Robotic-Assisted Laparoscopic Donor Nephrectomy of Patient With Nutcracker Phenomenon

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Abstract

We report the case of a 30-year-old male patient undergoing a robotic-assisted laparoscopic left donor nephrectomy, where compression of the left renal vein between the superior mesenteric artery and aorta was noted on magnetic resonance angiography before the operation. The patient was diagnosed with nutcracker phenomenon and was noted to be asymptomatic at that time. This is the first reported case to date of a patient with nutcracker phenomenon who underwent a robotic-assisted laparoscopic donor nephrectomy. This article also reviews the current literature on nutcracker phenomenon and nutcracker syndrome.

Key words: Nephrectomy, Nutcracker, Robotic

Introduction

The da Vinci Surgical Robot (Intuitive Surgical, Sunnyvale, CA, USA) was approved in 2000 by the US Food and Drug Administration and has been used for a variety of surgical procedures. Robotic-assisted laparoscopic donor nephrectomy allows for minimal invasion, precise movements, ergonomic comfort, and rapid recovery. Whether robotic-assisted laparoscopic donor nephrectomy is viable for patients with more complex anatomic anomalies, such as nutcracker phenomenon, has yet to be reported in the literature.

Nutcracker phenomenon most commonly occurs when the left renal vein (LRV) becomes compressed between the superior mesenteric artery and abdominal aorta. “Nutcracker phenomenon” is often used interchangeably with “nutcracker syndrome” in the literature, although Shin and Lee argued that nutcracker phenomenon should be reserved for asymptomatic patients and nutcracker syndrome for symptomatic patients.

The reasons why some patients remain asymptomatic are still unknown. Regardless, a nutcracker anatomy results in venous congestion in the LRV, which can cause left flank pain, varicocele of the left testicle along with testicular pain, and varicosities of the lower limb. The increased pressure in the LRV can cause rupture of the thin-walled septum in the renal fornix between the collecting system and varices, resulting in hematuria. Hematuria, the most common symptom of nutcracker syndrome, can also present with orthostatic proteinuria.

Case Report

This is a case report of a 30-year-old male patient who underwent a robotically assisted laparoscopic left donor nephrectomy to donate his left kidney to his uncle. The patient presented with compression of the LRV between the superior mesenteric artery and aorta on magnetic resonance angiography prior to the operation (Figure 1).

The patient was carefully evaluated and noted to have no significant medical history that contraindicated surgery. The risk of donation for a donor kidney with nutcracker phenomenon was extensively debated in the kidney donor preoperative evaluation process. Ultimately, the risk for surgery was noted to be minimal, and the patient and his family were consented for the surgical procedure.

The surgical approach was similar to previously described robotic kidney surgery. Once pneumoperitoneum was introduced, the abdomen was insufflated to 15 mm Hg. A 12-mm trocar catheter was introduced into the abdomen at the site of the needle. A three 8-mm robotic trocar diamond...
configuration was used, and a lower midline 12-mm trocar was placed as an assistant port. A cautery scissor was placed into the right robotic arm, and a Precise Bipolar instrument (Precise Surgical Instruments, Phoenixville, PA, USA) was placed into the left robotic arm. The third arm of the robot had Prograsp forceps (Intuitive Surgical) that was used for retraction.

Surgery was initiated by opening the line of Toldt from the level of the upper sigmoid to the splenic flexure. The left colon was gently lifted, and the plane between Gerota fascia and the mesocolon was identified. With blunt dissection, the colon was mobilized in a medial direction, off Gerota fascia, exposing the area of the renal hilum. Moving in a cephalad direction, we performed incision of the peritoneum lateral to the spleen in continuity with the ongoing dissection. The spleen, pancreas, and the left colon then moved medially, en bloc, with gravity alone. The tissues over the renal hilum were lifted and incised to expose the renal vein. The same was done on the anterior renal vein, exposing the adrenal and gonadal veins. The adrenal vein was dissected free of surrounding tissues. Clips were placed on the renal vein side and one on the adrenal side before the vein was divided with scissors. In a similar manner, the gonadal vein was prepared, controlled, and divided. A lumbar vein could be seen posterior to the gonadal vein and was dissected free, clipped, and divided. The renal artery was identified and dissected free of surrounding tissues. The renal vein was dissected free in a similar fashion toward the vena cava and noted to travel between the superior mesenteric artery and aorta.

Once the surrounding tissue had been freed from the kidney, the kidney was then removed as previously described. The complexity of the nutcracker phenomenon anatomy did not compromise the ability to remove the donor kidney in a safe manner. From incision to wound closure, the overall time of surgery was 215 minutes. The extraction time (time from artery to cross-clamp to delivery from the body) was 2 minutes, and the total warm ischemia time (time from artery cross-clamp until cold reperfusion) was 5 minutes. Total blood loss was less than 50 mL.

Discussion

The first reported minimally invasive living-donor nephrectomy was performed laparoscopically in 1995; since then, there has been a tremendous growth and evolution of minimally invasive procedures for living-donor nephrectomy. To aid in retrieval of the donor kidney, a hand-assisted laparoscopy procedure was subsequently introduced. Reviews comparing hand-assisted laparoscopy and pure laparoscopy have indicated no significant differences in outcomes between the 2 procedures. Highly specialized laparoscopic groups have furthered the technique toward less invasive methods like laparoendoscopic single-site surgery and natural orifice transluminal surgery, utilizing transumbilical and transvaginal approaches. These techniques have been shown to decrease length of hospital stay, decrease narcotic use, improve cosmesis, and improve overall recovery. Nonetheless, technical constraints resulting from limited maneuverability and poor visibility remain major deterrents toward widespread adoption of these techniques.

The robotic platform provides the surgeon with improved optics and flexible instruments, allowing the surgeon to perform complex surgical maneuvers without instrument clashing. Recent studies comparing the efficacy between laparoscopic donor nephrectomy and robotic-assisted laparoscopic
donor nephrectomy have shown that there is no significant difference in the rate of complications between the 2 techniques. Laparoscopic donor nephrectomy for complex anatomic cases such as nutcracker phenomenon have been reported to be successful in the literature, but future studies need to be conducted to determine whether there is a significant difference between laparoscopic donor nephrectomy and robotic-assisted laparoscopic donor nephrectomy for patients with complex anatomic anomalies.

The prevalence of nutcracker phenomenon and nutcracker syndrome is still unclear, although it has been noted that female patients are at a slightly higher risk than men. Nutcracker syndrome has been noted in all age groups. It is important to note that there are 2 types of nutcracker syndromes: anterior syndrome and posterior syndrome. Anterior nutcracker syndrome occurs when the LRV is compressed between the superior mesenteric artery and aorta, whereas posterior nutcracker syndrome occurs when the LRV is compressed between the aorta and vertebral bodies. Posterior nutcracker syndrome is extremely rare. Diagnosis of nutcracker anatomy can be done by a variety of imaging techniques, including magnetic resonance angiography, computed tomography angiography, Doppler ultrasonography, and retrograde venography. On magnetic resonance angiography and computed tomography angiography, a sudden narrowing of the LRV, resulting in a triangular shape at the aortomesenteric portion, can be visualized. This is known as the “beak sign” and is 88.9% specific for nutcracker syndrome. Retrograde venography is considered the criterion standard for diagnosis because pressure gradients across the site of compression can be determined; however, it is more invasive than computed tomography angiography, magnetic resonance angiography, or Doppler ultrasonography.

Treatment of nutcracker syndrome has traditionally been done through conservative methods and surveillance, surgery, or endovascular stents. Conservative treatment is suggested for patients with tolerable symptoms. Surgical options include but are not limited to LRV transposition, LRV transposition with patch venoplasty, patch venoplasty without LRV transposition, LRV transposition with saphenous vein cuff, gonadal vein transposition, and saphenous vein bypass. Among these, LRV transposition is the most common and effective approach. In this operation, the LRV is transposed distally to the inferior vena cava, thereby removing the compression on the LRV. Occasionally, an LRV transposition procedure is not sufficient enough to reduce symptoms because the LRV has been compressed for too long, resulting in permanent distortion of the vein. In these situations, the great saphenous vein can be used to provide support to the LRV as a patch, resulting in patch venoplasty in addition to the LRV transposition (LRV transposition with patch venoplasty). In other cases, the saphenous vein can be used to provide support to LRV as a cuff extension (LRV transposition with saphenous vein cuff). Overall, LRV transposition alone is sufficient enough to provide complete relief of symptoms for most patients with nutcracker syndrome. Renal autotransplantation can also be done for nutcracker syndrome patients but should be reserved as a last resort treatment option.

Another option for treatment is endovascular stenting, which involves a minimally invasive approach by placing a stent at the site of compression. Data are still limited on the efficacy of endovascular stenting for nutcracker syndrome, but the largest review of endovascular stenting for nutcracker syndrome to date showed that 59 of 61 patients treated with endovascular stenting had a resolution of hematuria, flank pain, and proteinuria with no complications. Follow-up of these patients ranged from 6 months to 6 years, suggesting positive long-term outcomes. Of the 2 patients who had complications, both had complication of stent migration either during or after the procedure, and both cases were resolved by open surgery. Other complications, such as thrombosis, in-stent restenosis, fracture, and venous occlusion resulting from fibromuscular hyperplasia, can also occur but are extremely rare.

This is the first reported case of a robotic-assisted laparoscopic donor nephrectomy of a patient with nutcracker phenomenon. This confirms that robotic surgery is a safe and viable option for patients with aberrant anatomy such as nutcracker phenomenon and who wish to donate their kidneys. Future studies need to evaluate the potential advantage of robotic-assisted laparoscopic donor nephrectomy over standard laparoscopic donor nephrectomy for living-donor nephrectomy patients with nutcracker phenomenon and other complex vascular anomalies.
Compliance with ethical standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors. Informed consent was obtained from all individual participants included in the study.

References


