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Case Report

Robotic-Assisted Laparoscopic Median Arcuate Ligament Release for Median Arcuate Ligament Syndrome

Carolyn G Judge, Michael W Hornacek and Gordon G Wisbach*

Department of General Surgery, Navy Medicine Readiness and Training Command, USA

Abstract

Median Arcuate Ligaments Syndrome (MALS) is a condition caused by symptomatic chronic mesenteric ischemia in the setting of celiac artery compression by the Median Arcuate Ligament (MAL), a fibrous arch of the diaphragm. MALS is a rare and controversial disease, due to the high prevalence of significant compression without associated symptoms as well as a widely variable response to surgical intervention. We present a case series of three patients with MALS treated at the same facility within two years of each other all of whom went on to experience complete resolution of their symptoms without recurrence to date. The patients all underwent a robotic-assisted laparoscopic median arcuate ligament release with the use of Indo Cyanine Green (ICG) and vascular ultrasound which guided dissection and allowed for confirmation of normal flow rates at conclusion of the release.

Keywords: Median arcuate ligament syndrome; Celiac artery compression; Celiac artery stenosis; Robotic surgery

Introduction

Median arcuate ligament syndrome is a controversial phenomenon and a diagnosis of exclusion. It is traditionally recognized by a triad of symptoms including postprandial abdominal pain, weight loss, and an epigastric bruit in the setting of compression of the celiac artery and/or celiac ganglion by the median arcuate ligament [1]. Compression of the artery can cause poor development of both the celiac axis and its branches [2], as well as intimal hyperplasia resulting in luminal narrowing, and stenotic arterial injury [3].

The finding was first reported in a series of cadaveric dissections in the early 20th century [2]. The associated syndrome was later described by Harjola followed by Dunbar [4,5], who noted relief of postprandial epigastric pain after surgical decompression.

Although historically managed by an open and later laparoscopic approach, the robotic approach has been shown to be safe and effective. The robotic platform facilitates precise and accurate dissection by virtue of increased dexterity and visualization when compared to laparoscopy in isolation [1]. It is associated with increased efficacy, decreased complications including decreased rate of conversion to open, and shorter hospital stay [1,6].

Case Presentation

Case 1

Patient DS was a 24-year-old female who presented with two years of abdominal pain. She described the pain as localized to her epigastric region without radiation. It was associated with 1-2 loose, non-bloody stools per week, bloating, nausea without emesis, and 10-15 pounds of unintentional weight loss. At the time of initial evaluation by general surgery her BMI was 17.58. She endorsed postprandial exacerbation of her pain with onset 5-10 minutes after eating and resolution 1-2 hours later. The patient also noted an exertional component and described relief with deep inspiration. Her symptoms were initially attributed to biliary colic but persisted following removal of her gallbladder (2017). Pre-operative colonoscopy was normal. EGD demonstrated LA Grade A esophagitis and gastritis without additional findings. CT angiogram (Nov 19) demonstrated narrowing of her celiac artery origin. Subsequent mesenteric duplex (Jan 20) demonstrated an inspiratory and expiratory velocity of 288 cm/sec and 310 cm/sec respectively at the celiac origin. Of note, she had no significant medical or surgical history, and her exam was unremarkable. She had a BMI of 21.79.

Case 2

Patient RM was a 42-year-old woman who presented with 10 years of epigastric abdominal pain, daily nausea, bloating, pelvic pain, diarrhea, and early satiety. She endorsed epigastric pain both with and without meals as well as intermittent bouts of emesis, most recently one month prior to presentation. Her exam was significant for mild tenderness to palpation in the epigastric region as well as a defect in her left jaw and associated lack of ipsilateral carotid pulse due to the resection and radiation of a parotid tumor at 16 years of age. Her medical history is also significant for hypothyroidism. Her surgical history is significant for a remote caesarian section as well as simultaneous Transabdominal Preperitoneal (TAPP) ventral hernia, umbilical hernia, and spigelian hernia repair in June of 2021. Imaging performed to evaluate her hernias, demonstrated an 85% stenosis of the celiac trunk, and associated post-stenotic dilatation. Surgical repair of her hernias did not relieve her symptoms nor did behavioral modifications or conservative management to include six daily small meals, exercise, and warm compresses. She had a BMI of 35.19.

Case 3

Patient TD was a 21-year-old man with a six-month history of

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***Corresponding author:** Carolyn G Judge, Department of General Surgery, Navy Medicine Readiness and Training Command, San Diego, 291 Awakea Rd, Kailua, HI, 96734, USA, Tel: +1-203-247-7736; E-mail: Carolyn.g.judge.mil@mail.mil

epigastric pain, cramping, diarrhea, increased flatus, and intermittent rectal bleeding. He endorsed marginal pain relief with defecation but denied post-prandial or exertional exacerbation as well as any additional alleviating factors. He initially presented to the emergency room (Oct 21) where he was evaluated by right upper quadrant ultrasound and basic labs, both of which were normal. He was diagnosed with irritable bowel syndrome and started on Pepcid without improvement in symptoms. At his primary care follow-up, he was noted to have an abdominal bruit and significant pulsation of his abdominal aorta concerning for vascular pathology. CT angiogram (08, Mar 22) demonstrated severe narrowing of proximal celiac trunk at the level of the MAL with post stenotic dilatation as well as increased caliber of gastroduodenal artery with collateralization to the SMA. Colonoscopy and esophagogastroduodenoscopy were normal. Of note, the patients preoperative BMI was 26.17. He had no significant medical or surgical history, and his exam was unremarkable.

Surgical Management

After alternative causes of abdominal pain were excluded, all patients underwent a robotic-assisted Median Arcuate Ligament Release (MALR). On entry to the abdomen the pars flaccida was divided to facilitate entry into the lesser sac. Fibrous attachments overlying the aorta were divided proceeding proximally. Vascular ultrasound and indocyanine green or ICG were used to identify the celiac arterial trunk. The left gastric artery was isolated and encircled with a vessel loop. Using gentle traction with the patient in steep reverse Trendelenburg, dissection proceeded along the left gastric artery toward the celiac trunk where the splenic and common hepatic arteries coalescence was visualized. Following exposure of the celiac artery trifurcation, the MAL was elevated and divided circumferentially to expose the aortic surface proximal to the celiac artery origin. Vascular ultrasound guided dissection and demonstrated normal flow rates at the conclusion of the case. In all cases the surgery and post-operative course were uncomplicated, and complete resolution of symptoms was reported.

Discussion

The MAL is a tenacious fibrous structure with tight bands often adherent to the celiac arterial wall [7]. It is known to be difficult to distinguish from the vessel wall especially in the setting of stenotic arterial injury as is often associated with prolonged compression [8]. This injury creates a vascular deformity which may place stress on the artery making its course uncertain and increasing the risk of vascular injury. While the mechanism of MALS remains unknown, the primary theories are neuropathic and ischemic. The MAL itself has been observed to be highly variable and closely associated with autonomic nerves which often participate in arterial compression [9]. It is thought that compression of nerves by the MAL could precipitate irritation resulting in vasoconstriction and subsequent ischemia [3]. Alternatively, compression of the CA could reduce blood flow resulting in foregut ischemia [9]. It is widely thought, however, that two vessel occlusion would be necessary to cause ischemia based on experience with mesenteric ischemia in the setting of the atherosclerotic disease [3,10,11]. Additionally, ligation of the CA is well tolerated in trauma suggesting single vessel disease would not cause ischemia [3]. Lastly, a steal phenomenon was proposed by Debakey [11,12], where in CA compression results in collateral vessels shunting blood away from the midgut to better perfuse the CA distribution.

Historically, there has been controversy regarding the clinical significance of celiac artery compression. The incidence of MALS is 0.002% [13], but as many as 10%-24% of the population may have some degree of compression [9]. In a study of 109 patients identified as having radiographically evident celiac artery stenosis, only 44% had symptoms [14]. Factors associated with symptoms were age less than 30, history of prior abdominal surgery, and high-grade stenosis [14]. In addition to asymptomatic compression, the inconsistent response to surgical intervention has caused further skepticism about clinical significance. Two recent reviews of robotic-assisted MALR reported 44%-68% resolution with 24%-27.8% recurrence of symptoms [1,6].

MALS is diagnosed by demonstration of peak systolic velocity of the celiac artery of >200 cm/s indicating celiac stenosis >70% [15]. This findings in conjunction with a fishhook deformity and the absence of calcifications or wall irregularities helps to distinguish MALS from more common causes of celiac stenosis such as atherosclerosis [16]. The fishhook deformity typically consists of a superior indentation usually about 5 mm from the celiac artery origin at abdominal aorta and is frequently associated with post-stenotic dilatation [8]. Additional imaging by CTA, MRA, and even gastric tonometry has been pursued, but lateral mesenteric angiography is the gold standard for diagnosis [1,17].

Treatment options include open surgery, laparoscopic surgery, vascular reconstruction, and endovascular angioplasty [1]. Open surgical intervention was first described by Dunbar [5] and was traditionally used prior to the advent of laparoscopic technology [18]. It fell out of favor due to major complications as high as 6.5% and hospital stays of 5 days or longer [19]. Laparoscopic decompression, first performed in 2000 [20] proved to be safe and effective [21]. Up to 85% of patients reported immediate symptom relief and long-term maintenance following laparoscopic decompression [22]. The primary disadvantage of the approach proved to be high conversion rates (9.1%) largely due to inability to control arterial bleeding (7.4%) [6,19,21,23].

The robotic-assisted approach was first performed in 2007 [24]. Six additional robotic studies have been reported since that time [6,10,22,25-27]. The robotic platform offers enhanced 3D visualization, enhanced stability, motion scaling controls, tremor elimination, improved ergonomics, and increased ability to perform intricate maneuvers in confined spaces due to jointed instrumentation all of which facilitate more precise microdissection [1,6,28].

The major advantage of robotic technology in this operation is precise circumferential dissection of the celiac artery, perhaps not possible with laparoscopic instrumentation. Facile integration with adjunct technologies, including ultrasound and ICG, adds potential safety and efficacy to the procedure. The disadvantages are increased cost, set-up time, requirement for extra training, limited availability at small institutions, and lack of haptic feedback [8,25]. The robotic-assisted MALR has been associated with improved response rates and decreased conversion to open when compared to the laparoscopic approach, early hospital discharge, fewer complications, and opportunity for narcotic liberation [1,6,7,19,21,25].

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