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An uncommon cause of metabolic acidosis in a haemodialysis patient

Case

A 40-year-old haemodialysis patient presented with hyperkalaemia of 7.1 mmol/l on his scheduled day of dialysis treatment. On examination, he appeared unwell, tachypnoeic and diaphoretic. His abdomen was non-tender with scars from recent surgery (Figure 1). The remainder of the clinical examination was unremarkable. Compliance had always been excellent so arterial blood gas analysis was performed in search of a cause for this new and unexpected hyperkalaemia. The findings were: pH 7.325, pO_2 102 mmHg, pCO_2 24 mmHg, bicarbonate 12.5 mmol/l, sodium 140 mmol/l, chloride 108 mmol/l. The patient was afebrile, lactate, white blood count and C-reactive protein were all normal. The patient was a male insulin-dependent diabetic with diabetic nephropathy who had been on maintenance haemodialysis until combined pancreas–kidney transplantation was performed in 1987. Later, pancreatic failure ensued but the renal graft survived until 1999. Haemodialysis was resumed until he again underwent simultaneous pancreas–kidney transplantation with pancreato-cystostomy 6 months prior to his current presentation. His new renal graft deteriorated rapidly and biopsy showed chronic transplant nephropathy. In addition, the patient also had a high-grade stenosis of his transplant renal artery. Two weeks prior to his current presentation, percutaneous dilatation of his transplant renal artery was performed as a final attempt to salvage the graft. The procedure was successful initially but arterial occlusion of his graft occurred several hours later. Immediate surgery failed to restore perfusion and transplant nephrectomy was performed while the pancreatic graft was still functioning. Suprapubic cystostomy was perfomed with saline flushing and continuous drainage of pancreatic secretions via an indwelling catheter in order to protect the bladder epithelium. Haemodialysis was begun with a well-matured arteriovenous dialysis fistula that had been used while the patient had been on dialysis prior to transplantation. A recirculation test was normal and the urea reduction rate was 65%. The dialysate bicarbonate content was 34 mmol/l. Neither hyperkalemia nor metabolic acidosis had ever been observed in this patient while he had been on haemodialysis prior to transplantation.

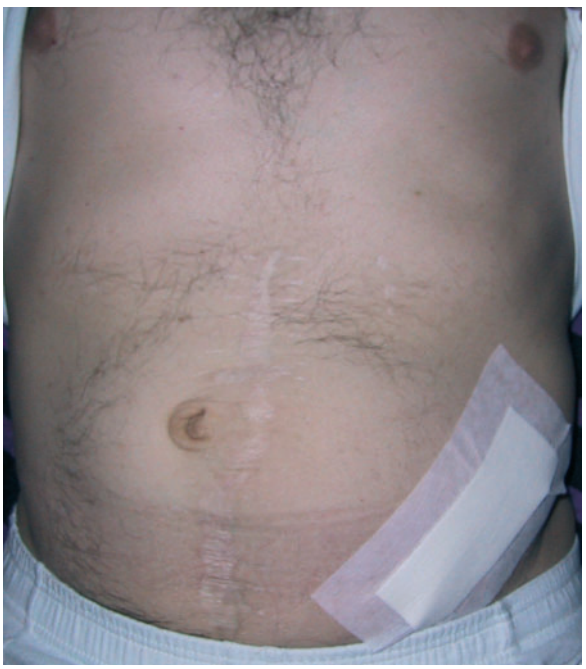

Fig. 1. Abdomen of the patient showing a midline laparotomy scar from previous surgery and the site where renal graft had been removed.

Question

What is the most likely diagnosis?

Answer to the quiz on preceding page

Arterial blood gas analysis showed compensated metabolic acidosis and the anion gap was 19.5 meq/l (normal range in our local laboratory is 5–11 meq/l). We then proceeded in accordance with an algorithm [1]. A high anion gap is most commonly encountered in ketoacidosis, accumulation of lactic acid or renal failure. Ingestion of toxic substances, such as ethylene glycol or methanol, is a rare but nevertheless important cause of high anion-gap metabolic acidosis. Ketoacidosis was ruled out by a negative assay for serum ketones, a urinary dipstick being used. Lactic acidosis due to sepsis should be the greatest worry here, more so in the context of immunosuppression, but lactate, WBC and C-reactive protein were all normal. Accumulation of D-lactic acid, which is not picked up by routine laboratory tests, is rare and occurs almost exclusively in the context of short-bowel syndrome which could be ruled out on clinical grounds alone. Renal failure was an unlikely explanation in this patient. Patients on maintenance haemodialysis usually have normal or near-normal blood gases even before a dialysis session unless inadequate dialysis or sepsis have ensued. Malfunction of the arteriovenous fistula was excluded on the basis of a recirculation test. The urea reduction rate confirmed that a sufficient dose of dialysis was delivered. Moreover, our patient had never had acidosis during his previous years on dialysis. Sepsis was ruled out by the absence of fever and normal laboratory values for WBC and C-reactive protein. Finally, ingestion of toxic substances was excluded on the basis of history taking alone. In summary, an algorithm-based approach failed to yield a definitive diagnosis here.

Technical failure had to be excluded prior to any further speculation. Another fresh sample of arterial blood confirmed our initial findings. Next, we had to 'check the numbers' for even the most extraordinary acid base disorder must adhere to Hendersson-Hasselbalch's equation:

$$[H^+] = 24 \times pCO_2/[HCO_3^-] \quad \text{or}$$
$$pH = 6.1 + \log([HCO_3^-]/0.03 \times pCO_2)$$

The numbers were correct here. A technical error could now be ruled out with confidence.

The next step was to exclude a mixed acid–base disorder. For every mmol/l that the plasma bicarbonate declines from 24 mmol/l, the pCO_2 should be lowered by 1.2 mmHg, which was true in the patient under discussion. The next stage was to step back and ask for limitations of the algorithm.

In fact, an anion gap of 20 mmol/l is not high enough to suspect a classical cause of metabolic acidosis such as ketoacidosis or lactic acidosis; these disorders usually cause an anion gap well in excess of 20 mmol/l [2]. It has been shown that moderate elevation of the anion gap may also be encountered in a classic low anion-gap scenario such as loss of gastrointestinal secretions [2]. Therefore, loss of pancreatic secretions due to pancreatocystostomy [3], became an ever more tempting explanation. In order to fully appreciate the peculiar acid–base disorder of our patient, we measured bicarbonate in the pancreatic secretions drained from his urinary bladder. This approach was possible because the patient had no residual urine output. Injecting a heparinized sample of fresh drainage fluid into an arterial blood gas machine revealed a bicarbonate content of 27 mmol/l with pH 7.756. Pancreatic secretions have previously been reported to contain as much as 50 mmol/l bicarbonate [4]. The patient had received 3 l of saline daily to flush the bladder and drained 4 l of fluid. Therefore, he must have drained 108 mmol of bicarbonate per day, which is indeed a considerable loss. In fact, many recipients of a pancreatic graft with pancreatocystostomy require treatment with oral bicarbonate [3]. It is not uncommon for this form of acidosis to worsen with deteriorating renal function. This is easily understood if one appreciates renal response to non-renal metabolic acidosis that depends on renal secretion of hydrogen ions via NH_4^+ cations. This explains why our patient developed acidosis as a sequel to loss of renal function. A diagnosis of metabolic acidosis due to substantial loss of pancreatic secretions was made and the patient received high-dose oral bicarbonate supplements. With that treatment, he made an uneventful recovery and was put on the waiting list for another renal transplantation with high-urgency status.

In conclusion, our encounter with this patient served as an opportunity to study a rather uncommon scenario of acid–base physiology and convinced us, again, not to rely on algorithms alone.

References

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