CASE REPORT

Infrarenal aortic clamp reviving a patient from acute surgical haemorrhagic shock: a novel management technique

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SUMMARY

Surgical management of renal cell carcinoma extending into the inferior vena cava (IVC) is almost always accompanied by massive intraoperative blood loss and associated complications. It is a widely recognised problem, and its active management is essential in improving the perioperative morbidity and mortality. We share our experience with a similar case of open radical nephrectomy with massive blood loss of twice the circulating volume in a duration of <8 surgical hours. Although we emphasise the goals of securing haemostasis, restoration of circulating volume, and efficient management by replacing blood components, in the present case, despite the above-mentioned goals being fulfilled, we were unable to extricate the patient from haemorrhagic shock by conventional means and therefore resorted to desperate measures, namely the novel approach of infrarenal aortic clamping along with higher than recommended vasopressor support. We resorted to this in order to maintain the haemodynamic parameters and to prevent avoidable morbidity and mortality related to persistent intraoperative hypotension. With such an approach, we successfully managed the patient perioperatively, ultimately resulting in the patient being discharged after a week of intensive care unit stay without major complications.

BACKGROUND

Historically, up to 10% of patients with renal cell carcinoma (RCC) have a tumour thrombus involving the renal vein or inferior vena cava (IVC) and 1% have a tumour thrombus extending until the right atrium. Shvarts *et al*¹ had assessed blood loss during surgery and the amount of blood needed for transfusion in patients who had undergone partial or radical nephrectomy for RCC. They concluded that if nephrectomy was performed in advanced disease, it led to a risk of greater blood loss and may require transfusion of multiple units of blood. So preoperative erythropoietin be a viable option. The importance of early surgical intervention to arrest bleeding in a case of radical nephrectomy cannot be overemphasised. Surgical procedures in crisis management during intraoperative haemorrhagic shock include completion of scheduled procedures, change to minimal procedures, temporary bimanual compression of the bleeding point, packing of the bleeding area, clamping of the bleeding artery or the aorta or damage control surgery.² The occurrence of hypothermia, persistent hypotension, acidosis and

shortage of blood products are the absolute indications for damage control surgery.

CASE PRESENTATION

A man aged 67 years presented with left flank pain and haematuria for 2 months. He was a known hypertensive on treatment with atenolol and amlodipine for 5 years. CT showed left RCC and IVC thrombus extending until the iliac bifurcation and not extending above the renal vein. Other baseline blood investigations, ECG, chest X-ray and echocardiography, were within normal limits. The plan was open radical nephrectomy and IVC thrombectomy. Morphine 4.5 mg intramuscularly, tablet famotidine 20 mg, diazepam 5 mg and metoclopramide 10 mg were given as premedication, along with continuing the antihypertensive medications.

In the operation theatre, an epidural catheter was secured at L2–L3 space and activated with 6 mL of 2% lignocaine and 6 mg of morphine. He was induced with thiopentone and intubated after paralyzing with vecuronium. The patient was maintained with 33% O₂+N₂O+isoflurane with minimum alveolar concentration (MAC) of 1 and vecuronium. The left radial artery was cannulated and the right internal jugular vein was cannulated with a triple-lumen catheter. We monitored invasive blood pressure (IBP), central venous pressure, pulse oximetry (SpO₂), five-lead ECG, ST segment analysis, end-tidal concentrations of O₂, N₂O, agent and CO₂, temperature and urine output (U/O).

In the first hour of surgery, the patient was stable. After 1 hour, ~750 mL of blood loss over minutes and the BP fell to 70/40 mm Hg. We intervened with infusion of 1000 mL colloid, and 500 mL of crystalloid and BP improved to 90/50 mm Hg. However, within 15 min, BP declined again and so we began replacing with packed red blood cells (PRBC). Again, improvement in BP was noted, but short-lived, ~30 min. Given the continued fall in BP, we had gradually switched off isoflurane.

After this, dopamine was started and gradually increased to 20 µg/kg/hour. Even with such a high dose of dopamine, we were unable to maintain BP for more than 30 min. Norepinephrine was added on and stepped up to 0.2 µg/kg/hour. Again, there was improvement, but this was transient. Meanwhile, we had transfused 4 units of PRBC and 2 units of fresh-frozen plasma (FFP) along with 2000 mL crystalloid. Next, we added epinephrine and dose was increased to 0.2 µg/kg/hour. Further

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2 units of PRBC and 4 units of FFP were transfused. Hypotension was managed thus for 45 min, after which it declined to 50/30 mm Hg. At this point, clamping of the infrarenal aorta was advised to the surgeons for control of BP. After this intervention, BP was maintained for half an hour, following which BP declined until 50/30 mm Hg. We decided to stop dopamine, and vasopressin was started at 2 IU/hour and increased it to 20 IU/hour.

With these interventions, that is, vasopressin 20 IU/hour+epinephrine 0.2 µg/kg/hour+norepinephrine 0.2 µg/kg/hour+infrarenal aortic clamping and continuously pumping 4 units of PRBC, severe hypotension was averted for another 2 hours. Surgery lasted for 8 hours, with hypotension for 6 hours. There was a possibility of hypoxic-ischaemic brain injury. Arterial blood gas (ABG) analysis showed acidosis and 50 meq of bicarbonate was given to correct it (figure 1).

Once the tumour dissection ended, and IVC thrombectomy was performed, bleeding from the surgical site stopped and the infrarenal aortic clamp was removed. Total clamp time was 1 hour 55 min. Now replacement of intravascular volume with blood and blood products began. Once BP rose to near-normal levels (>90/50 mm Hg), isoflurane was reintroduced and gradually increased to 1 MAC. Introduction of isoflurane did not result in a fall in BP, and we tapered the inotropes, stopping epinephrine first, followed by norepinephrine. By the end of skin closure, epinephrine and norepinephrine had been stopped. In the end, we had transfused 18 units of PRBC+3 bottles of colloids+18 bottles of crystalloids+13 units of FFPs+9 units of platelets and 5 units of cryoprecipitate. Repeat ABG showed acidosis and it was corrected with bicarbonate. The urine output over 8 hours of surgery was 300 mL and total blood loss was 11 L. Total 9000 mL crystalloids and 1500 mL colloids were transfused.

Because of massive blood transfusion and hypothermia, we had shifted the patient to intensive care unit (ICU) for elective ventilation continuing vasopressin at 20 IU/hour. On examination in ICU, pupillary reflexes were present. After 2 hours of end of surgery, the patient became conscious and responded to verbal commands, lessening the probability of hypoxic-ischaemic brain damage. In the ICU, another 3 units of PRBC, 5 units of FFP, 5 units of platelets and 5 units of cryoprecipitate (as advised by the haematologist) were transfused, and gradually, vasopressin was tapered. Vasopressin was stopped completely by 11:00 on postoperative day 1 (POD1) and extubation achieved by 16:00 on POD 1. On POD 3, the patient was interviewed,

seeking to detect any recall of intraoperative events. The patient did not have recall of any events. The patient was shifted out of the ICU on POD 5 and discharged on POD12 with no further morbidity and an uneventful ICU stay.

OUTCOME AND FOLLOW-UP

The patient was healthy on review at 3, 6 months and after a year.

DISCUSSION

A majority of the radical nephrectomy cases where there is vascular involvement result in massive blood loss and transfusion. This case was complicated further by a rare blood group (O-ve) and requirement of a significant amount of blood. We anticipated this and started the case, having reserved 8 units of packed red cells. But intraoperative blood loss was greater than foreseen, and we were forced to transfuse O+ve blood. Ten units of O+ve blood were given intraop. Coombs test after 24 hours of transfusion revealed no haemolysis and there was no morbidity due to Rh incompatibility.

Infrarenal aortic cross-clamping produces a significant increase in systemic arteriolar resistance and systolic BP, with no change in the left ventricular stroke work index.³ The idea of using it in the present case was inspired from the regular practice of bilateral application of tourniquets in bilateral lower limb orthopaedic surgeries. We had to resort to this technique in a desperate attempt to maintain BP. It was possible as the surgery was on the IVC and the aorta was within the surgical field. This intervention allowed us only a short interval of stable BP, but this was sufficient to arrange adequate blood products and recruit further blood donors. There are no strict guidelines for the duration of tourniquet application. A safe limit of 1–3 hours has been described.^{4 5} Total tourniquet time in our case was 1 hour 55 min which was well below the advised limit. Save for mild acidosis in the ABG, no major complications occurred due to tourniquet application.

During the early phase of haemorrhagic shock, BP is maintained by sympathetic activation, leading to arterial and compensatory venous vasoconstriction.^{6 7} When a large amount of blood is lost, this mechanism becomes less effective, leading to vasoplegia of organs. At this juncture, vasopressors become helpful. Dopamine was started first as the reason for hypotension was hypovolaemia. But this rapidly became inadequate, and we need to start norepinephrine and epinephrine. Still, the inotropic support was insufficient to combat the ongoing blood

Figure 1 Haemodynamics during surgery.

loss, and we needed time during which further blood products could be arranged. Next, we added vasopressin. Vasopressin is useful in the irreversible phase of haemorrhagic shock. Vasopressin inhibits vasodilator mechanisms that contribute to hypotension and vascular hyporeactivity in the late phase of haemorrhagic shock. There is no recommended ceiling dose of vasopressin in humans.⁷ But typically doses did not exceed 2–4 U/hour to counter vasodilatory shock. The seemingly excessive dose of vasopressin was warranted in this case, as few options were left to counter the massive blood loss. Higher doses of vasopressin can cause vasoplegia due to profound vasoconstriction leading to ischaemia of organs. In our present case, such organ damage was anticipated, but not encountered.

Treatment of haemorrhagic shock requires massive blood transfusions. Lifesaving though it may be, complications abound when transfusing large blood volumes. The high mortality rate in massive transfusion is associated with the lethal triad of

acidosis, hypothermia and coagulopathy. Hypothermia, acid/base derangements, electrolyte abnormalities, citrate toxicity and transfusion-related acute lung injury are the other complications. Blood transfusion in trauma, surgery and critical care has been identified as an independent predictor of multiple organ failure, increased infection, systemic inflammatory response syndrome and increased mortality in various studies.⁸ Of these, we encountered hypothermia and acidosis, which were corrected by warming the patient and bicarbonate, respectively.

Contributors MVSSP had designed the plan for anaesthesia. RK and SD had executed the plan of anaesthesia. RM is the surgeon who had obliged and did the cross clamp of aorta.

Competing interests None declared.

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Learning points

- In a crisis situation, quick application of principles used in other fields can be lifesaving.
- A dose of vasopressor, which would not be routinely used for fear of adverse events, may not result in anticipated adverse events when used for a short period in the face of severe blood loss.
- Reducing the concentration of anaesthetic agent during periods of hypotension may not lead to intraop recall, as the cerebral perfusion will also be reduced during such events.

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