE 2: ECG taken in eighth hospital week. R waves are now present in precordial leads. The tracing is within normal limits.
view, reported the ECG findings in 16 patients dying with atrophy of the heart. Nine of them showed low QRS voltages and T waves were abnormally low, flat or negative in 11 out of the 16 patients. This being a rare study that included precordial leads, it is interesting to note that he found a low voltage in QRS waves and negative or flat T waves in V-1 to V-5. Sinus bradycardia, however, was not a characteristic feature.

In the Minnesota experiment, Keys et al. reported that their significant changes consisted of a decreased QRS and T wave amplitude, and so agree with Tur and Cardozo and Eggink. They failed, however, to find lengthening of the QT intervals and therefore disagreed with the findings of Ellis and Cardozo and Eggink. Our patient also exhibited low QRS voltage in the standard leads. The striking feature, however, is the presence of QS complexes in V-4 through V-7. An old anterior wall infarct or other intrinsic myocardial pathology such as atrophy was considered in the search for an adequate explanation. Other possibilities included extreme degree of positional changes. None of these, however, completely and adequately explained the findings of the electrocardiographic changes in view of the eventual return to a normal pattern in the period under observation. The ECG changes noted in this patient have never been described in previously recorded reports of patients suffering from severe undernutrition.

REFERENCES