Intraoperative migration of an inferior vena cava tumour detected by transesophageal echocardiography

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Direct extension of renal cell carcinoma into the inferior vena cava (IVC) is observed in 3% to 25% of cases.¹ Based on the extent of IVC involvement, these tumours are classified as level I (intrahepatic IVC), level II (retrohepatic IVC to hepatic veins), and level III (right atrium). The surgical approach varies for each level. Level I and II tumours are commonly resected through a laparotomy, with an intrahepatic or suprahepatic IVC clamp with or without liver mobilization. Level III tumours require a multidisciplinary surgical approach that involves cardiac and hepatobiliary surgeons in order to gain access to the proximal IVC. Cardiopulmonary bypass standby is often made available for these cases. Tumour disruption and pulmonary embolization is a rare but well-recognized complication that occurs in up to 5.4% of resections of renal cell carcinoma with IVC involvement.² There have been reports regarding the benefit of intraoperative transesophageal echocardiography (TEE) for these cases in

order to provide real-time hemodynamic monitoring during IVC clamping and to detect occurrences of tumour embolization and incomplete resection.²⁻⁵

Clinical scenario

A 58-year-old female patient presented to our hospital for surgical resection of a right renal cell carcinoma. Preoperative magnetic resonance imaging demonstrated tumour extension into the proximal IVC up to the level of the hepatic veins. Her medical history was notable for previous episodes of pulmonary embolism in the absence of any heart disease that mandated chronic anticoagulation therapy. No evidence of distant metastatic disease was found. Cardiac surgery was involved, and a request was made for cardiopulmonary bypass standby.

After induction of anesthesia, a complete TEE examination identified the IVC tumour located 1.6 cm from the IVC-right atrial (RA) junction (Fig. 1). The mass appeared homogeneous with smooth edges, and it occupied the lumen of the intrahepatic IVC. The IVC was dilated with evidence of flow around the tumour. Based on the extent of the IVC involvement shown on the TEE, the surgical team chose a simultaneous combined approach consisting of a midline sternotomy and a full laparotomy.

Continuous TEE during the course of the surgery revealed a progressive cephalad displacement of the IVC tumour towards the RA. The distance between the tumour and the IVC-RA junction decreased to 0.75 cm (Fig. 2) soon after dissection of the right kidney was initiated. When the right kidney was mobilized, periods of sudden transient severe hypotension were observed. Massive blood loss, a decrease in systemic vascular resistance (SVR), and pulmonary embolism were considered within the

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Fig. 1 This modified transesophageal echocardiographic view was obtained using the mid-esophageal bicaval view, advancing the probe to view the inferior vena cava (IVC) to the right atrial (RA) junction, and decreasing the omniplane angle. In this view, the distance of the IVC mass to the IVC-RA junction is measured

differential diagnosis. During these episodes, the patient's heart rate and electrocardiogram remained unchanged from baseline values, while the end-tidal carbon dioxide concentration and right-sided filling pressures decreased significantly. Severe surgical bleeding was excluded by the surgical team. The low end-tidal carbon dioxide concentration at this time was attributed to a significant decrease in cardiac output that could not be explained by a decrease in SVR alone. The diagnosis of pulmonary embolism was unlikely due to the low central venous pressure and lack of right ventricular distension on visual inspection through the sternotomy.

At this point during the case, TEE images showed a further cephalad migration of the IVC tumour into the IVC-RA junction with complete obstruction of the IVC (Fig. 3) (Video 1). Surgical traction on the right kidney relieved the

Fig. 2 The modified bicaval view showing a cephalad migration of the inferior vena cava mass towards the right atrial junction. For abbreviations, refer to legend of Fig. 1

Fig. 3 During kidney mobilization, this modified bicaval view showed further inferior vena cava (IVC) mass cephalad displacement with occlusion of the IVC-right atrial junction. For abbreviations, refer to legend of Fig. 1

IVC obstruction and immediately restored hemodynamic values to within normal ranges. Reverse Trendelenburg positioning and rapid volume loading had been considered as alternative interventions.

An en-bloc extraction of the tumour from the IVC was a coordinated manoeuvre between the cardiac and urological surgical teams. The pericardium was opened and the IVC dissected. Under TEE guidance, surgical traction was applied on the right kidney to pull the tumour caudally into the IVC a few centimetres below the IVC-RA junction. An umbilical tape was then passed around the IVC-RA junction and snared above the IVC mass. The right kidney and the IVC tumour were then extracted under continuous real-time TEE imaging (Video 2). The IVC snare was released after TEE confirmed the absence of residual tumour in the IVC. A comprehensive TEE examination performed after tumour resection demonstrated laminar flow patterns in the hepatic vein, right heart, and main and right pulmonary arteries. Mild turbulence was noted in the IVC at the point of application of the snare. The turbulence decreased with time, and flow in the IVC became laminar towards the end of the case (Fig 4) (Video 3). The procedure was completed without further complication and the patient was transferred to the intensive care unit for postoperative management. The remainder of her in-hospital course was uneventful, and she was discharged home seven days later.

Conclusion

In this case, continuous intraoperative TEE monitoring promptly identified the etiology of sudden intraoperative hypotension during kidney mobilization. Furthermore, TEE helped to guide the surgical intervention, ensuring safe application of the IVC snare prior to tumour extraction and

Fig. 4 Modified bicaval view after inferior vena cava tumour removal

potentially minimizing the chances of tumour fragmentation and embolization. Consideration should be given to performing TEE in all cases of IVC tumour resection.

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