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Case Report

Camel Hump T Waves and the "Tee-Pee Sign" – Electrocardiographic Evidence of Severe Electrolyte Abnormalities

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Abstract

The Electro Cardiogram (ECG) is an invaluable tool in the assessment of the acutely unwell patient. Several conditions, including electrolyte imbalance, can result in classical ECG appearances. We present a case in which simultaneous severe deficiencies in magnesium, calcium and potassium were present and discuss the ECG features present, namely "camel hump T waves" and the "Tee-Pee sign". Moderate deficiency in phosphate was also present. The causes of these electrolyte deficiencies in this patient are also reviewed. Following an extensive literature search this appears to be the first report in which both "camel hump T waves" and the "Tee-Pee sign" are simultaneously present on the same ECG and also the most dramatic example of "camel hump T waves" that we have encountered.

Introduction

Electrocardiographic (ECG) interpretation is an essential requirement for higher specialist training in emergency medicine [1] and increasingly so in other specialties [2].The role of the ECG in the assessment and management of acutely unwell patients has long since extended beyond the evaluation of chest pain. Electrolyte imbalance is one of many conditions which can produce classical ECG appearances [3,4]. We present a case in which the simultaneous presence of multiple severe electrolyte deficiencies resulted in dramatic ECG changes, namely "camel-hump T waves" [5] and the "Tee-Pee sign" [6].

Case Report

A 69-year old female presented to our Emergency Department (ED) with a one-week history of a productive cough and shortness of breath. Her family physician had treated her with antibiotics but nevertheless her symptoms persisted. She was found in a collapsed state by her partner at 08:00am having last seen her at 03:00am when she got up to go to the bathroom. Her past medical history was significant for chronic alcohol abuse and pancolitis, for which, she underwent a total colectomy with fashioning of an end ileostomy, several years earlier. On arrival she was noted to be obtunded (Glasgow coma scale was 13/15). She was confused, opened her eyes to verbal stimuli and she obeyed commands).Respiratory examination revealed a respiratory rateof48 breaths per minute. She was unable to speak in full sentences and widespread crepitations were noted over both lung fields.

Relevant laboratory investigations, taken shortly after arrival to the ED revealed severe deficiencies of potassium, calcium and magnesium as well as moderate deficiency in phosphate (Table 1). Acid base balance revealed a combined severe respiratory acidosis (PCO214.7 KPa) and severe metabolic alkalosis (BE 33.3, HCO3 56) which was almost completely compensated. Correction of electrolyte abnormalities was commenced. Approximately 2 hours and 20 minutes after arrival to the ED she suffered a cardiac arrest. The initial cardiac arrest rhythm was PEA (pulseless electrical activity). The cardiac arrest lasted for 6 minutes (three, two-minute cycles of cardiopulmonary resuscitation) after the intensive care unit where her treatment was continued. An ECG, performed by paramedics en-route to hospital (Figure 1), revealed a bizarre ap-

pearance to the T waves in leads V2 and V3, which have been likened to the appearance of a camel's hump, hence the name camel-hump T waves (Figures 2& 3). Other findings include pre-existing left bundle branch block, prolonged QTc and U-waves were noted in leads V2-V5. Marked ST segment depression was observed in the inferior and lateral leads (II, III, aVF, V5 and V6).

Parameter	Value	Reference Range
Sodium	143 mmol/L (143mEq/L)	135-145 mmol/L (135-145 mEq/L)
Potassium	1.8 mmol/L (1.8mEq/L)	3.5-5.3 mmol/L (3.5-5.3 mEq/L)
Corrected Calcium	1.51 mmol/L (6.04 mg/dL)	2.20-2.60 mmol/L (8.7-10.3 mg/dL)
Magnesium	0.55 mmol/L (1.32mg/dL)	0.75-0.95 mmol/L (1.82-2.31 mg/dL)
Phosphate	0.6 mmol/L (1.87mg/dL)	0.8-1.5 mmol/L (2.5-4.5 mg/dL)
pH	7.33	7.35-7.45
PaCO2†	14.7 kPA† (110.3mmHg)	4.7-6.0 kPA† (35-45 mmHg)
Base excess (BE)	33.3 mmol/L	+2 to -2
Bicarbonate (HCO3)	56 mmol/L (56 mEq/L)	22-26 mmol/L (22-26 mEq/L)
Lactate	4.1 mmol/L (41mg/dL)	< 2 mmol/L (<2 mg/dL)

Table 1: Electrolyte concentrations and acid base result on presentation to hospital [7]. †KiloPascals

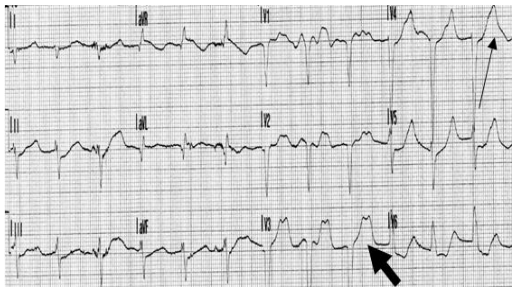

Figure 1: ECG performed by paramedics prior to their arrival to hospital– Camel hump T waves are visible in leads V2-V3 (thick arrow) and the "Tee-Pee sign" in leads V4-V5 (thin arrow).

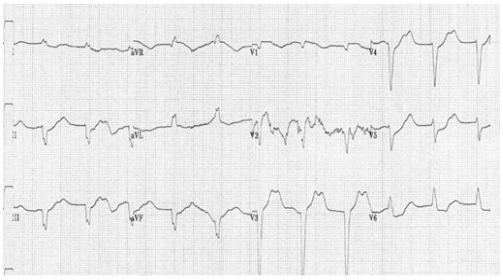

Figure 2: Initial ECG in the Emergency Department.

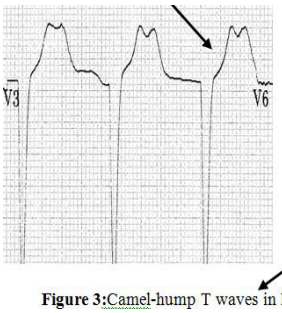

Figure 3: Camel-hump T waves in lead V3resulting from the fusion of tall T and GiantU waves.

The "Tee-Pee sign",so called as it resembles the shape of a traditional native American Indian's home [6]. Initially, in Figure 4, Panel A, the QT interval appears long but once the end of the T wave is identified the QT interval is considerably shorter than first appeared in Panel A, which in fact we can now state was a QU not a QT interval. The start of the U wave is identified as the point where the slope of the T wave deviates away from its normal slope (arrow head).

A repeat ECG was performed 3 hours after commencement of treatment (Figure 5). This showed resolution of the camel-hump T wavesand "Tee-Pee sign".

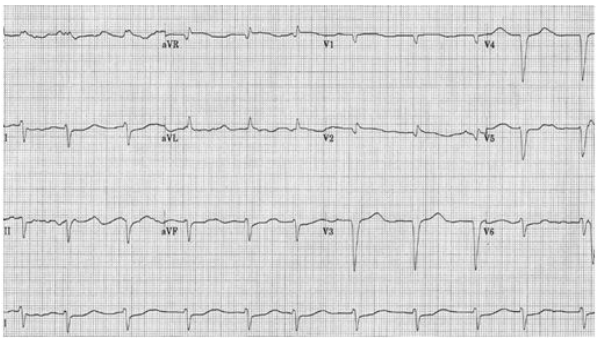

Figure 5: ECG recorded 3 hours after correction of both severe hypocalcaemia and severe hypokalaemia (Ca2+= 2.14 mmol/L and K+ = 3.6 mmol/L).

Case progression: In addition to the electrolyte abnormalities our patient was treated for aspiration pneumonia. On day 3 she was successfully extubated and over the following 2 weeks she improved slowly. On day 16 she was discharged home. Outpatient follow up was arranged with the treating medical team and with the dieticians.

Discussion

Isolated electrolyte deficiencies can result in classical ECG changes (Table 2). When deficiencies in more than one electrolyte ispresent, it is often more difficult to detect the electrolyte abnormalities on ECG alone [6]. Surawicz reported that the QT interval in hypocalcaemia rarely exceeds 140% of the normal [9]. If it does then a second electrolyte abnormality is likely to be present. Johri et al reported a case in which a combination of hyperkalaemia, hypocalcaemia and hypomagnesaemia resulted in pre-cordial QRS complexes with peaked T waves, prominent U waves and prolongation of the descending limb of the T wave [6].This resulted in the T wave overlapping the U wave and they called it the "Tee-Pee Sign" because the shape of the QRS complexes resembled the traditional shape of native American Indians dwelling. The combination of prolongation of both the ST segment and descending limb of the T-waveresulted in pseudo-prolongation of the QT interval [6].We identified the same ECG changes in our patient[Figures 1&4] eventhough the electrolyte abnormalitieswere somewhat different. In our patient severe hypokalaemia (1.8 mmol/L) instead of hyperkalaemia was present in addition to severe hypomagnesaemia (0.55 mmol/L), severe hypocalcaemia (1.51 mmol/L), and moderate hypophosphataemia. (0.6 mmol/L) [Table 2].

Electrolyte Abnormality	ECG Features
Hypomagnesaemia	Slight prolongation of PR interval Slight prolongation of QRS complexes ST depression Tall peaked T-waves Broad, flattened T-waves Prominent U waves Prolonged QT interval Reduced height of QRS complexes
Severe hypomagnesaemia (<60 mmol/L)	Ventricular tachycardia Torsades de pointes Ventricular fibrillation
Severe Hypocalcaemia (<1.9 mmol/L)q	Prolonged QT due to prolonged ST segment Flattening of the T-waves
Hypokalaemia	Increased amplitude and width of the P wave Prominent U waves Prolonged PR interval ST depression Flattening of T waves
Very low K+ (<1.9 mmol/L)	Giant U waves which encroach on and fuses with the T waves T wave inversion Increased risk of ventricular ectopic beats
Hypophosphataemia Moderate deficiency	Supraventricular tachycardia Premature ventricular beats

Table 2: Electrolyte abnormalities and classical ECG features [8][9]

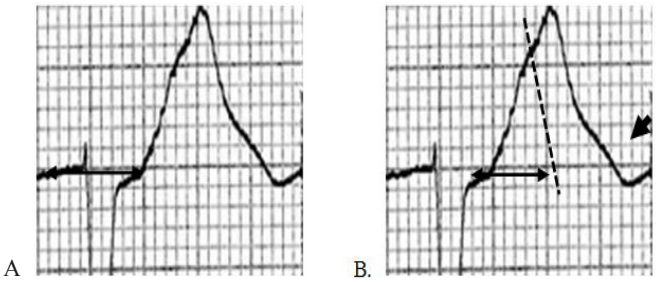

Figure 4: Lead V4 "Tee-Pee sign" resulting from fusion of the T and U waves (Arrow head).

Christl et al observed the excretion of between 400–1000 ml of isotonic ileostomy fluid resulting in a chronic salt and water depletion [11]. Hypomagnesaemia is the most common electrolyte abnormality in chronic alcohol abuse (29.9%) while hypophosphataemia is the second most common (29.1%) [11]. Camel hump T waves are not specific for electrolyte imbalance. We think that the presence of multiple severe electrolyte abnormalities is the cause for these very dramatic camel hump T waves, formed by fusion of the T waves and Giant U waves (Figure 3). The electrolyte imbalances in our patient, were due to a combination of poor intake of electrolytes as seen in chronic alcohol abuse [10], reduction in absorption following total colectomy [11], and loss of isotonic fluid as a result of ileostomy [11].

Conclusion

Electrolyte imbalanceis common in association with chronic alcohol abuse and in patients with anileostomy. Classical ECG features may be present when single electrolyte imbalance is present facilitating early diagnosis and treatment. The simultaneous presence of multiple electrolyte imbalances can be more difficult to detect. We have identified multiple electrolyte imbalances and have observed dramatic ECG changes of camel-hump T waves and the "Tee-Pee sign". This combination of electrolyte imbalance has not previously been reported and this is the most dramatic example of camel hump T waves which we have encountered. Further research aimed at early identification of multiple electrolyte deficiencies is required.

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