Case Report

Hypokalaemia-induced acute renal failure

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Introduction

Chronic hypokalaemia is encountered in a variety of clinical settings. These include chronic diarrhoea resulting from inflammatory bowel disease, gastrointestinal infection or laxative abuse. Alternatively ‘renal’ wasting of potassium causing chronic hypokalaemia can arise from primary or secondary hyperaldosteronism, diuretic use or abuse and primary tubular disorders such as Bartter’s syndrome.

Potassium deficiency alters the function of several organs and most predominantly affects the cardiovascular system, neurological system, muscles and kidneys [1]. Cardiac complications of prolonged hypokalaemia include ventricular arrhythmias and hypertension. Neuromuscular manifestations include muscle weakness and cramps as well as an increased incidence of rhabdomyolysis. The described renal lesions associated with chronic hypokalaemia include: proximal tubular vacuolization accompanied by nephrogenic diabetes insipidus [2], interstitial nephritis accompanied by varying degrees of renal impairment [3,4] and an increased incidence of simple renal cysts [5]. We report a case of reversible anuric acute renal failure arising in a patient with known chronic hypokalaemia secondary to prolonged laxative abuse.

Case

A 62-year-old male presented with constipation associated with vomiting and abdominal pain. The patient was known to abuse laxatives, consuming up to 1 l/day of Agarol (liquid paraffin preparation) for at least 5 years. He was obese (body mass index of 31, normal range 18.5–24.9 kg/m²) and had recently developed leg weakness requiring the use of a pick-up frame to walk. The patient admitted to drinking approximately 100 g/day of alcohol.

Physical examination revealed the patient to be obese but not unwell. His blood pressure was 120/80 mmHg with a postural drop of 30 mmHg, heart rate was 80 bpm and temperature was 36.5 °C. Mucous membranes were dry and tissue turgor was decreased. The patient had poorly localized abdominal tenderness with no signs to suggest peritonism. Neurological examination revealed evidence of a proximal myopathy.

Initial investigations showed serum concentrations of sodium 127 mmol/l, potassium 2.7 mmol/l, chloride 90 mmol/l, bicarbonate 13 mmol/l, urea 28.6 mmol/l, creatinine 0.55 mmol/l. Arterial blood gases on room air revealed a pH of 7.28, PCO₂ 29 mmHg, PO₂ 96 mmHg, bicarbonate 13 mmol/l, oxygen saturation 98%. Serum glucose, amylase and lactate were within normal limits. Serum calcium was 2.19 mmol/l, magnesium 1.05 mmol/l and phosphate 3.57 mmol/l. Creatine kinase was 300 U/l (normal <200 U/l). Total protein was 70 g/l, albumin was 34 g/l, other liver function tests were within normal limits. Full blood examination revealed a Hb of 17 g/dl, WCC 14.04 × 10⁹/l, neutrophils 12.29 × 10⁹/l, platelets 239 × 10⁹/l. INR (international normalized ratio for prothrombin time) was 2.6 and APTT (activated partial thromboplastin time) 44.2 s. ECG revealed sinus rhythm with a left axis deviation, T-wave flattening but no U waves. Renal ultrasound showed normal sized kidneys with no evidence of hydronephrosis.

Serum electrolytes and renal function tests had been performed on the patient 3 and 5 years prior to this presentation. These showed normal serum sodium, bicarbonate, urea and creatinine but a serum potassium of 2.2 mmol/l and 2.4 mmol/l respectively.

A central venous catheter was inserted into the patient and an initial central venous pressure measurement of 2 mmHg was recorded. The patient was infused with both crystalloid and colloid solutions until a central venous pressure of 12 mmHg was achieved. Despite the insertion of an indwelling catheter no urine output was observed. Dopamine infusion (4 µg/kg/min) and frusemide infusion were commenced however, the patient remained anuric.

A renal biopsy was performed after correction of the patient’s coagulopathy with fresh frozen plasma.

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Renal biopsy findings

The predominant lesion seen on biopsy was extensive vacuolization of the proximal convoluted tubular epithelial cells. The vacuoles were generally large but varied in their size and diameter (Figure 1). In many instances they were seen beneath the nuclei of the epithelial cells. These changes were so florid that in places the tubular epithelium appeared to be disintegrating and the tubular lumens appeared to be totally obliterated. Some glomeruli demonstrated widening of Bowman’s space suggesting an element of obstruction, but otherwise glomeruli appeared normal. The distal convoluted tubules appeared normal, as were the medullary tubules and collecting ducts. There was widespread moderate medullary and mild cortical interstitial fibrosis present with a minimal mononuclear infiltrate. There was mild to moderate uneven sclerotic thickening of the intima of arteries with mild arteriolar hyalinosis. There was no evidence of juxtaglomerular hyperplasia or hypertrophy.

Progress

The patient was commenced on haemodialysis and dialysed against a dialysate potassium concentration of 4 mmol/l. He was also commenced on oral potassium supplementation. By day 7 of his admission, the patient’s serum potassium and bicarbonate were within normal limits. The patient began to pass urine on day 9 and haemodialysis was ceased on day 10. The patient’s renal function improved over the subsequent weeks such that by day 40 the patient’s electrolytes were all within normal limits.

During his hospital stay, it became clear the patient had a fixation on bowel function. He used laxatives to ensure that he passed frequent soft bowel actions (up to 25/day). With much counselling, the patient acknowledged that his behaviour had proved to be life-threatening and he agreed upon discharge to abstain from laxatives. At last follow-up, 18 months following the initial presentation, the patient’s serum creatinine was 0.09 mmol/l, serum potassium 4.2 mmol/l, creatinine clearance 0.73 ml/s and total protein excretion 0.20 g/day. There was no observed improvement in the proximal myopathy.

Discussion

The term ‘kaliopenic nephropathy’ was coined by Conn and Johnson in the 1950s to describe the vacuolization of the proximal convoluted tubule that often accompanied prolonged hypokalaemia in both rats and humans [6]. The lesion itself was thought to give rise to impairment in the concentrating ability of the tubular cells with minimal effect on glomerular filtration rate (GFR). This impairment in concentrating ability was shown to be fully reversible with restoration of the potassium deficit [2].

More recent studies in patients with prolonged potassium depletion [3,4] have shown that this lesion occurred quite infrequently (~15–20% of patients). The lesion more commonly described is that of an interstitial nephritis with variable decline in GFR. Whether the interstitial nephritis is a direct result of prolonged hypokalaemia remains unclear. Most patients described with this lesion in association with hypokalaemia were known to abuse a cocktail of medications including laxatives, diuretics, phenacetin-containing analgesics, barbiturates and benzodiazepines. Many of the patients in this group developed quite severe renal failure with several patients progressing to end-stage renal failure.

The few patients described with chronic hypokalaemia arising from primary hyperaldosteronism as opposed to drug abuse, had similar findings of an interstitial nephritis on renal biopsy but significantly less impairment of renal function. No patients in this group have been reported as requiring long-term renal replacement therapy.

There are many case reports that describe episodes of acute renal failure arising in the setting of prolonged hypokalaemia [7,8]. By far the most common setting for this is in patients with anorexia nervosa who are abusing laxatives and/or diuretics with resultant hypokalaemia. In this group of patients the purgative abuse in association with prolonged starvation leads to profound volume depletion and acute ‘pre-renal’ renal failure with variable requirements for dialysis. Hypokalaemia-induced rhabdomyolysis has been reported to contribute to the acute renal failure in this setting of profound volume depletion. Few of these patients underwent renal biopsy as the cause of renal failure was assumed to be acute tubular necrosis. There was no evidence of rhabdomyolysis in our case.

Cremer and Bock [3] describe acute renal failure arising in several patients with known prolonged hypokalaemia where there was no obvious precipitant such as volume depletion or rhabdomyolysis. Two of the

Fig. 1. Photomicrograph demonstrating marked coarse and subnuclear vacuolation (arrow) of proximal convoluted tubular cell cytoplasm, typical of hypokalaemia. Silver methenamine–Masson trichrome stain, original magnification ×400; bar represents 20 μm.
seven instances of acute renal failure occurred after surgical intervention without any documented renal insults such as transient hypotension. Similarly in the other five cases of acute renal failure in this setting, no cause could be identified. Again none of these patients was reported to have undergone renal biopsy and hence the exact cause of their renal failure remains unclear.

To our knowledge this is the first reported case of reversible anuric acute renal failure arising in a patient in whom the predominant lesion seen on renal biopsy was that of so-called 'kaliopenic nephropathy'. From this case, and those of unexplained acute renal failure arising in the setting of prolonged hypokalaemia reported by Cramer and Bock, we postulate that potassium depletion and the tubular vacuolization that accompanies it, somehow leave the patient more sensitive to relatively minor renal insults. For example, although our patient was haemodynamically stable on presentation, he was noted to be moderately volume deplete with a low central venous pressure and postural hypotension. While this alone would be unlikely to precipitate acute renal failure in an otherwise well individual, when combined with the tubular lesion associated with hypokalaemia, renal function may be significantly impaired as a result of tubular obstruction by enlarged and vacuolated proximal tubular cells.

References


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