Acute compartment syndrome in a patient with sickle cell disease

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ABSTRACT

Haemoglobin SC (HbSC) disease accounts for 30% of cases of sickle cell disease in the United Kingdom and the United States. Unlike other sickle cell carriers, who are relatively asymptomatic, people with HbSC disease have a combination of genotypes with the potential to cause considerable morbidity due to intracellular water loss. Patients can present with acute pain, acute chest syndrome, proliferative retinopathy, splenic and renal complications, or stroke. We present a young man with HbSC disease who developed acute compartment syndrome. This is only the second report of this syndrome in a patient with HbSC disease. This is a very rare complication in HbSC disease, but it can have serious implications.

KEYWORDS

Haemoglobin SC – Haemoglobinopathy – Fasciotomy – Compartment syndrome

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Case history

A 20-year-old male student was admitted to the acute medical take with a one-day history of severe cramping abdominal pain. This was after attending a party to celebrate finishing his university exams. He denied the use of alcohol or illicit substances. His past medical history was unremarkable, except for sickle cell disease with HbSC genotype. His clinical observations were within normal parameters and his abdomen was generally tender, but soft bowel sounds were present.

Initial investigations revealed haemoglobin of 126g/l, a white cell count of $20.56 \times 10^9/l$, amylase of 83U/l, creatine kinase of 93U/l and normal renal function. Arterial blood gas analysis values were within normal limits, with a base excess of -1.5mEq/l and lactate of 1.3mmol/l . Urinalysis was unremarkable. Plain films demonstrated a mildly distended abdomen with a degree of faecal loading, but no pneumoperitoneum. An opinion from the general surgeons was sought. With no evidence of peritonism and the patient describing the pain to be very similar to that experienced during a previous sickle cell crisis, initial treatment included intravenous fluids, oxygen and analgesia, as per recommendations for the management of sickle cell crisis.

On the day after admission, the man deteriorated significantly. After resuscitation, a computed tomography scan demonstrated free air within the abdominal cavity. Urgent laparotomy was performed for a perforated duodenal ulcer with four-quadrant contamination. The procedure was performed with the patient supine. He was managed postoperatively in the intensive treatment unit, but he

remained unstable, with severe metabolic acidosis requiring haemofiltration and high fluid exchanges for refractory hyperkalaemia and an exchange blood transfusion. Inotropes were required for cardiovascular support.

On the third day following admission, the man was noted to have tense and rigid lower limbs, and a plastic surgical opinion was sought. The upper limbs, chest and abdomen remained soft. Compartmental pressures were measured. On the right side, the anterior, medial and lateral thigh pressures were more than 30mmHg. The right calf pressure was 74mmHg. On the left side, the anterior, medial and posterior thigh pressures were 35mmHg, 24mmHg and 50mmHg, respectively. The left calf pressure was 60mmHg.

A diagnosis of compartment syndrome was made. The man was taken to theatre for decompression of both lower legs and thighs. Following full release, all muscles in all compartments were noted to be grossly oedematous but viable. No dead tissues were identified, and dorsalis pedis and posterior tibial pulses were present in both feet. This resulted in prompt resolution of his hyperkalaemia and reduction in inotrope requirements.

The following day, the patient developed a persistent metabolic acidosis with increasing inotrope requirements, and the general surgeons took him back to theatre for re-look laparotomy. The bowel was found to be oedematous but healthy, with no contamination or collection.

The fasciotomy wounds were inspected simultaneously. They showed muscle necrosis in all compartments in both lower limbs, despite complete release and viable muscle

the day before. A creatine kinase level was measured at 318,550iU/l. An intraoperative vascular opinion was sought. No flow was seen in the femoral, profunda femoris, anterior tibial or posterior tibial vessels. Thrombosis was seen in all microvasculature.

The only remaining surgical option was a bilateral hindquarter amputation. Due to the man's physiological instability, however, such extensive surgery was deemed unsurvivable. A discussion with the family took place after the man was back in the intensive treatment unit, and the decision was made to proceed with supportive care and stop interventions. He died shortly after.

Discussion

Acute compartment syndrome results from a critical rise in interstitial pressure within an osseofascial compartment, such that tissue perfusion is impaired, leading to ischaemia, infarction and subsequent necrosis within that compartment. It is a limb-threatening emergency requiring prompt identification and, ultimately, surgical decompression with fasciotomies. The most common cause of acute compartment syndrome is traumatic, following long-bone fractures, crush injuries or burns. Other recognised precipitants include infections and iatrogenic causes, notably from constrictive dressings and casts.

There have been a number of case reports in which people with haemoglobinopathies have developed acute compartment syndrome. Dincer and Raza¹ and Ridha and colleagues² reported people with sickle cell trait developing exercise-induced compartment syndrome. Our case is the second published report describing a patient with HbSC disease developing acute compartment syndrome. The first case was described by Ivil and Mannion, after a patient presenting with deep vein thrombosis subsequently developed acute compartment syndrome³ and was later found to have HbSC disease.

HbSC disease accounts for 30% of people with sickle cell disease.⁴ People with HbSC disease are compound heterozygous for HbS and HbC. Unlike other sickle cell carriers, who are relatively asymptomatic, people with HbSC disease have a combination of genotypes with the potential to cause considerable morbidity.

Factors responsible for red blood cell sickling include duration of tissue deoxygenation and intracellular concentration of HbS.⁵ People with sickle cell anaemia have high intracellular concentrations of HbS due to their homozygous genotype. When deoxygenated, in this case due to the acidosis following duodenal perforation, haemoglobin chains bind and form polymer chains, which fill and distort the red blood cells. In people with sickle cell trait, there is 50% less HbS than in people with sickle cell anaemia who are homozygous for HbS.^{4,6}

The presence of HbC further lowers the threshold for sickling due to dehydration of the red blood cells. This is caused by increased activity of potassium chloride cotransport channels within red blood cells that contain HbC.^{4,6} This in turn increases the concentration of HbS.

When red blood cells in people with HbSC become dehydrated, the increased HbS concentration amplifies the polymerisation, resulting in cell distortion. Distorted red blood cells obstruct the microcirculation, causing rhabdomyolysis and acute compartment syndrome. We were unable to obtain a muscle biopsy from our patient, but sickling red cells have been observed within the vasculature on histology of other patients with the disease.¹

To further minimise the risk of thrombosis, our patient wore Flowtron boots during the first laparotomy, but these were replaced with dressings following fasciotomies. The man developed a resistant coagulopathy that required support with blood products, including platelets and fresh frozen plasma. Given the man's thrombocytopenia, increased fibrin markers and prolonged prothrombin time, it is likely that he had disseminated intravascular coagulation. Previous studies suggest disseminated intravascular coagulation is a sequela of sickle-induced rhabdomyolysis.^{1,7} With no evidence of atherosclerosis in our patient, the development of acute compartment syndrome was attributed to sickle cell-induced rhabdomyolysis.

This case highlights a number of learning points regarding HbSC. The significance of this condition should be taken into account in the context of an acutely unwell patient. This is particularly important in young people who are able to compensate. Close collaboration with haematology colleagues is also important.

Conclusions

HbSC disease should be considered a significant condition with the potential to cause considerable morbidity and mortality. Increased red blood cell sickling as a result of the interaction of HbS and HbC can lead to obstruction of the microcirculation and infarction, despite there being 50% less HbS than in people with true sickle cell anaemia. Acute compartment syndrome is a potential complication of sickling in HbSC disease that requires prompt identification and intervention. When people with HbSC are under physiological stress, clinicians should have a low index of suspicion for rhabdomyolysis and be aware of the risk of developing acute compartment syndrome.

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