

# **A NEW ELECTROCARDIOGRAPHIC SIGN IN INFANTS AND CHILDREN WITH HYPOTHYROIDISM AND ITS DIFFERENTIATION FROM SIMILAR ELECTROCARDIOGRAPHIC PATTERNS**

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The purpose of this paper is to present examples of the absence of the ST segment and dome-shaped T waves immediately following the QRS complex in hypothyroid children as a new observation. We want also to emphasize the differences between this electrocardiographic pattern and electrocardiographic patterns due to viral myocarditis, diphtheria, myocardial degeneration, nephritis, kwashiorkor, hypercalcemia and serpasil treatment.

The original paper about hypothyroidism was written in 1880 by Ord,<sup>1</sup> and the first cardiovascular findings and clinical characteristics of myxedema were described by Zondek in 1918.<sup>2</sup> The electrocardiographic changes in hypothyroidism were also described in an article by Zondek in which he mentioned the decreased amplitude of P and T waves. In 1918 Aub and Stern wrote that complete heart block can occur in hypothyroidism.<sup>3</sup> Williams observed that in hypothyroidism the electrocardiogram shows a low voltage of QRS and T waves usually with accompanying negative T waves. He also noted that the ST segment becomes raised and convex as in coronary heart disease, the only difference being that in hypothyroidism the amplitude of the T waves remains low, and the PR interval is prolonged.<sup>4</sup> Goldman determined that in myxedema and bradycardia, prolongation of the PR interval, low voltage of the QRS complex and flattening of the T waves were common observations in the electrocardiogram.<sup>5</sup> Holzmänn observed that in hypothyroidism the electrocardiogram showed low voltage in all of the complexes with depression of the ST segments.<sup>6</sup> Scherf and Boyd state that «in a typical and uncomplicated case the electrocardiogram shows very low voltage of all waves in each lead. The low P and T waves may disappear completely and the QRS complexes are often only a few millimeters in height.»<sup>7</sup> Nelson in his *Textbook*

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of *Pediatrics* states that the electrocardiogram of infants with hypothyroidism may show delayed right ventricular excitation.<sup>8</sup> He also observed that «cretinism seldom produces gross cardiac involvement but the electrocardiogram discloses a slower than normal cardiac rate, low voltage of all complexes, especially of the P and T waves, left axis deviation and prolonged electrical systole.»<sup>9</sup> Wilkins ascertained that in hypothyroidism the electrocardiogram commonly revealed decreased voltage of both the QRS and T wave deflections which had been shown previously to be independent of skin resistance. Occasionally there was a prolonged QRS interval with evidence of interventricular block.<sup>10</sup> Danowski in his famous textbook on endocrinology describes the prolongation of the PR interval, low voltage of the QRS complexes with notching or widening, and diphasic, flattened or inverted T waves in hypothyroidism. The T wave changes are most frequent, occurring especially in lead II.<sup>11</sup>

This review of the literature in the fields of the electrocardiogram and cardiology reveals the electrocardiographic changes noted in hypothyroidism. There has been no mention in the literature, however, of the disappearance of the ST segment plus the accompanying dome-shaped T waves in the electrocardiogram. The purpose of this paper is to present and emphasize this observation and its diagnostic significance.

### *Material and Method*

Eighty-four pediatric cases of hypothyroidism, and many cases of viral myocarditis due to diphtheria, nephritis, kwashiorkor; hypocalcemia and the effect of serpasil in infancy and childhood were diagnosed at Hacettepe Medical Center during a seven year period, from the beginning of 1958 to June 1965. Detailed electrocardiographic studies were made on the last 45 patients of hypothyroidism, using a Sanborn Model 52 electrocardiographic machine for electrocardiographic recordings. The machine was standardized 1 millivolt for 10 mm deflection. A speed of 25 mm per second was used. On patients whose electrocardiograms showed the mosque sign typical of hypothyroidism, the electrocardiograms were repeated every third day and Thyranon (organon) therapy was continued until the T wave began to appear normal and the ST segment reappeared. From the end of the S wave (J point) to the beginning of the T wave is considered the ST segment (Figure 1). In the last 12 patients of hypothyroidism, the PBI, serum calcium,

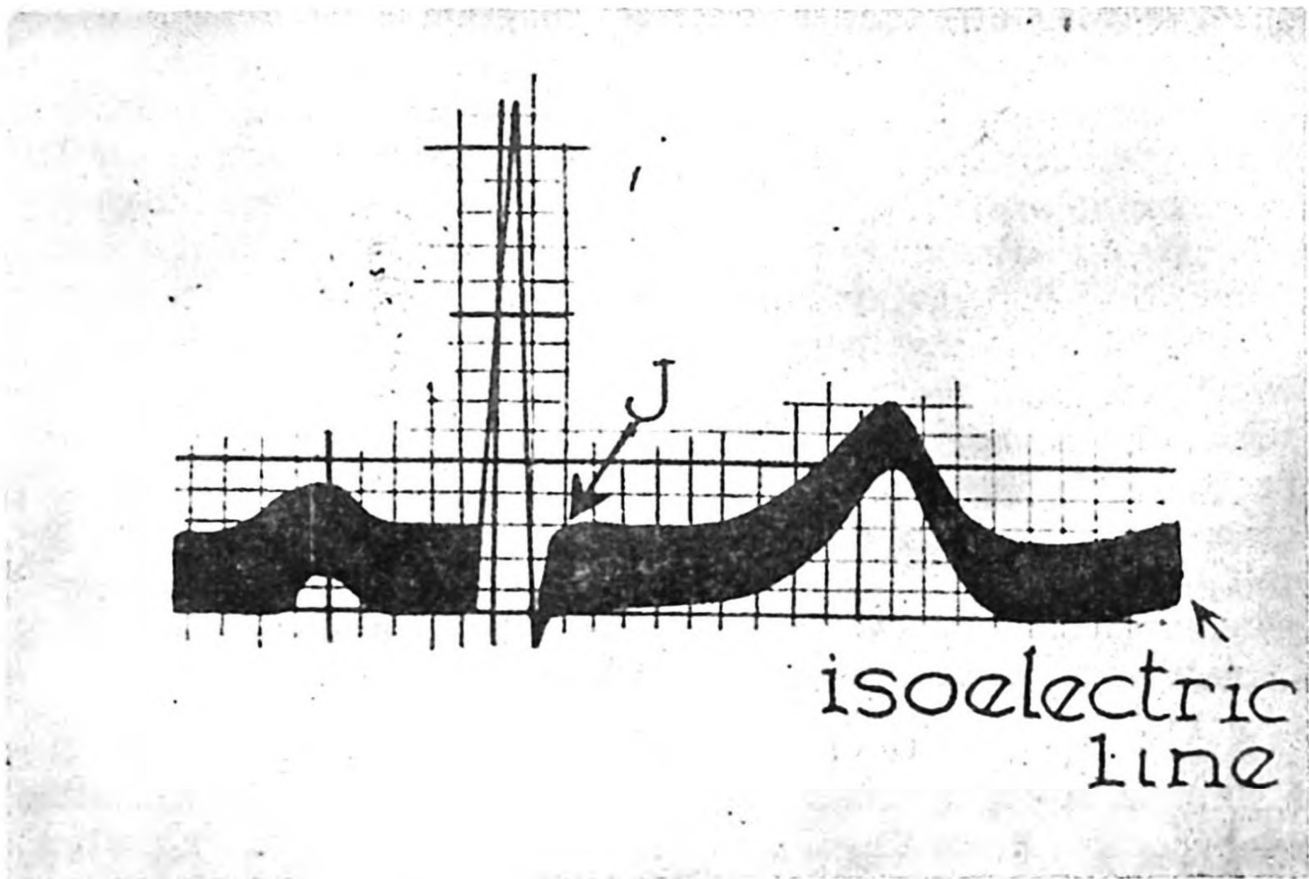


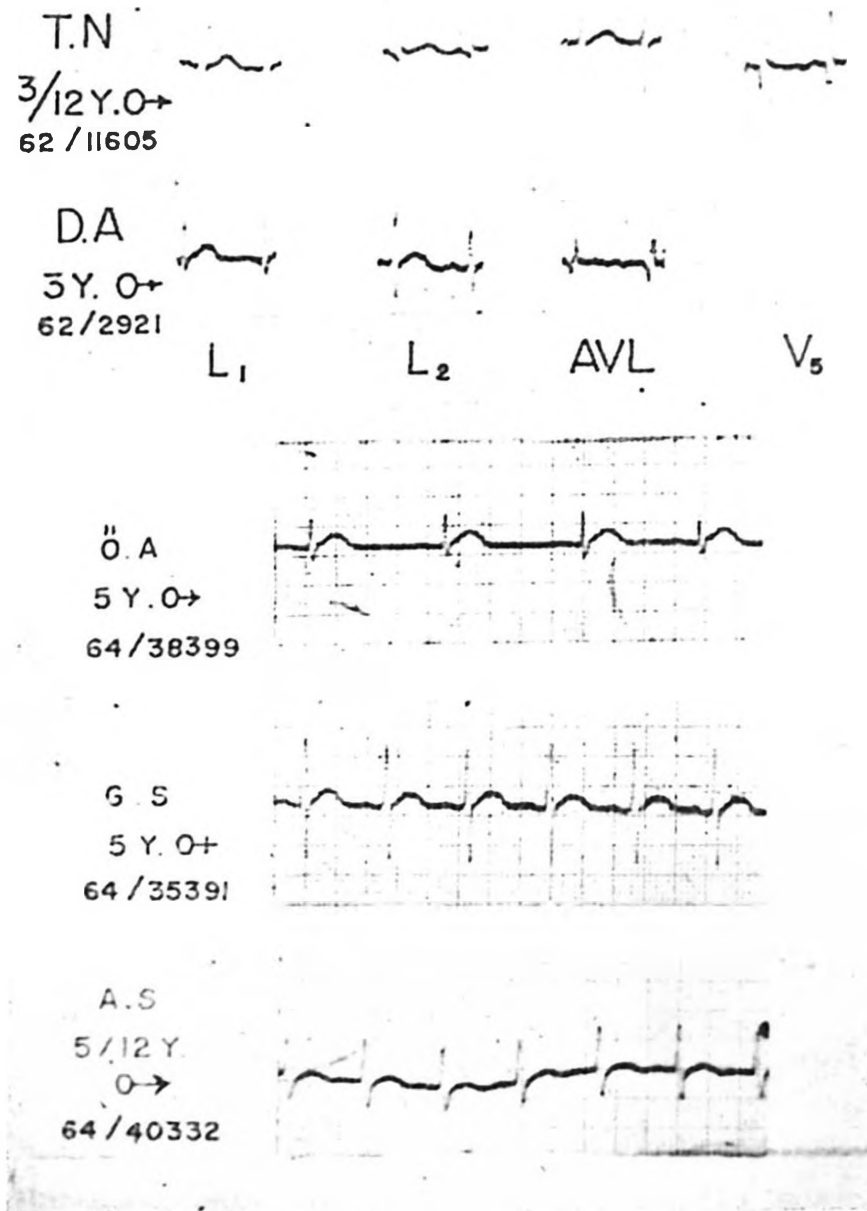
Figure 1. Shows a normal P-QRS-T complex. From the end of the S wave (J point) to the beginning of the T wave is considered the ST segment.

serum phosphorus, total serum proteins, and alkaline phosphatase were determined before the start of treatment and after the T waves began to return to normal. A chest x-ray for an AP view of the heart was made before and after treatment.

Typical laboratory and clinical findings for hypothyroidism were observed in all of the patients, i. e.; dry and rough skin, coarse and brittle hair, vacuous face, mental retardation, thick and protruding tongue, decreased physical activity, myxedema, muffled heart sounds, bradycardia, x-ray observations of delayed bone age, low PBI and high cholesterolemia.

### *Observations*

Electrocardiograms taken in ten different cases of hypothyroidism are shown in Figures 2 and 3. All of the electrocardiograms very greatly resemble each other as is obvious in the pictures. The common feature is the dome shape of the T waves and the absence of the ST segment. The T waves are not flattened, isoelectric, or negative, nor is the duration prolonged as previously described in



**Figure 2.** Shows the electrocardiograms of five hypothyroid patients of various ages. Notice the electrocardiographic changes typical of hypothyroidism, i.e. absence of the ST segment and dome-shaped T waves as well as bradycardia and generalized low voltage.

the literature. The only common feature in these ten electrocardiograms is the disappearance of the ST segment and the dome shaping of the T waves right after the QRS complex as shown in Figures 1 and 2. If we look at the individual QRS complex and the T wave, ignoring the S wave, the remaining electrocardiographic complex resembles the silhouette of a mosque (Figure 4). The amplitude of the arch of the T wave is not as important as its shape which resembles a dome, and which may be high or low arched (see Figure 3, first and second electrocardiograms from the top). This typical mosque sign was present in 16 out of 45 cases of hypothy-

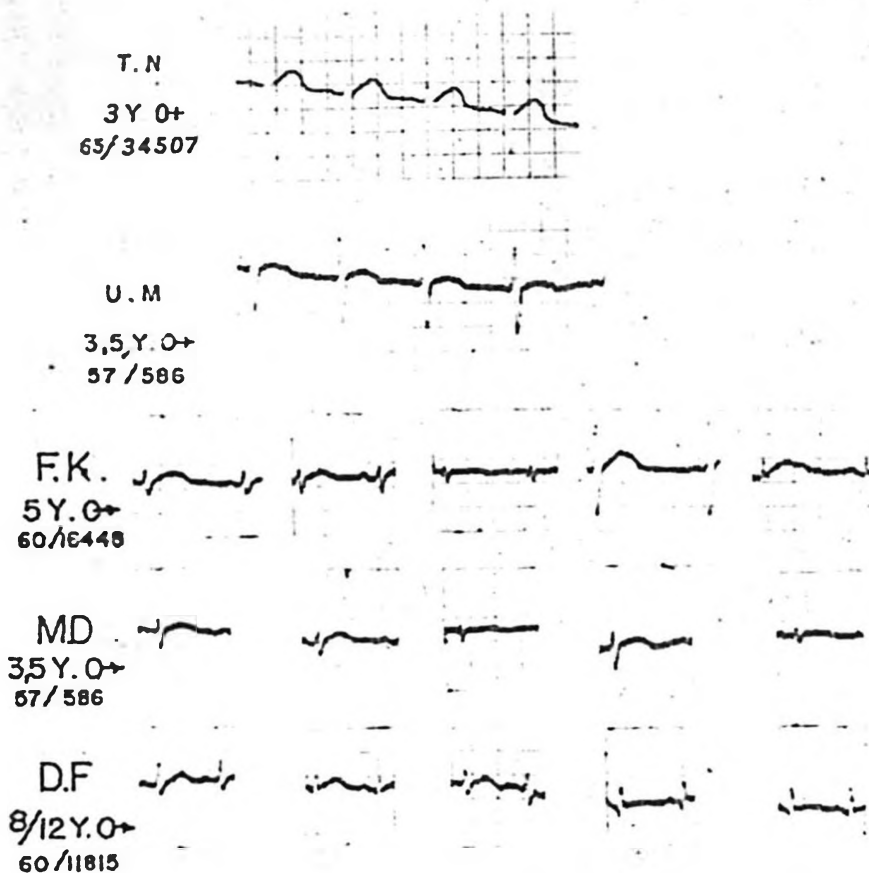


Figure 3. Shows typical electrocardiograms of five cases of hypothyroidism.

roidism or 35 per cent. These observations were not only present in the electrocardiograms reviewed here but also could be detected in the already published electrocardiograms of cases of cretinism but are neither mentioned nor described.<sup>12-13</sup> In 13 patients the electrocardiographic changes were strongly suggestive of hypothyroidism but could not be considered as diagnostic because the T waves were not completely dome-shaped; they were slightly peaked or asymmetric, and some of them had a short ST segment (Figure 5).

The electrocardiograms of the remaining 16 patients revealed normal configuration of the T waves and ST segment. The relationship of these observed electrocardiographic changes to the serum

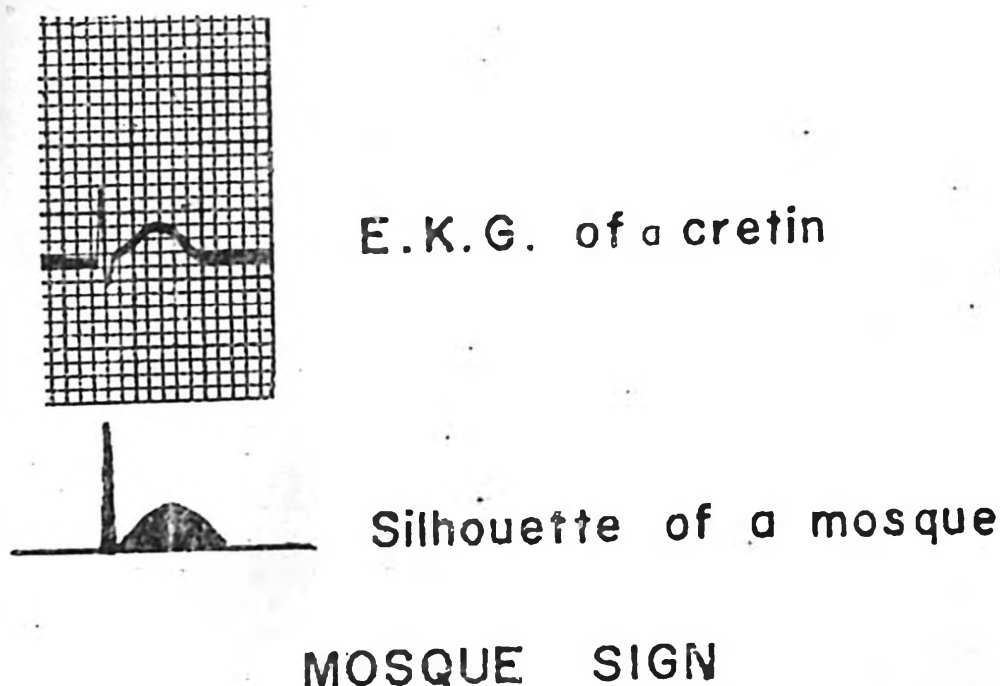


Figure 4. Shows the resemblance between the silhouette of a mosque and the typical electrocardiographic complex of a hypothyroid.

calcium level has been investigated. In 12 patients, before treatment, the serum calcium, serum phosphorus, alkaline phosphatase, serum protein, serum potassium levels and heart x-ray were all within normal limits. During Thyranon treatment, the T waves became normal and repeated control of the serum examinations revealed no change. The ST segment may disappear and the T waves may become convex in idiopathic hypercalcemia but the voltage remains high and there is tachycardia in those cases (Figure 6). A study of the literature also reveals that hypercalcemia is very seldom seen in hypothyroidism.<sup>14-17</sup>

Patients taking Rauwolfia who suffer from glomerulo nephritis, may show the dome-shaped T waves of hypothyroidism but the direction of the T waves usually reverses and the ST segment remains normal or prolonged (Figure 7).

In Figure 8 the lower line shows an electrocardiographic pattern of pericarditis which somewhat resembles the electrocardiographic pattern of the hypothyroid patient above. The T wave here is not dome-shaped and there is an ST segment and tachycardia present. However the voltage is low as in hypothyroidism.

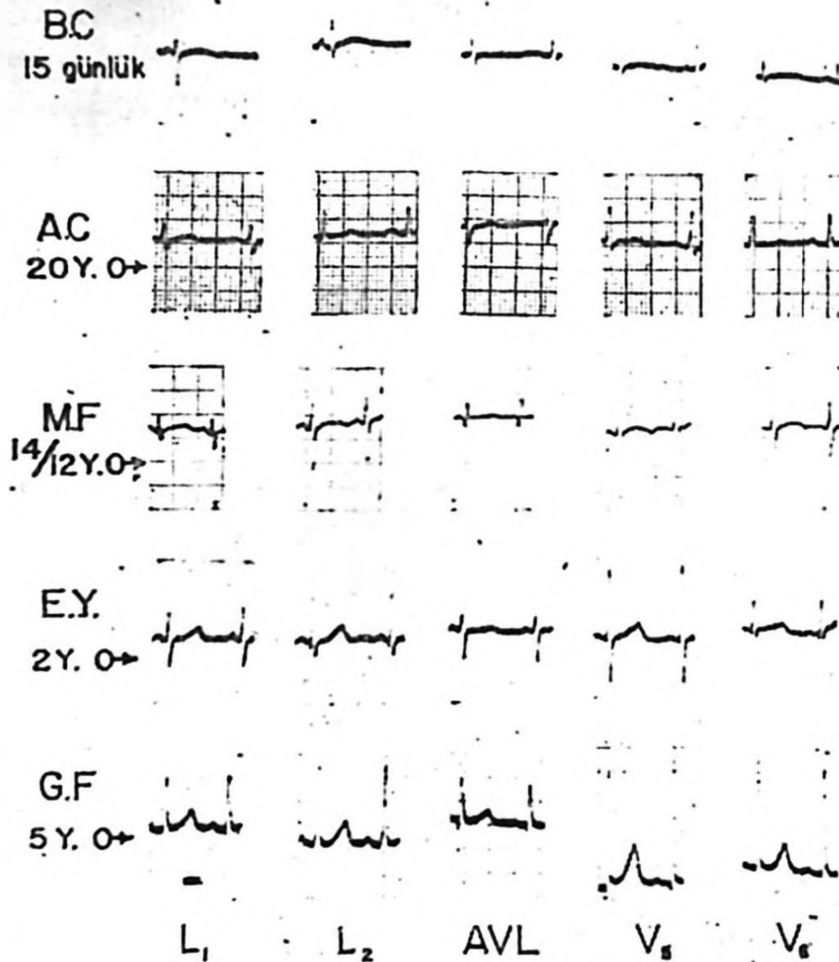
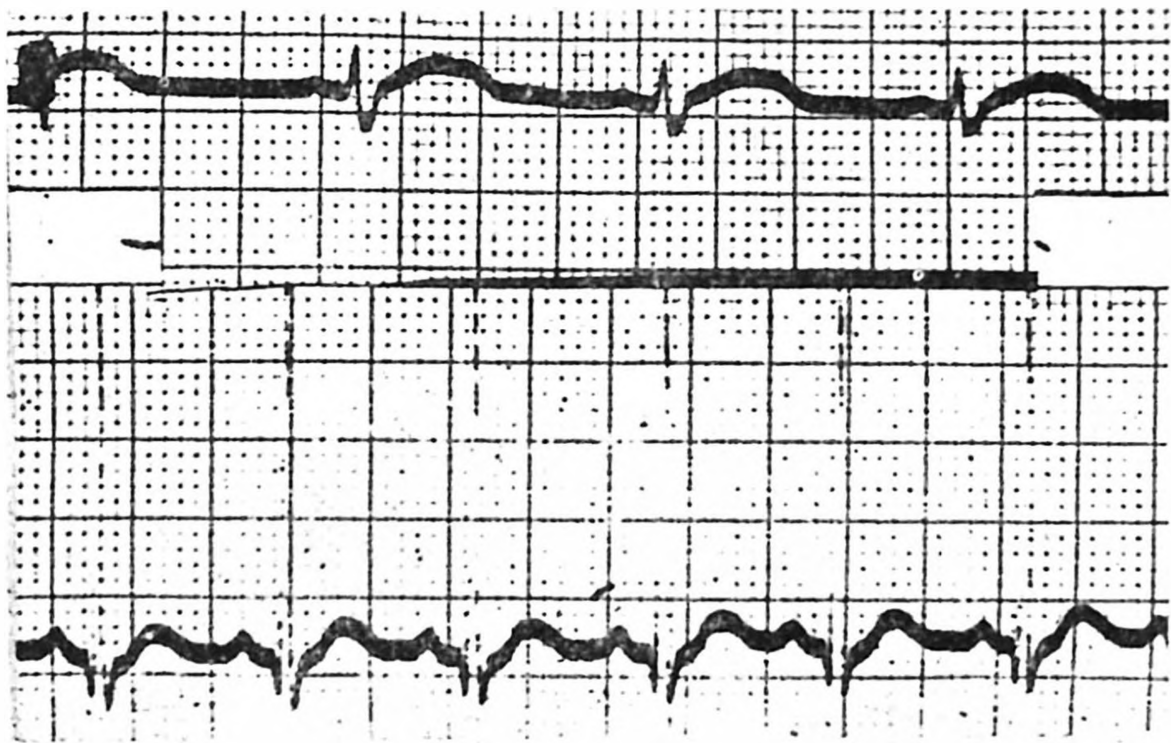


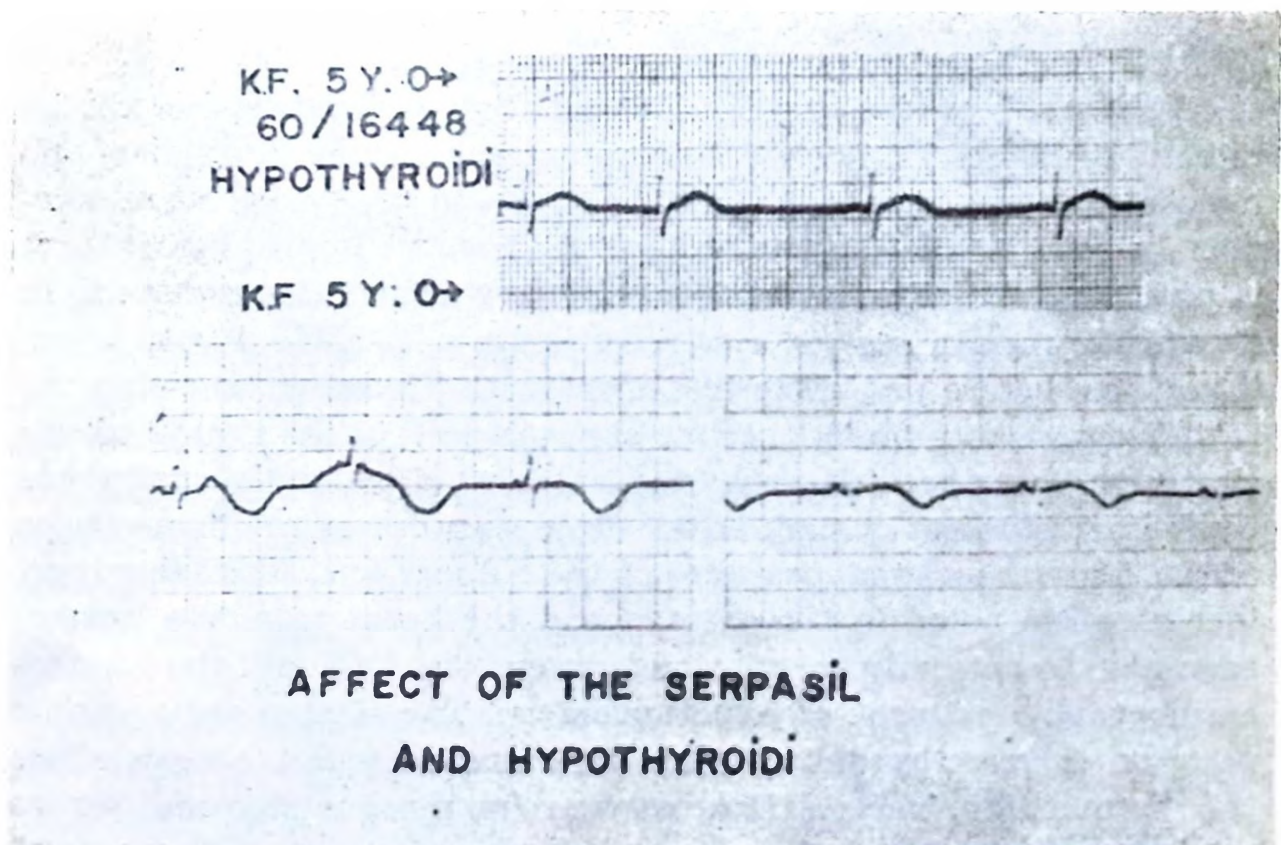
Figure 5. Shows the suggestive electrocardiograms of five hypothyroid cases in which there is a short ST segment and peaked T waves (with the exception of the first case). Generalized low voltage of all the complexes with bradycardia are present.

In Figure 9 the upper line shows an electrocardiogram of a patient with hypothyroidism and the middle and lower lines show the electrocardiograms of a patient suffering from diphtheric myocarditis. In diphtheric myocarditis there are many different electrocardiographic patterns. We chose the one presented here due to its similarity to electrocardiographic changes in hypothyroidism. The difference is shown in the presence of tachycardia and the absence of the mosque sign in myocarditis. Figure 10 shows a comparison between the electrocardiogram of a patient with hypothyroidism and one with kwashiorkor. Notice here that in kwashiorkor, T waves are not dome-shaped, but are asymmetric and slightly peak-



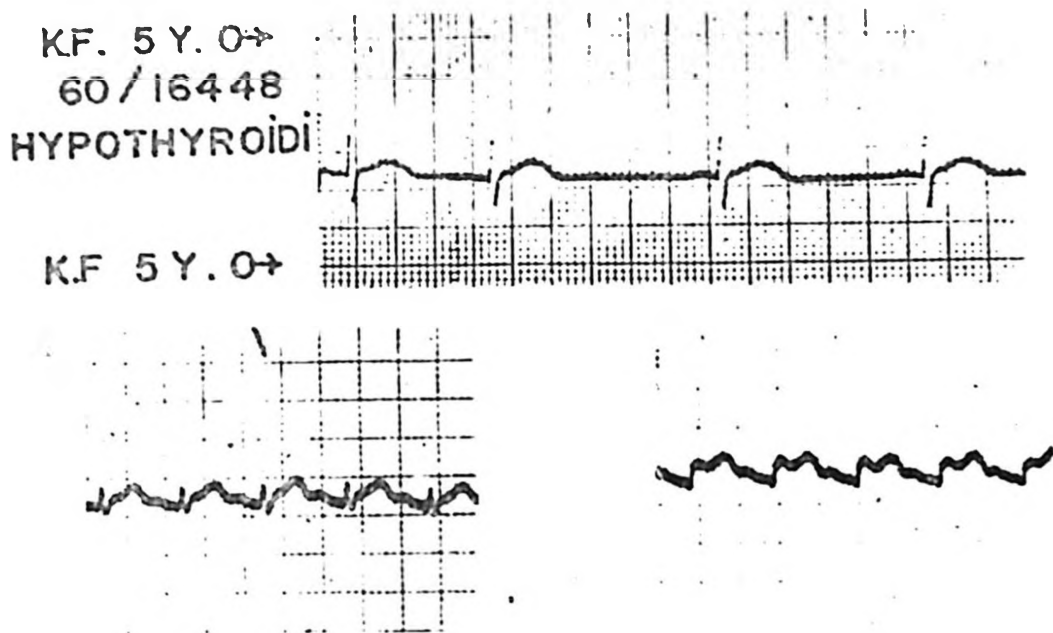


**Figure 6.** Shows disappearance of ST segment and dome-shaped T waves in both diseases. Upper line lead II E.K.G. of a hypothyroid patient, lower line electrocardiogram of a hypercalcemia patient.



**Figure 7.** Shows the effect of the serpasil in acute glomerulo nephritis. Notice reserved but dome-shaped T waves in patient taking serpasil. The upper line is a typical E.K.G. of hypothyroidism in lead II.





### PERICARDITIS AND HYPOTHYROIDİ

Figure 8. The upper line is a typical E.K.G. of hypothyroidism. The lower line is an E.K.G. showing pericarditis. Notice : presence of ST segment and tachycardia in pericarditis.

ed. Tachycardia is also present. However low voltage is common in both. In Figure 11, two electrocardiograms of hypothyroidism and hypokalemia are compared. Low voltage and bradycardia are common in both of the electrocardiograms, but in hypokalemia there is prolonged ST segment and the T wave is not dome-shaped. In Figure 12 you can see the electrocardiogram of a child with hypothyroidism before and after treatment with Thyranon, showing the fast disappearance of the mosque sign. As seen in the figures of the electrocardiograms of hypothyroid cases who are under continuous treatment, the first change is the disappearance of the dome shape of the T waves and reappearance of the ST segment. At a later time, increases are noted in the voltage and the heart rate. We haven't been able to note any correlation between the PBI and the electrocardiographic patterns of hypothyroidism. The electrocardiographic patterns in hypothyroidism may vary and may not always show the mosque sign. The relation between the mosque sign and serum calcium, serum phosphatase, alkaline phosphatase, PBI, x-ray of the heart, bone age, mental retardation could not be established in our study.

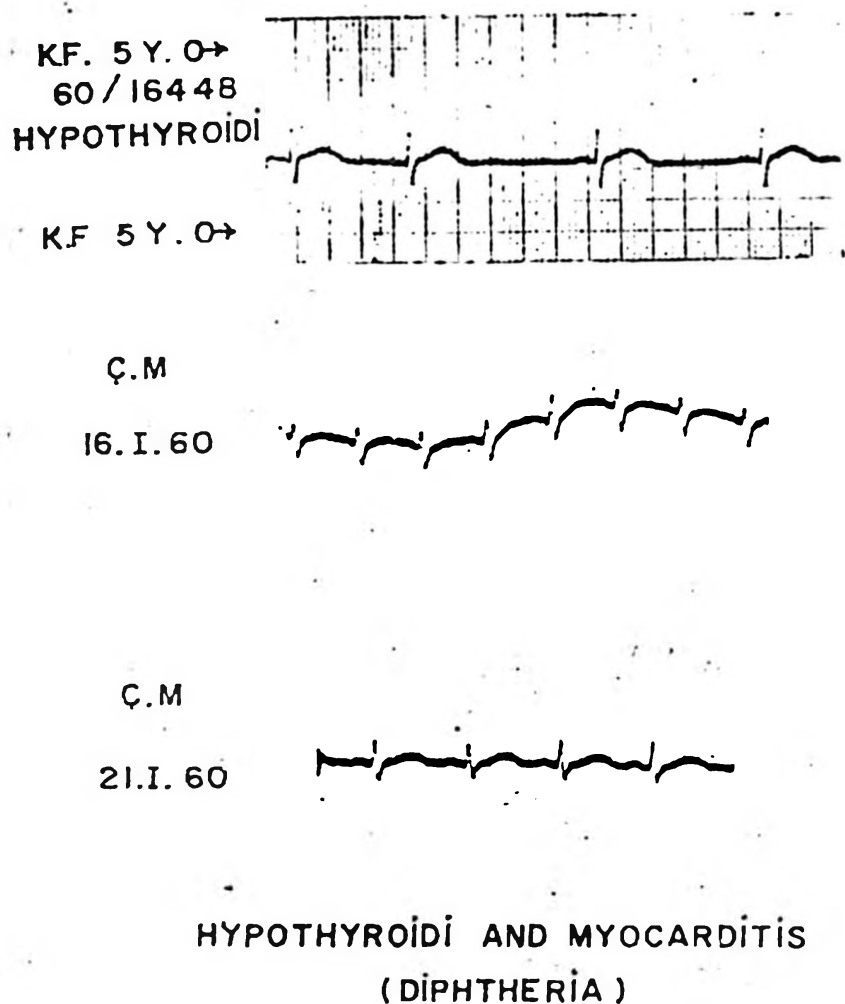


Figure 9. Reveals the similarity of the E.K.G. showing hypothyroidism (upper line) and that showing diphtheric myocarditis (middle and lower line). Low voltage and flattening of T waves are common; the presence of tachycardia in myocarditis makes the differentiation.

It is possible to diagnose a case of hypothyroidism in infants and children with these characteristic changes in an electrocardiogram.

### *Summary*

Dome-shaped T waves and the absence of the ST segment combined with generalized low voltage of all complexes with bradycardia are specific signs of hypothyroidism. Views of some electrocardiograms of hypothyroid patients remind one of the silhouette of a

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HYPOTHYROIDİ



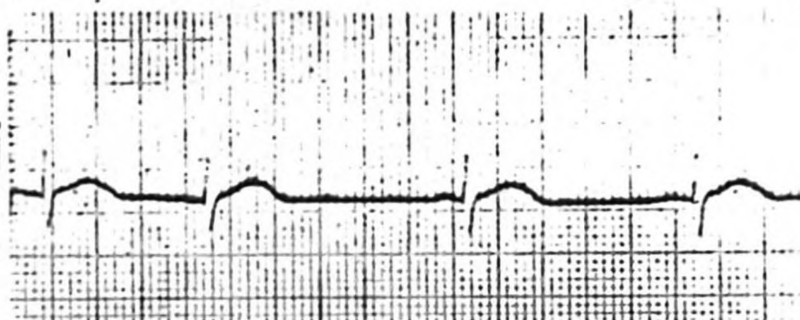
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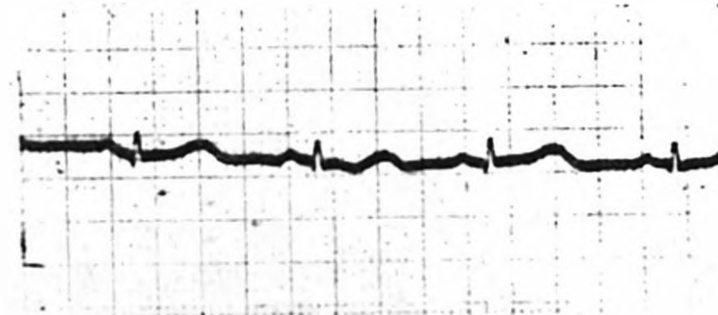
## KWASHIORKOR AND HYPOTHYROIDİ

Figure 10. Shows E.K.G. changes of hypothyroidism (upper) and Kwashiorkor (lower line) low voltages are common. T waves are not domed in Kwashiorkor. Notice the presence of tachycardia.

K.F. 5 Y. O→  
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HYPOTHYROIDİ



K.F. 5 Y. O→



## HYPOTHYROIDİ AND HYPOKALEMİA

Figure 11. Shows E.K.G. of hypothyroidism and the E.K.G. of Hypokalemia (lower line). Notice that bradycardia and low voltage are common, but the prolonged ST segment in hypokalemia makes the distinction.

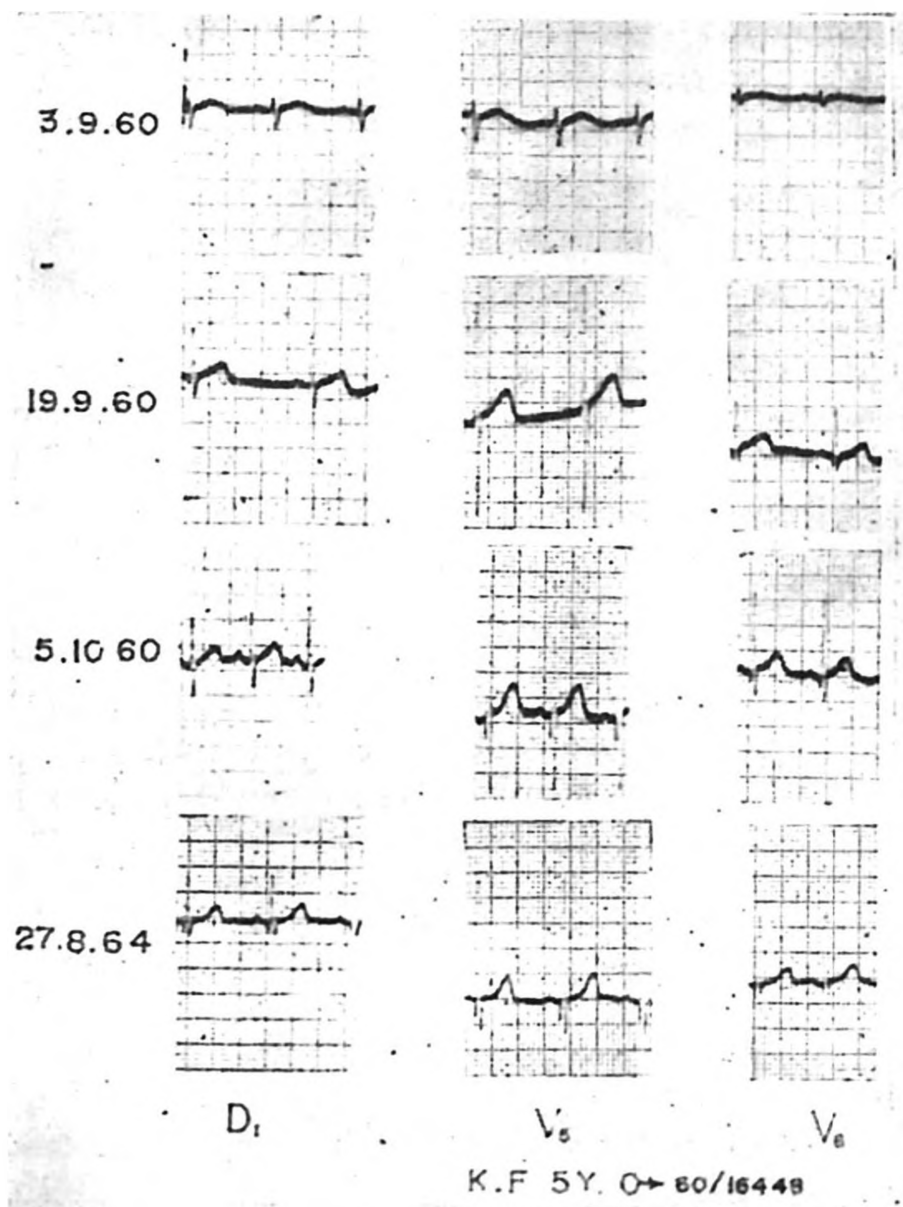


Figure 12. Reveals the progressive electrocardiographic changes of a hypothyroid undergoing treatment. The T waves gradually lose their dome-shaped appearance followed by the reappearance of the ST segment and a voltage increase, especially obvious in lead V6.

mosque. The dome-shaped T wave immediately after the QRS complex without an ST segment resembles a minaret with a dome. This observation has been present in 16 of 45 hypothyroid patients. In 13 patients the electrocardiographic changes were suggestive of hypothyroidism but not diagnostic. The electrocardiograms of the remaining 16 patients had only some non-specific changes.

I found that when this change is present, it is diagnostic, but when it is not present, it is not necessarily indicative of the absence of hypothyroidism.

On rare occasions, electrocardiographic findings in different types of myocarditis and electrolyte disturbances might have an

appearance somewhat resembling these changes. However, I have not been able to find these characteristic electrocardiographic changes in any other disease except hypothyroidism in infants and children.

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