Robotic-assisted left renal vein transposition as a novel surgical technique for the treatment of renal nutcracker syndrome

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ABSTRACT
Renal nutcracker syndrome is an anatomic anomaly characterized by the compression of the left renal vein between the superior mesenteric artery and the aorta or between the aorta and the vertebral body. Diagnosis is often challenging. Common presenting symptoms include hematuria, abdominal pain, and pelvic congestion. Several open and endovascular techniques have been described to treat this syndrome. We report a novel surgical technique with robotic-assisted left renal vein transposition to treat a 19-year-old woman with renal nutcracker syndrome. Robotic vascular surgery can be a safe and effective therapy for this condition. (J Vasc Surg Cases and Innovative Techniques 2018;4:31-4.)

Renal nutcracker syndrome (RNS) is characterized by the compression of the left renal vein (LRV) between the superior mesenteric artery (SMA) and the aorta or between the aorta and the vertebral body. The true prevalence of RNS is unknown. The most common symptoms are hematuria, abdominal pain, and pelvic congestion. Diagnosis of RNS is often challenging and typically one of exclusion. Several open and endovascular techniques have been described to treat this syndrome. We present a case report and video of robotic-assisted LRV transposition to treat a patient with RNS. The patient described in this case consented to the publication of this report.

CASE REPORT
A healthy 19-year-old woman with a body mass index of 19 presented with a 2-year history of abdominal pain and microscopic hematuria without a discernible cause. She underwent an extensive workup including abdominal duplex ultrasound (US), computed tomography (CT), magnetic resonance imaging, endoscopy, and psychiatric evaluation because of discordance in her symptoms and radiographic findings. A follow-up CT scan later demonstrated worsening compression of her LRV by the SMA. A left renal venogram demonstrated a 70% stenosis with multiple large venous lumbar collaterals and a pressure gradient of 3 mm Hg (Fig 1). Intravascular US also identified vascular webs within the renal vein.

Under general anesthesia, the patient was placed in a modified lithotomy position (Fig 2, A). Standard sterile preparation and draping were performed. Six robotic ports were inserted in the bilateral lower abdomen (two 12 mm, four 8 mm; Fig 2, B). The patient was placed in a steep Trendelenburg position. The robotic system (da Vinci Xi; Intuitive Surgical Inc, Sunnyvale, Calif) was docked and connected to the ports. The peritoneum around the cecum and right hemipelvis was incised up to the base of the small bowel mesentery. The peritoneum was then reflected anteriorly and tucked to the anterior abdominal wall with a Vicryl stitch. The cecum and ascending colon were retracted behind the peritoneum. The small bowel was retracted cephalad and to the left. Blunt dissection of the central retroperitoneum was carried out to the level of the left renal hilum. The SMA was identified superiorly; marked indentation was noted along the LRV (Fig 3, A). The inferior vena cava (IVC) was mobilized circumferentially, and all posterior venous branches were suture ligated. Vascular control of the suprarenal IVC, infrarenal IVC, and right renal vein was obtained with Maxi Vessel Loops (Medline, Northfield, Ill); 5000 units of heparin was given intravenously. Complete occlusion of the IVC was achieved by cinching the vessel loops down with Hem-o-lok clips (Teleflex, Morrisville, NC). The LRV was mobilized. Left adrenal and gonadal veins were divided with an EndoWrist vessel sealer (Intuitive Surgical) and EndoGIA 30-2.5 Stapler (Covidien, Minneapolis, Minn), respectively. The LRV was clamped near the hilum with a bulldog clamp. The LRV was then transected at its confluence with the IVC. The IVC was closed with 5-0 Prolene in running fashion (Fig 3, B). Luminal vascular webs were excised from the open renal vein. The LRV was then reanastomosed laterally on the IVC approximatley 2 to 3 cm more distally in a tension-free, end-to-side fashion with a running 5-0 Prolene suture (Fig 4). Total procedure time was 4 hours. The estimated blood loss was 50 mL. Diet was advanced immediately after surgery. The patient was discharged on postoperative day 1 with enoxaparin sodium (Lovenox 40 mg) for deep venous thrombosis prophylaxis for 30 days. The patient

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Author conflict of interest: none.
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https://doi.org/10.1016/j.jvscit.2017.09.008
demonstrated a full recovery and reported significant improvement in her abdominal pain at 1-week, 1-month, and 2-month follow-up visits. Renal US demonstrated normal renal vein velocity and resistance.

**DISCUSSION**

RNS is also known as nutcracker phenomenon and LRV entrapment. This anatomic anomaly was first described by Grant¹ in 1944. El-Sadr and Mina² published the first clinical report of this phenomenon in 1950. De Schepper³ coined the term nutcracker to describe the disorder in 1972. Appreciating the anatomy of the retroperitoneum is crucial to understanding the etiology of RNS. The LRV drains into the IVC 5 to 9 cm from the renal hilum, usually coursing ventrally over the juxtarenal aorta and posterior to the SMA.⁴ Anatomic variance also exists whereby the LRV can have a retroaortic course or be circumaortic.⁴-⁶ A steep and posterior takeoff of the SMA has been proposed to explain the compression of the LRV into the aorta.⁴-⁶ Another theory suggests that the
lack of retroperitoneal fat results in a narrowed aortic mesenteric angle.

Diagnosis is often difficult. Patients are typically tall women in their 20s and 30s with aesthetic body habitus. The most common symptoms are often vague gastrointestinal discomfort, flank pain, hematuria, and pelvic congestion syndrome. In women, pelvic congestion may be manifested as chronic pelvic pain, dyspareunia, dysuria, dysmenorrhea, polycystic ovaries, and varicosities. Noninvasive examinations include urinalysis, blood tests, and duplex US. In RNS, the diameter of the distal LRV to the aortomesenteric portion can have a 4:1 ratio or greater. US diagnostic criteria have a sensitivity, specificity, and accuracy of 80%, 94%, and 83%, respectively. Abdominal CT angiography or venography can show compression of the LRV by the SMA. Invasive examinations such as venography can confirm hemodynamically significant compression of the LRV by pullback venous pressure measurements. A pressure grade >2 mm Hg is diagnostic of RNS.5,6

Treatment of RNS includes conservative management, open surgery, and endovascular therapy. Conservative management should be used first, especially in younger patients. Low-dose aspirin and angiotensin inhibitors have been suggested as possible medical treatment. Some authors suggest weight gain to increase the fat pad between the SMA and the renal vein. If symptoms become intolerable or persist beyond 1 or 2 years, more invasive therapy should be offered. Before surgery, our patient had tried biofeedback therapy and nutritional supplementation with the help of a psychiatrist and a nutritionist without any significant symptom relief. Open transposition of the LRV is the “gold standard” for the treatment of RNS. Other approaches include renal venous bypass, gonadal vein transposition, autotransplantation of the left kidney, SMA transposition, angioplasty, and stenting.

We report a case and video of robotic-assisted LRV transposition for the treatment of RNS. Wang et al were first to publish a case report of successful robotic-assisted laparoscopic transposition of the LRV for the treatment of RNS in a 26-year-old man who presented with hematuria. In their report, they obtained vascular control of the renal vein and IVC with metal clamps, whereas we used vessel loops. Wang et al used a Hem-o-lok clip to close the IVC after the LRV was transected, whereas we suture closed the IVC. Our patient was discharged on postoperative day 1. Her microhematuria resolved. Her primary complaint preoperatively was abdominal pain. The patient experienced immediate reduction of her pain after surgery. At her 1-week, 1-month, and 2-month follow-up visits, our patient reported continued improvement in the frequency and severity of her abdominal pain.

This report demonstrates that robotic renal vein transposition can be a safe and effective technique for the treatment of RNS. We believe this novel technique confers the same advantages of open surgery, such as safety, effectiveness, and durability, with lower perioperative and postoperative morbidities and hospital length of stay. Robotic surgery avoids the need for open celiotomy and all related complications. Another less invasive alternative to open surgery is laparoscopic LRV transposition.8,9 Robotic surgery has been developed to overcome many of the surgical disadvantages associated with laparoscopic surgery by increasing the range of motion for instruments, the vision of operative field, and the surgeon’s comfort and by eliminating human tremors.10 We believe robotic renal vein transposition is superior to laparoscopic surgery for these reasons.

CONCLUSIONS

Robotic LRV transposition is a safe, effective, and feasible surgical technique to treat patients with this condition.

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Submitted Jun 15, 2017; accepted Sep 8, 2017.