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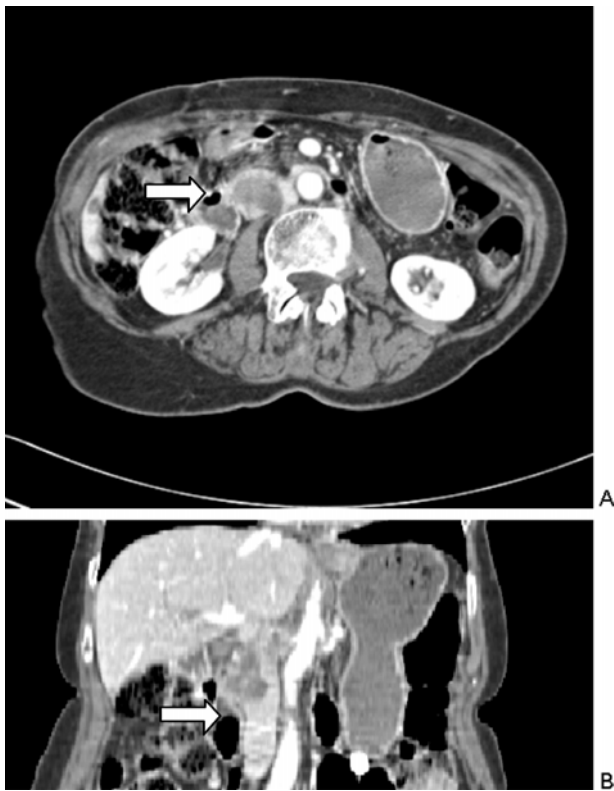
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Images in vascular medicine

Vena cava leiomyosarcoma: preoperative planning with complex vessel reconstruction using 3D surface rendering algorithms

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Panel A

A 50-year-old woman with diffuse abdominal pain and weight loss of 5 kg (total body weight 60 kg) in 2 months was referred to our institution with the diagnosis of a pancreatic mass based on an ultrasound scan performed at an outside institution. Initial cross-sectional

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Video footage of this can be seen at <http://www.vascularmedjournal.com> by clicking on the 'Additional material' button.



Panel B

imaging with multidetector computed tomography (MD-CT) revealed a 5.0 × 4.0 × 2.7 cm tumor of soft tissue density, heterogeneous contrast medium enhancement derivation from the infrarenal vena cava and infiltrating the surrounding tissue. Panel A shows contrast-enhanced CT in the axial (a) and coronal (b) reconstructed view demonstrating an abdominal mass (arrow). A primary leiomyosarcoma of the vena cava inferior was assumed. Staging using CT thorax and bone scintigraphy presented no evidence of metastatic spread. Phlebography of the vena cava inferior confirmed an obstruction of lumen (Panel B, arrow) with prominent lumbar veins for collateral venous blood flow via azygos and hemiazygos veins. For surgical planning, multiphasic magnetic resonance angiography (CE-MRA) (Panel C, arrow) was performed to evaluate the degree of vascular involvement (local tumor infiltration and renal vessel involvement), but tumor involvement of renal venous vasculature was still uncertain.

Therefore, computer-assisted surgical planning using the three-dimensional (3D) surface rendering technique was performed based on multiphasic CE-MRA raw data (Panel D). The virtual imaging techniques allowed an intra-luminal view and revealed left and right renal veins without direct tumor involvement (Panel D). Results of computer-assisted planning are as follows: vena cava (blue) and tumor (hatched) (Panel D, left) have been

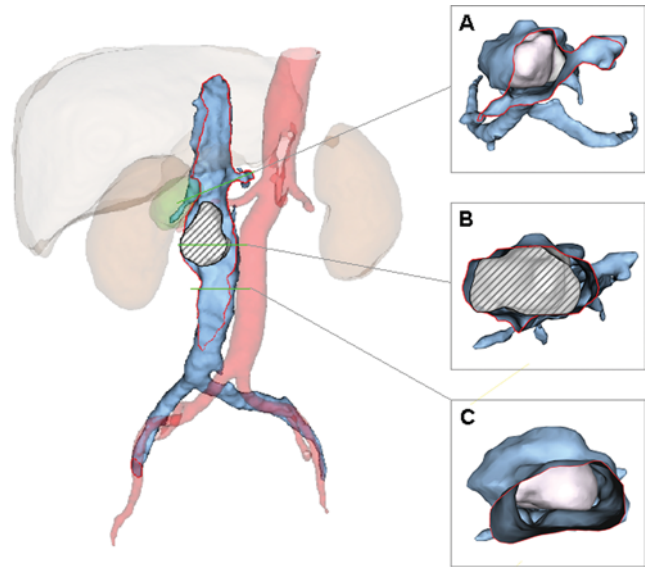


Panel C

clipped with a coronar plane to provide a view into the lumen; right: exemplary intraluminal views (Panel D, (a) cranio-caudal view; (b) cross-section; (c) caudo-cranial view) placed at different positions indicated by green lines. Arbitrary camera positioning and interactive measurement tools allowed the qualitative and quantitative assessment of tumor size and amount of stenosis. It was confirmed that the renal veins were not involved.

After resection of the leiomyosarcoma, the vena cava was reconstructed by a prosthetic tube graft. The operation confirmed pre-surgical imaging results (Panel D). Pathological examination revealed a middle-differentiated, spindled sarcoma (G2). The postoperative course was uneventful, and the patient was discharged two weeks after adjuvant radiotherapy. At one-year follow-up, the patient presented healthy with a patent graft and without recurrence of malignancy.

Leiomyosarcoma is a rare malignancy of smooth muscle. More than half are located in retroperitoneal or intra-abdominal sites presenting a major clinical challenge. Most tumors are large, making it difficult to obtain adequate margins of resection. The prognosis depends on the histopathological grade, tumor size, and evidence of metastasis.¹ The 5-year survival for patients with low-grade tumors is more than 90% versus 50% for high-grade tumors. Sarcoma of the inferior vena cava is a rare clinical entity that has been reported in fewer than 300 patients.² Vascular involvement is also a basis for unresectability of other retroperitoneal soft tissue sarcomas. Therefore, detailed and exact preoperative imaging is necessary and may influence late survival of these patients. Magnetic resonance imaging (MRI) and CT display the anatomic and structural details of the tumor, adjacent structures and morphological relationship to confluent veins with high accuracy. In addition to this information, 3D surface rendering and 'fly-through' are of increasing interest for vascular surgeons, being a tool of preoperative surgical navigation.³ The 'fly-through' option is a promising navigation tool within the frame of



Panel D

interventional medicine. This initial experience indicates that 3D surface rendering is an additional non-invasive and helpful procedure that allows clear visualization by providing detailed 3D depiction of the vascular involvement of arteries and/or veins in malignancy.

However, manual data segmentation is still time-consuming and requires the interdisciplinary approach of radiologists, vascular surgeons and computer scientists. Further studies and improved software skills will be needed to assess the definitive efficacy of this modality in the preoperative assessment of vascular tumors prior to resection.

Movie 1 General overview provided as a rotation around the longitudinal axis of the body. Semi-automatic segmentation tools allowed the accurate delineation of the vena cava (blue), as well as the aorta (red), the liver (grey), the kidneys (brown) and the gall bladder (green). Virtual cuts give an insight into the vena cava, the cava sarcoma (white) and its involvement.

Movie 2 Virtual fly-through of the vena cava. First, the scene is tipped over to provide a cranio-caudal view. Then, the virtual camera is propagated along a flight path defined interactively by the user. The camera is guided to the renal veins, which were marked red for a better depiction. Then, the tumor is passed at the widest point of constriction and the flight ends in the common iliac veins.

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