Electrocardiographic Abnormalities in Combined Hypercalcaemia and Hypokalaemia—Case Report

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Abstract

A 47-year-old woman presented with extreme hypercalcaemia due to a parathyroid carcinoma. An electrocardiogram which was recorded when the hypercalcaemia was associated with hypokalaemia showed absence of the ST segment, prolonged T wave, a shortened QTac interval and prominent U waves.

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Key words: Parathyroid carcinoma, Shortened QTac interval

Introduction

The electrocardiographic abnormalities in isolated hypercalcaemia and hypokalaemia have been well documented in the literature.[1-3] However, electrocardiogram (ECG) findings in combined hypercalcaemia and hypokalaemia have rarely been described. We report the ECG findings in a patient with parathyroid carcinoma who presented with severe hypercalcaemia which was associated with mild hypokalaemia.

Case Report

A 47-year-old Chinese woman was admitted to hospital because of fever, weight loss, vomiting and frequency of micturation. She was previously treated for bilateral renal stones with surgery and short wave lithotripsy. Clinical examination revealed a palpable mass on the right side of the neck. The blood pressure was 160/90 mmHg, but subsequently fell to about 140/80 mmHg in the next few days.

The laboratory tests on admission to hospital showed the following findings: haemogloblin was 11.3 gm/L, total white blood cell count was 13,170/L, serum creatinine was 2.2 mg/dL, blood urea nitrogen was 46.8 mg/dL, serum Na^+ was 132 mEq/L, K^+ was 3.0 mEq/L, Cl^- was 89 mEq/L, glucose was 110 mg/dL, Ca^+ was 21.4 mg/dL, ionized Ca^+ 11.9 mg/dL, phosphorous was 5.2 mg/dL and alkaline phosphatase 158 u/L. The serum parathyroid hormone level was extremely elevated at 2751.0 pg/ml (normal <65 pg/ml). Several sequential ECGs were performed. The serum calcium and electrolyte levels were also repeatedly measured. Ultrasound examination of the neck showed a solitary mass which was inseparable from the lower pole of the right lobe of the thyroid gland. Ultrasound of the kidneys showed several small calculi. The patient was initially treated with intravenous disodium clodronate together with saline infusion for the severe hypercalcaemia, intravenous potassium chloride for the hypokalaemia and also intravenous ceftriaxone for suspected pyogenic infection. An excision biopsy of the neck mass was then carried out. Two days later, right hemi-thyroidectomy and right neck dissection were performed. Histological examination of both the biopsy specimen as well as the tumour which was removed at surgery showed a parathyroid carcinoma. The patient made a good recovery and was discharged from the hospital 2 weeks after the operation in a satisfactory condition. One day before the operation, serum Na^+ was 139 mEq/L, K^+ was 3.7 m/EqL and Cl^- was 105 mEq/L. About 10 months after the operation, serum Na^+ was 142 mEq/L, K^+ was 3.7 mEq/L and Cl^- was 104 mEq/L. All these values were within the normal limits.

Figure 1 was recorded 2 days after admission to hospital when the serum calcium and ionized calcium levels were both elevated at 19.4 mg/L and 12.0 mg/L respectively and the serum Na^+ was 139 mEq/L, K^+ was 3.6 mEq/L and Cl^- was 107 mEq/L. The ST segment was almost absent and the QTc and QTac intervals were both

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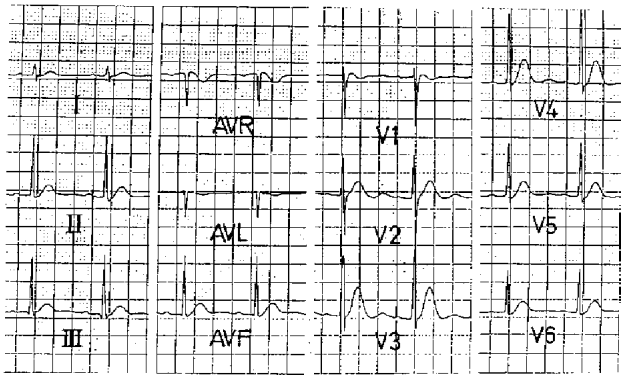

Fig. 1. 12-lead ECG. Note the following: (1) virtual absence of ST segment (2) shortened QTc (0.36s) and QTac (0.23s) interval (see text).

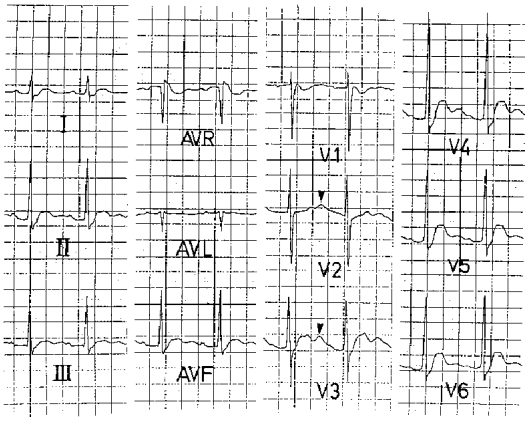

Fig. 2. 12-lead ECG. Note the following: (1) absence of ST segment (2) prolonged T wave. This is due largely to a blunted and widened apex in leads I, II, III, AVF, V4 to V6 and a wide and bifid apex in lead V3 (3) normal QTc interval (0.41s) (4) shortened QTac interval (0.26s) (5) prominent U waves especially in leads V2 and V3 (arrow heads) (see text).

considerably shortened at 0.36s and 0.23s respectively. The QTac interval was measured from the onset of the QRS complex to the apex of the T wave and it was corrected for heart rate. Figure 2 was recorded soon after admission to hospital when the serum calcium and ionized calcium levels were both elevated at 21.4 mg / dL and 11.9 mg / dL respectively and the serum potassium level was low at 3.0 mEq / L. The ST segment was again virtually absent. However, the T wave was prolonged in duration due largely to a blunted and widened apex in leads I, II, III, AVF, V4 to V6 and a wide and bifid apex in lead V3. As a result of the prolonged T wave, the QTc interval was normal at 0.41s although the QTac was still shortened at 0.26s. In addition, very prominent and high amplitude U waves were seen especially in leads V2 and V3. In lead V2, the amplitude of the U wave exceeded and in lead V3, it was approximately equal to the amplitude of the T wave. Figure 3 was recorded several days after surgery, when the serum calcium and ionized calcium levels were both slightly decreased at 7.2 mg / dL and 4.5 mg / dL respectively and the serum K^+ was 4.0 mEq / L. The ECG showed subtle changes of hypocalcaemia as reflected by an elongation of the ST segment and

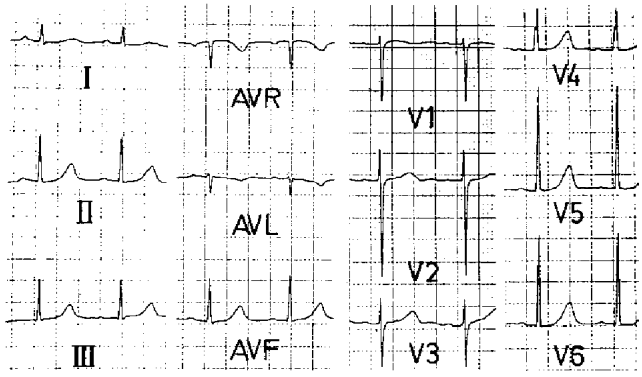

Fig. 3. 12-lead ECG. There is prolongation of QTc interval (0.46s). Low amplitude U waves are seen in leads V2 and V3 (see text).

a prolonged QTc interval of 0.46s. Low amplitude U waves are present in leads V2 and V3.

Discussion

The classical ECG feature of hypercalcaemia is a shortening of the ST segment resulting in an abbreviation of both the QTc as well as the QTac intervals. The other abnormalities which have also been described are:

1) a J wave or a widened QRS complex,
2) elevation of the ST segment, and
3) flattened or inverted T waves.

At serum calcium levels of ≥16 mg / dL, the T wave may become prolonged resulting in a normal QTc interval even though the ST segment is shortened.[1] Bronsky and co-workers[4] reported that U waves were seen in 1 out of 12 of their patients presenting with hypercalcaemia due to hyperparathyroidism and in 6 out of their 23 other patients presenting with hypercalcaemia due to other causes. However, in all these 7 patients, the U waves were of normal appearance and amplitude. Sridharan and Horan[5] reported a patient with hypercalcaemia who manifested prominent J waves in addition to the classical ECG abnormalities of hypercalcaemia. In addition, tall U waves were also present although this was not highlighted in their paper. However, since the serum potassium level was not stated in their report, one wonders whether hypokalaemia could have been a contributory cause of the prominent U waves.

In contrast to hypercalcaemia, the ECG changes of hypokalaemia consist chiefly of:

1) an increase in the U wave amplitude,
2) a decrease in the T wave amplitude,
3) a depressed ST segment, and
4) first and second degree A-V block of the Wenckebach type.[1,2]

The simultaneous occurrence of hypercalcaemia and hypokalaemia is uncommon in clinical practice. Electrocardiographic manifestation of these two combined metabolic abnormalities is even rarer. Figure 1

shows the classical features of isolated hypercalcaemia as reflected by an absence of ST segment and very short QTc and QTac intervals of 0.36s and 0.23s respectively. Although U waves are present in the ECG, they are normal in morphology and amplitude. Figure 2 illustrates the ECG manifestation of combined hypercalcaemia and hypokalaemia. It is very likely that the absence of the ST segment, widened T wave and the shortened QTac were all due to the extreme hypercalcaemia. On the other hand, the very tall U waves were most likely due to hypokalaemia alone or a combination of the hypokalaemia and hypercalcaemia. According to Lepeschkin,[6] the normal U wave is tallest in leads V2 to V3 and the largest precordial U wave amplitude averages 11% of the largest T wave amplitude ranging from 3% to 24% in 98% of cases. In Figure 2, the U waves were very prominent and markedly abnormal. In lead V2, the amplitude of the U wave exceeded and in lead V3, it was approximately equal to the amplitude of the T wave.

This case report illustrates that distinctive ECG abnormalities can occur in combined hypercalcaemia and hypokalaemia. However, the sensitivity and specificity of these ECG changes in the diagnosis of these two combined metabolic abnormalities must await future studies involving large numbers of patients.

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