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Intraoperative Evaluation of Blood Perfusion by Laser-Assisted Indocyanine Green Angiography After ex vivo Vascular Reconstruction of Intrahilar Renal Artery Aneurysm

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The surgical reconstruction of intrahilar renal artery aneurysms (RAAs) is a difficult surgery because of complex anatomy. We present a case of right intrahilar RAA diagnosed in a 67-year-old man. We performed ex vivo reconstruction using an organ preservation solution to prevent postoperative renal failure. We assessed graft patency and blood perfusion was assessed by laser-assisted indocyanine green angiography using the SPY system after autotransplantation. Postoperative renal insufficiency was not observed. The results demonstrate that ex vivo reconstruction of intrahilar RAAs using an organ preservation solution, and graft patency and blood perfusion evaluation using the SPY system are effective methods for preserving renal function.

The incidence of renal artery aneurysms (RAAs) is very rare, occurring at approximately 0.01-0.09% as reported in an autopsy study[1] and at 0.1-0.3% as described in an angiography study.[2] Moreover, the risk of RAA rupture has been reported to be 2.8-5.6%,[3] with a reported mortality rate of 80% from ruptured RAAs.[4] Progress of the endovascular technique has enabled the treatment of RAAs located in the main renal artery, but not of those found in the renal hilum. The surgical arterial reconstruction of intrahilar RAAs involves many risks, including difficulty in securing a surgical view, difficult surgery due to complex anatomy in the renal hilum, possible ischemia-reperfusion injury of the kidney, and postoperative renal failure. We report a case demonstrating that the ex vivo arterial reconstruction of intrahilar RAA using an organ preservation solution, and graft patency and organ blood perfusion evaluation using the SPY^{TM} intraoperative imaging system (Novadaq Technologies, Toronto, Canada) are useful methods for preserving renal function.

CASE REPORT

We describe the case of a 67-year-old man who presented with fecal occult blood. To determine the cause of the occult blood, we performed abdominal computed tomography (CT) during the medical checkup. CT showed a saccular aneurysm of 25 mm maximal dimension in the right renal artery, and specifically located in the right renal hilum. The patient had been healthy without any evidence of cardiovascular risk factors, such as hypertension, hyperlipidemia, diabetes mellitus, or a history of smoking. On physical examination, the patient showed no symptoms related to the renal aneurysm. Laboratory data were unremarkable, including a blood urea nitrogen level of 12.3 mg/dL and a creatinine level of 0.65 mg/dL. CT angiography with 3-dimensional reconstruction (3DCT) and digital subtraction angiography revealed each polar branch arising from the aneurysm in the renal hilum (Fig. 1). Because the location of the aneurysm contraindicated endovascular repair, an ex vivo arterial reconstruction and autotransplantion was performed.

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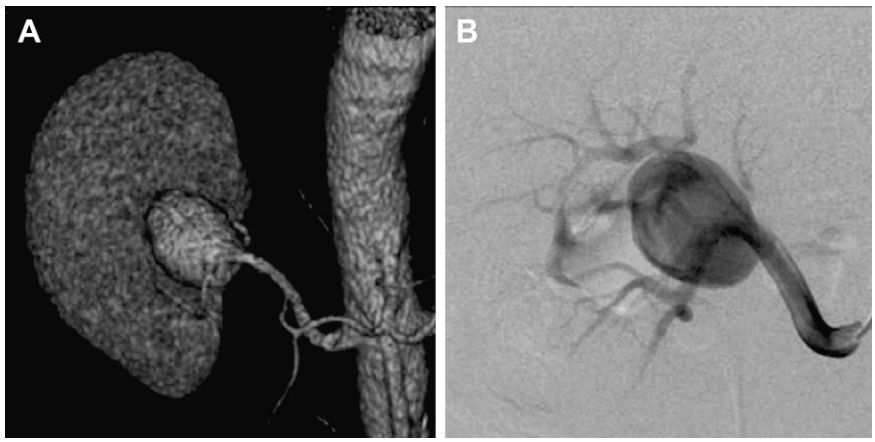

Fig. 1. (**A**) Computed tomography angiography with three-dimensional reconstruction demonstrated a right renal artery aneurysm in the renal hilum. (**B**) Digital subtraction angiography revealed a right renal artery aneurysm in the renal hilum.

As the duration of renal ischemia was expected to be longer than 2 hours, we decided to use an organ preservation solution to protect the kidney. For the operative procedure, the patient was placed in a supine position. After median laparotomy, right visceral mobilization was performed which facilitated entry to the retroperitoneal space anterior to Gerota's fascia. The right renal artery, renal vein, and ureter were then exposed. The RAA was located in the renal hilum, as also shown by 3DCT and digital subtraction angiography. Concomitantly, a saphenous vein graft (SVG) was harvested from the proximal right thigh. After systemic heparinization, the proximal right renal artery was clamped and divided. The renal vein was clamped at its juncture with the vena cava and excised. The ureter was left intact. The kidney was placed on ice slush and flushed with 400 mL of ice-cold (4°C) Ringer solution containing heparin (2,000 IU/L), prednisolone (20 mg/L), and 7% sodium bicarbonate (20 mL/L). Additionally, 200 mL of University of Wisconsin solution (Viaspan®, Astellas Pharmaceutical, Tokyo, Japan) containing dexamethasone (16 mg/L), penicillin G (20×10^4 IU/L), and human insulin (40 IU/L) was perfused from the renal artery to prevent renal insufficiency. Following these procedures, the aneurysm was resected. The upper and lower polar branches were reconstructed together to the SVG with end-to-end suture, and vein graft interposition was required for the middle polar branch reconstruction (Fig. 2). Following arterial reconstruction, University of Wisconsin solution was washed out with 400 mL of ice-cold Ringer solution. Then, the kidney was placed in an orthotopic position and anastomosis from the SVG to the proximal right renal artery was performed. Finally, the renal vein was sutured to the vena cava. The total ischemic time was 138 minutes. To assess renal blood perfusion and the anastomosis, the SPY intraoperative imaging system (Novadaq Technologies) was used. We injected 25 mg of indocyanine green (ICG) dissolved in 20 mL of normal saline into the abdominal aorta.

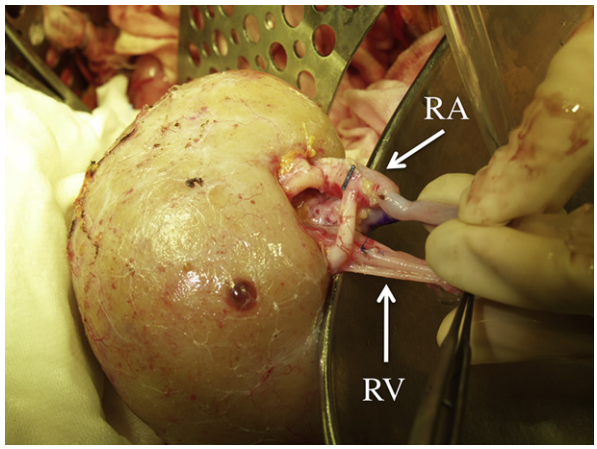

Fig. 2. Right renal artery reconstructed with saphenous vein graft (RA, renal artery; RV, renal vein).

Laser-assisted ICG angiography demonstrated adequate arterial reconstruction and reperfusion (Fig. 3). For renal flow assessment, we used an ultrasonic transit-time flow meter which showed a flow rate of 267 mL/min in the main renal artery. Postoperative blood urea nitrogen and creatinine levels were within the normal range. Renogram with technetium-99m-labeled dimercaptosuccinic acid (99mTc-DMSA) demonstrated mild renal dysfunction in the right kidney (53 mL/min), and 3DCT showed segmental renal infarction in one part of the upper pole. The patient was discharged 11 days after the surgery.

DISCUSSION

The surgical indication for asymptomatic RAAs is currently not established. However, rupture of small-diameter RAAs has been reported.[5] For most cases, nephrectomy may be required if the RAAs