

Celiac Artery Compression Syndrome: Successful Utilization of Robotic-Assisted Laparoscopic Approach

Nikhil P. Jaik¹, S. Peter Stawicki², Natalie S Weger¹, John J. Lukaszczyk³

1) Department of Surgery and 3) Division of Minimally Invasive Surgery, St. Luke's Hospital and Health Network, Bethlehem.
2) Stawicki Research Foundation King of Prussia, PA

Abstract

Median arcuate ligament (MAL) syndrome, also known as the celiac axis compression syndrome (CACS) is rare, and a topic of ongoing academic controversy. CACS is a diagnosis of exclusion, characterized by the clinical triad of postprandial abdominal pain, weight loss, and vomiting. The classic management of CACS involves the surgical division of the MAL fibers. We report successful treatment of a 23-year-old woman with CACS utilizing the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, California) via robotic-assisted minimally invasive surgical division of the MAL. To our knowledge this is the first report of this modality used in the treatment of the celiac axis compression syndrome.

Key words

Celiac axis compression syndrome – robotic-assisted – minimally invasive surgery

Introduction

Median arcuate ligament (MAL) syndrome, also known as the celiac axis compression syndrome (CACS), was first described by Harjola in 1963 (1). The CACS is rare and a topic of ongoing academic controversy (2). CACS is a diagnosis of exclusion, characterized by the clinical triad of postprandial abdominal pain, weight loss, and vomiting (1-3). Several treatment options have been described in the management of CACS, including transluminal dilatation, surgical division of the MAL, and arterial bypass surgery (3).

The classic management of CACS involves the surgical division of the MAL fibers (4). Open and laparoscopic techniques have been described in the treatment of CACS,

with varying degrees of success (4-6). We report successful treatment of CACS utilizing the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, California) to perform a robotic-assisted minimally invasive surgical division of the MAL. To our knowledge this is the first report of this modality used in the treatment of the CACS.

Case report

A 23-year-old woman presented to the emergency department with severe upper abdominal pain. The pain was intermittent and recurred multiple times over the preceding 12 months. The pain was mostly post-prandial, associated with nausea, non-bilious vomiting, and occasional diarrhea.

The patient had a prior cholecystectomy for biliary dyskinesia. However, her symptoms persisted. After an exhaustive clinical investigation of the persistent postprandial upper abdominal pain, the patient underwent an esophagogastroduodenoscopy and colonoscopy, which were both normal.

In search of less common causes of upper abdominal pain, we entertained the possibility of CACS, and an abdominal visceral Duplex ultrasound was obtained. This study demonstrated a high-grade celiac artery stenosis with a peak systolic velocity of 357 cm/sec (Table I).

Computed tomographic angiography showed 50% stenosis at the origin of the celiac axis, which appeared to be externally compressed (Fig. 1A and B). After carefully weighing the risks and the benefits of surgical intervention for CACS, the patient decided to proceed with MAL release. Presented with different operative alternatives, the patient opted to undergo robotic-assisted laparoscopic release of the MAL using the da Vinci Surgical System.

Technique

In the operating room, the patient was placed in the supine position. After induction of general anesthesia and

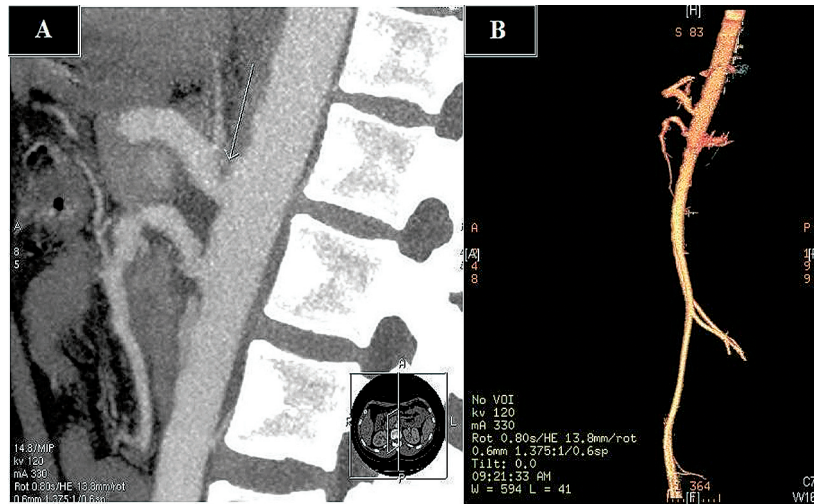


Fig.1 Computed tomography demonstrating proximal stenosis of the celiac axis (long arrow) on coronal reconstruction (A) and on 3-D aortic reconstruction (B).

endotracheal intubation, an infra-umbilical incision was made. A Veress Needle was then introduced into the abdominal cavity; 3.5 liters of CO₂ were insufflated following which a 12-mm cannula was placed for the robotic camera. A 5mm cannula was introduced in the right lateral abdomen through which a liver retractor was placed to lift the left lobe of the liver. Two 8mm robotic cannulas were introduced in the right and left upper abdomen in a fashion similar to that used in a Nissen fundoplication. An additional 10mm cannula was introduced in the left lateral abdomen (Fig.2).

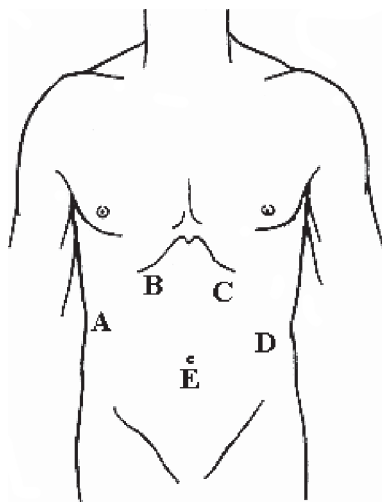


Fig.2 Diagram of laparoscopic cannula placement. A = 5 mm liver retractor port; B and C = 8 mm robotic arm ports; D = 10 mm surgical assistant port; E = 12 mm stereoscopic robotic camera port.

Using the robotic arms, dissection was carried down to the diaphragmatic crura through the lesser sac. The stomach was retracted to the left to gain better exposure. At one point, the right gastric artery was looped with a penrose drain and also retracted to the left. The right crus dissection was carried out caudally. Upon further dissection, the aorta and celiac artery came into view and the right diaphragmatic

crus was seen coursing over the aorta and around the celiac axis. The right crus was then carefully divided. There were more fibrous attachments around the aorta and the origin of the celiac artery, which were carefully divided. Division of these fibers on the celiac artery was carried out for some distance onto the celiac artery circumferentially until the artery appeared to be free of any external compression. Once these maneuvers were completed, the celiac axis was clearly visualized without any residual kinking and uniform throughout its course. Although not available at our institution, the use of intraoperative laparoscopic Doppler ultrasonography could also be helpful in confirming the adequacy of the dissection, as it allows for real-time determination of improvement in arterial flow characteristics (6). Operative time was 168 minutes and blood loss was minimal. See Fig. 3 for intraoperative video capture images.

The postoperative period was characterized by complete relief of preoperative symptoms. Repeat Duplex ultrasound showed decreased and uniform celiac axis velocity of 145cm/sec (Table I). The patient was discharged on postoperative day 1, and was completely symptom-free at one, three and 6-week follow up visits.

Table I Comparison of preoperative and postoperative systolic and diastolic velocities in the celiac axis as measured by Duplex ultrasonography

	Systolic velocity (cm/sec)	Diastolic velocity (cm/sec)
Preoperative	363	75
Postoperative	145	53

Discussion

Celiac artery compression syndrome is a controversial clinico-pathologic entity (2). This controversy is fueled largely by the presence of celiac artery compression in many

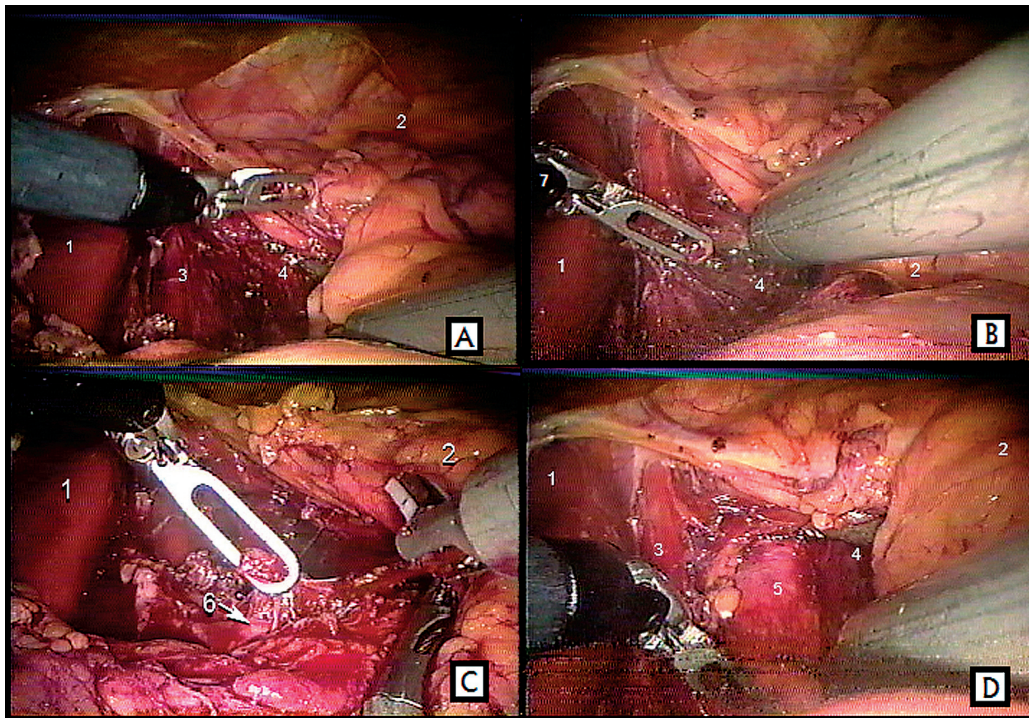


Fig.3 Intraoperative videotape capture images. A) before dissection; B) right crus being elevated prior to division; C) division of constrictive bands around the celiac artery (arrow); D) end of dissection with the aorta fully exposed. Fig. labels: 1) liver; 2) stomach; 3) right crus; 4) left crus; 5) aorta; 6) celiac artery (arrow); 7) robotic arm grasper.

asymptomatic individuals and by the lack of clear pathophysiological mechanisms involved in symptomatology of CACS (5). While operative intervention has been shown to relieve symptoms in carefully selected patients, the rates of surgical failure are significant (7, 8).

CACS is a diagnosis of exclusion, characterized by the clinical triad of postprandial abdominal pain, weight loss, and vomiting (3, 5). An epigastric abdominal bruit can be present in CACS (4). Radiographic evidence of external compression of the celiac artery is needed to confirm the diagnosis, with recent reports of successful use of the computed tomographic angiography in the diagnosis of CACS (9). The MAL normally crosses the aorta cephalad to the origin of the celiac trunk. In cases when the MAL inserts unusually low or the celiac axis is located unusually high, the MAL will may compress the origin of the celiac artery (5).

Until recently, open surgery was the mainstay therapy for CACS (2,5). With the advent of minimally invasive surgery, increasing number of reports advocate the laparoscopic approach to CACS (4,6,10). Robotic assistance or tele-manipulation is one of the most significant recent technological advancements in minimally invasive surgery (11).

The reported benefits of robotic surgery in other settings include superior stereoscopic visualization of the surgical field, high degree of precision afforded by wrist like articulations at the end of instruments, low morbidity, decreased blood loss, rapid postoperative recovery, and excellent functional outcomes from surgery in anatomical

regions of critical functional importance (i.e., the preservation of continence and potency following robotic-assisted prostate surgery) (11-13). However, excellent clinical outcomes have also been reported in non-robotic laparoscopic procedures, including the Nissen fundoplication, radical prostatectomy, pyeloplasty, and release of CACS (6,14-16). In addition, non-robotic laparoscopic procedures are less expensive to perform and almost universally require less operative time (including equipment setup) than their robotic equivalents (6,14,15,17). After carefully considering the preoperative risks and benefits, we determined that the optimal procedure for our patient would constitute a combination of the least morbid and the least invasive options, despite higher expected cost and time requirements. Based on the above factors, we decided to proceed with robotic-assisted laparoscopic approach using the daVinci Surgical System for the release of CACS.

The surgery for CACS release in our case was supported by significant clinical evidence. First, the patient had chronic abdominal pain, predominantly postprandial in nature accompanied by nausea and vomiting. Second, the patient underwent exhaustive preoperative workup, the results of which were otherwise unremarkable. Thirdly, the patient had Duplex ultrasonographic evidence of celiac artery stenosis, with unequivocal CTA evidence of significant external compression of the celiac artery by the MAL. Intraoperatively, we were able to identify and confirm the external compression of the celiac artery by the MAL. We were able to release the external compression of celiac artery without complications and with minimal postoperative discomfort.

Intraoperative laparoscopic-based ultrasonography, although not available at our institution, has been described to be helpful in assessing the adequacy of operative decompression by documenting improvement in celiac artery flow velocities before and after the division of crural fibers (6).

The postoperative resolution of the patient's initial symptomatology, coupled with Duplex ultrasonographic evidence of improved celiac axis hemodynamics, appear to fully justify our approach. Considering the above findings, we do not believe that there is a role for immediate postoperative repeat angiographic imaging in cases similar to ours. Rather, computed tomographic or traditional angiography should be reserved for cases of operative failure, inability to assess the celiac artery using Duplex ultrasonography, or recurrent symptomatology following surgical release of MAL. Previous literature reports demonstrated that combining surgery and other adjunctive techniques (i.e., concurrent celiac revascularization) in the treatment of CACS may be beneficial in reducing the long-term recurrence rate (2). Although angioplasty and stenting of visceral arteries seems to be successful in the setting of atherosclerosis, their use in the setting of CACS has been questioned because of the presence of extrinsic compression that may prevent adequate dilatation of the artery (6, 19-20). Nevertheless, these adjunctive techniques may be beneficial in the setting of recurrent disease or failure to completely release the MAL surgically (2). Because of the known incidence of recurrent symptoms (24 - 47%) in patients with CACS (3,6,18), we plan a long-term radiographic and clinical follow up of the patient.

Conclusion

Given the delicate balance between the risks and benefits in surgery for CACS, it appears reasonable that the robotic approach, with its superior visualization and precision of movement, could represent the optimal treatment modality for CACS.

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