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Laparoscopic Release of the Median Arcuate Ligament: A Case Series and Review of Literature

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Abstract **Objectives:** Median Arcuate Ligament Syndrome (MALS) is a rare vascular compression disorder causing chronic abdominal symptoms. Surgical decompression via the laparoscopic approach has gained popularity due to its minimally invasive nature and favourable outcomes. **Methods:** This was a prospective case series conducted at SMHS Hospital, Srinagar, Department of General & Minimal Access Surgery, between 2024 and 2025. Informed consent was obtained for all cases. Inclusion criteria were age >16 years, radiologically confirmed MALS, and laparoscopic release. Exclusion criteria were concomitant gastrointestinal pathology, incomplete data, or non-laparoscopic approach. Doppler ultrasonography (peak systolic velocity >200 cm/s), CT angiography/MR angiography with positional variation, CT enterography, gastric emptying studies, and upper GI endoscopy. All patients underwent laparoscopic release under general anesthesia (4–5 port approach). The procedure involved retraction of the left lobe of the liver, dissection of the crura of the diaphragm, exposure of the celiac axis, and division of the median arcuate ligament with surrounding fibrotic tissue. Decompression was confirmed either by intraoperative Doppler or visual pulsatility. The primary outcome was symptom relief at short-term follow-up, assessed with postoperative duplex ultrasonography. Secondary outcomes included operative time, blood loss, conversion rate, postoperative complications, and length of hospital stay. **Results:** Symptom relief was achieved at short-term follow-up with supportive evidence from postoperative duplex ultrasonography. Operative details, perioperative outcomes, and follow-up findings were recorded for all included patients. **Conclusion:** Laparoscopic release of the median arcuate ligament is a feasible and effective approach in selected patients with MALS, with favourable short-term outcomes and minimal perioperative morbidity.

Key Words Median Arcuate Ligament Syndrome, Laparoscopy, Vascular Compression Syndrome, Celiac Axis Compression, Case Series

INTRODUCTION

Median Arcuate Ligament Syndrome (MALS), also known as celiac artery compression syndrome or Dunbar syndrome, is a rare vascular disorder characterised by extrinsic compression of the celiac trunk by the median arcuate ligament—a fibrous arch that connects the diaphragmatic crura across the aortic hiatus. Although the median arcuate ligament anatomically compresses the celiac artery in up to 10–24% of the population, only a minority develop clinical symptoms, suggesting a complex interplay of anatomical and neurogenic factors in the pathogenesis of MALS [1–3].

The classical clinical triad of MALS includes postprandial epigastric pain, significant weight loss, and an abdominal bruit. However, many patients present with non-specific or vague upper abdominal symptoms such as nausea, early satiety, bloating, or intermittent vomiting—leading to diagnostic uncertainty and frequent misdiagnosis as functional gastrointestinal disorders, peptic ulcer disease, or psychosomatic complaints [4,5]. The variability in symptomatology and absence of disease-specific biomarkers contribute to significant delays in diagnosis, often resulting in chronic debilitation and impaired quality of life.

Diagnosis of MALS is fundamentally reliant on a combination of clinical suspicion and radiological confirmation. Doppler ultrasound is a non-invasive and commonly used first-line modality that demonstrates elevated peak systolic velocities (>200 cm/s) in the celiac axis, particularly during expiration. However, due to operator dependency and variability with respiration, computed tomography angiography (CTA) or magnetic

resonance angiography (MRA) is often required for anatomical confirmation. Classic findings include a focal narrowing of the proximal celiac axis with a characteristic "hooked" appearance on sagittal reconstructions, exacerbated during expiration, and post-stenotic dilatation of the artery [6,7]. Recent studies have emphasized the utility of dynamic imaging protocols and three-dimensional reconstructions for accurate assessment of celiac artery compression and collateral circulation.

The pathophysiology of MALS remains multifactorial. Beyond mechanical compression of the celiac trunk leading to mesenteric ischemia, some researchers propose a neurogenic component involving irritation or entrapment of the celiac plexus fibers by the median arcuate ligament, contributing to the visceral pain and autonomic symptoms observed in many patients [8]. This neurovascular hypothesis underpins the rationale for surgical decompression that includes not only ligament division but also celiac ganglionectomy.

Historically, open surgical release of the median arcuate ligament was the standard of care. However, since the early 2000s, laparoscopic techniques have gained favor due to their minimally invasive nature, improved visualization of the operative field, reduced postoperative pain, shorter hospital stay, and quicker return to normal activity [9–11]. The laparoscopic approach facilitates precise dissection of the crura and surrounding fibrotic tissue from the celiac artery with minimal morbidity. Several studies have reported success rates exceeding 70–80% for symptom resolution following laparoscopic decompression, especially in carefully selected patients [12–14]. Nevertheless, the variability in operative technique, inconsistent use of adjunctive intraoperative vascular imaging, and lack of long-term follow-up data continue to limit generalizability and standardization of this approach.

Despite a growing interest in laparoscopic management of MALS, published data remain limited to case reports and small series, with significant heterogeneity in patient selection, diagnostic protocols, and outcome measures. Given the rarity of the condition and diagnostic complexity, further surgical case series with structured methodology and follow-up are needed to contribute to the body of evidence.

The present case series aims to describe three consecutive patients with symptomatic MALS who underwent successful laparoscopic median arcuate ligament release at our tertiary care institution. We highlight diagnostic criteria, operative technique, perioperative outcomes, and symptom resolution in the postoperative period, providing insights into the role of minimally invasive surgery in this complex vascular syndrome (Table 1).

Pre-operative Duplex USG image of Case 3 showing peak systolic velocity of 128 cm/sec at the celiac axis (Figure 1).

Table 1: Case Presentations

Case no	1	2	3
Age	45	18	22
Sex	Female	Male	Male
Occupation	Farmer	Student	Businessman
Presenting symptoms	Postprandial pain upper abdomen, intermittent vomiting, weight loss.	Postprandial pain, Weight loss.	Dull continuous pain epigastrium, intermittent vomitings, occasional hematuria
Duration of symptoms	1 year	7 months	8 years
Duplex-USG (Celiac Axis PSV)	210 cm/sec. Post-stenotic Turbulence.	185 cm/sec Post-stenotic Turbulence	128 cm/sec. Post-stenotic Turbulence.
CT-Angiography findings	Celiac artery compression at its origin with post stenotic dilatation.	J-hook shaped bend in the Celiac artery at its origin with post stenotic dilatation	• Compression of celiac artery at its origin with post stenotic dilatation. • Decreased distance between abdominal aorta and SMA with Aorto-mesenteric angle of 21 degrees. • Mild stenosis of the Left renal vein suggestion of Nutcracker morphology.

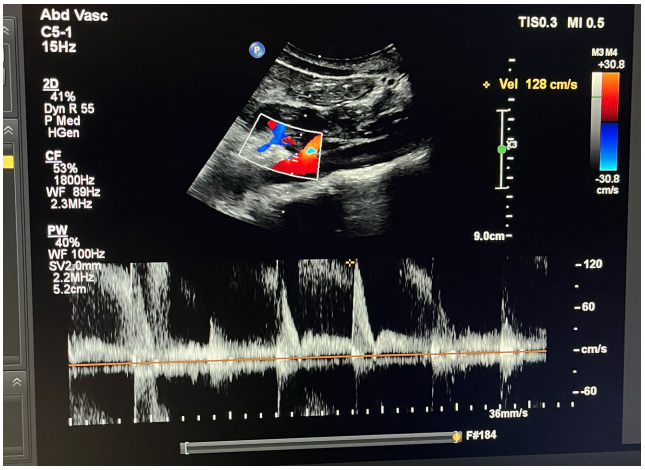

Figure 1: Pre-Operative Duplex USG Images

Figure 2: CT-Angiography images

Figure 3: Venous phase CT (sagittal) of Case 3 showing compressed left renal vein (nutcracker morphology) and compression of the third part of the duodenum (SMA syndrome)

In Case 3, CT-angiography performed in the arterial phase (sagittal section) demonstrated significant vascular compression. The celiac artery appeared narrowed at its origin with post-stenotic dilatation, while the superior mesenteric artery (SMA) showed a decreased aorto-mesenteric angle, indicating additional vascular involvement (Figure 2).

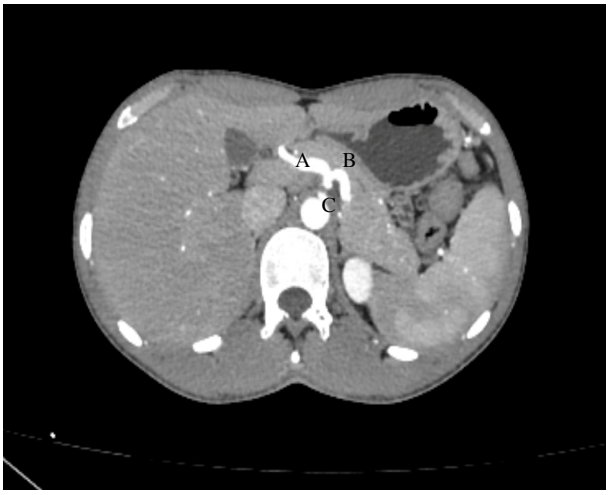

Figure 4: Arterial phase CT (axial) of Case 3 showing compressed celiac artery (C) with adjacent common hepatic artery (A) and splenic artery (B)

In the venous phase sagittal CT-angiography of Case 3, the left renal vein was seen compressed, consistent with nutcracker morphology. In addition, the third part of the duodenum was compressed, a finding suggestive of superior mesenteric artery (SMA) syndrome. These observations highlight the presence of multiple vascular compressive features in the same patient (Figure 3).

Figure 4 demonstrates the arterial phase axial CT of Case 3, highlighting compression of the celiac artery (C). The adjacent common hepatic artery (A) and splenic artery (B) are also clearly visualized. This vascular compression may suggest underlying anatomical variations or external compressive factors, which could have clinical implications such as compromised blood flow to the upper abdominal organs. The image emphasizes the importance of careful assessment of celiac artery morphology in patients presenting with relevant symptoms.

Figure 5 illustrates the vascular compression in Case 3, where the superior mesenteric artery (SMA) exerts pressure on the left renal vein, as seen on the arterial phase (A). The venous phase image (B) reveals pre-stenotic dilatation proximal to the site of compression, indicating impaired venous outflow. These findings are characteristic of nutcracker phenomenon and highlight the significance of multiphasic CT imaging in evaluating vascular compression syndromes.

In all the three cases we have done thorough diagnoastic laparoscopy to rule out any gross pathologies. Further, left lobe of the liver is retracted, exposing the hepatogastric ligament (Figure 6).

The Pars Flaccida part of the ligament is fanned out and divided using a harmonic scalpel to gain access to the lesser sac.

Figure 7 demonstrates the identification of the left gastric artery (A) during surgery. Upon entering the lesser

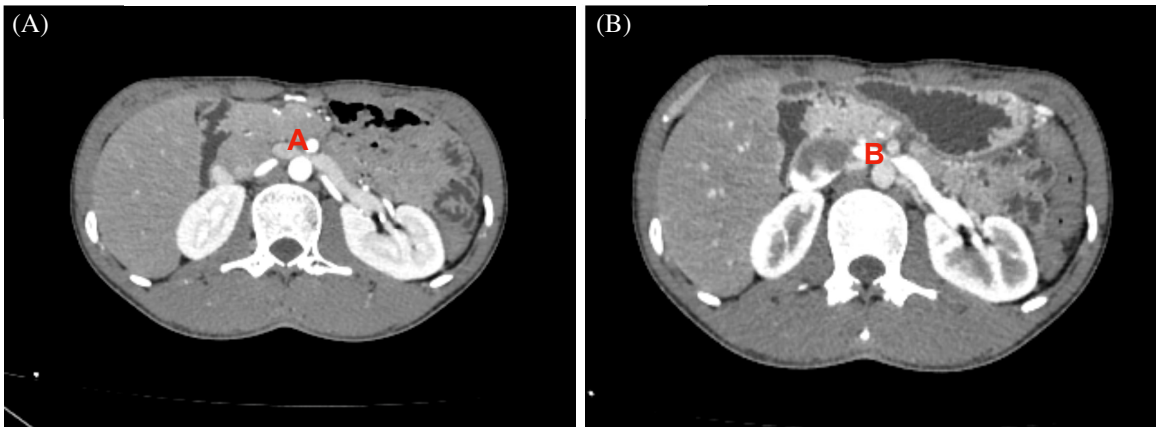

Figure 5: Arterial (A) and venous (B) phase CT images of Case 3

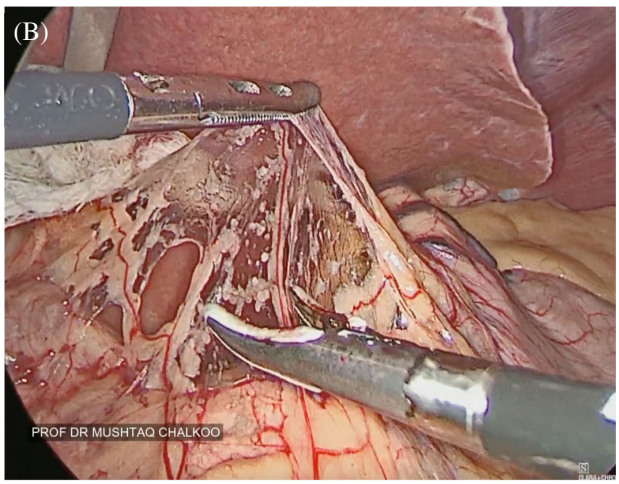

Figure 6: Operative steps showing (A) port placement and (B) diagnostic laparoscopy with access to the lesser sac

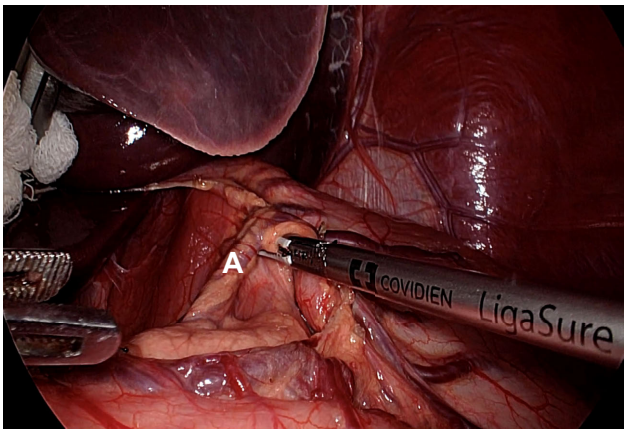

Figure 7: Identification of Left Gastric artery

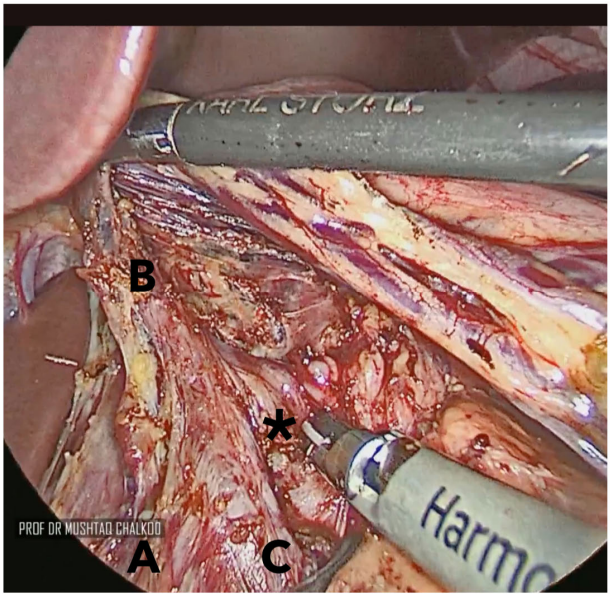

Figure 8: Identification of celiac artery trifurcation ("Mercedes Benz sign") with left gastric artery (B), common hepatic artery (A), and splenic artery (C); thick fibrous median arcuate ligament (*) noted

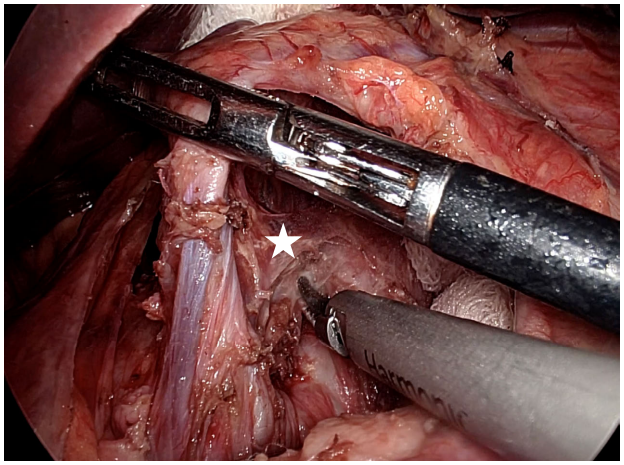

Figure 9: Dissection at the point marked (☆) showing complete division of the median arcuate ligament fibers and exposure of the celiac axis with visible arterial pulsations

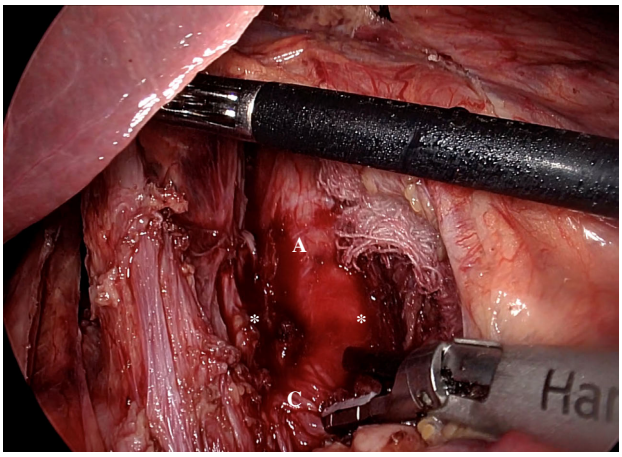

Figure 10: Celiac artery (C) exposed after cranial division of the median arcuate ligament (*) with adjacent abdominal aorta (A)

sac, the left gastric artery was the first vessel encountered and was carefully traced caudally to delineate the trifurcation of the celiac axis. This step is crucial for safe dissection and proper vascular orientation during the procedure.

Figure 8 illustrates the celiac artery trifurcation, known as the "Mercedes Benz sign," with the left gastric artery (B), common hepatic artery (A), and splenic artery (C) clearly identified. The thick fibrous portion of the median arcuate ligament (*) was observed overlying the celiac artery, suggesting external compression at this site. Careful identification of these vascular structures is essential to assess and manage potential celiac artery entrapment.

Figure 9 highlights the dissection at the point marked ☆, where the fibers of the median arcuate ligament were completely divided to expose the celiac artery. The visible arterial pulsations at this site indicate successful release of the ligament and restoration of unobstructed blood flow.

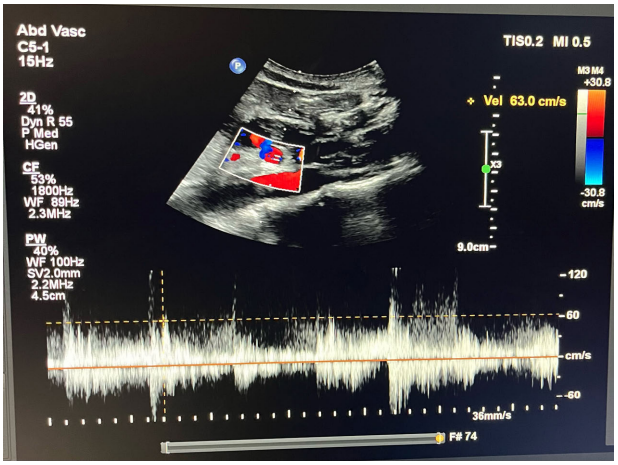

Figure 11: Post-Operative Duplex USG of Case 3 showing significant decrease in the Post Stenotic Velocity at the Celiac axis

After releasing the compression over the celiac artery, the ligament is further divided more cranially towards the hiatus, approximately 5 cm. This plane of dissection is very close to the wall of the Abdominal Aorta, which requires meticulous precision to carry out this maneuver (Figure 10).

Utmost care must be taken not to injure the aorta which could lead to adverse outcomes. The image above shows the celiac artery arising from the aorta, abdominal complete being stripped off of the MAL and exposed, both the cut end of the ligament could be appreciated.

RESULTS

A total of three patients (2 male, 1 female; mean age 28.3 years) underwent laparoscopic median arcuate ligament release for symptomatic MALS at our institution. All the three procedures were done by a well experienced laparoscopic surgeon in a tertiary care hospital. The mean duration of symptoms prior to diagnosis was 14 months (range: 9–22 months), and all patients presented with postprandial epigastric pain, weight loss (mean 7.2 kg), and functional impairment (Table 2). Preoperative imaging confirmed celiac artery compression and characteristic hook-shaped narrowing on CT angiography. All procedures were completed laparoscopically without the need for conversion to open surgery. The mean operative time was 100 minutes (range: 92–112 minutes), and estimated blood loss was minimal (<10 mL) in all cases. No intraoperative or immediate postoperative complications occurred. Conversion rate was nill. Patients resumed oral intake on postoperative day one and were discharged within 2–3 days. At a short follow up of 3months, all three patients reported complete symptom improvement. No reinterventions were required. Postoperative duplex ultrasound confirmed adequate celiac artery flow, with a peak systolic velocity of 63 cm/s, indicating successful decompression (Figure 11).

Table 2: Operative details, intra- and post-operative outcomes, and celiac artery peak systolic velocity (PSV) on post-operative duplex ultrasound for all cases

Case no.	Operative time	Intra-Op Blood loss (Approx)	Intra-Op Complications	Conversion to Open	Post-Op Complications	LOS (days)	Symptom relief (%)	Post-op Duplex USG PSV at Celiac axis
1	112 min	10 mL	None	No	None	3 days	100%	77 cm/sec
2	98 min	8 mL	None	No	None	2 days	100%	65 cm/sec
3	92 min	8 mL	None	No	None	3 days	100%	63 cm/sec

DISCUSSION

Median Arcuate Ligament Syndrome (MALS) represents a rare but clinically significant cause of chronic abdominal pain, often misdiagnosed due to its nonspecific symptomatology and overlap with functional gastrointestinal disorders. The syndrome is characterized by extrinsic compression of the celiac artery by the median arcuate ligament, a fibrous band formed by the diaphragmatic crura. The clinical manifestations of MALS—typically postprandial epigastric pain, unintentional weight loss, early satiety, nausea, and sometimes an audible abdominal bruit—are believed to result from a combination of mesenteric ischemia due to compromised celiac blood flow and neurogenic irritation of the surrounding celiac plexus [15–17].

Although radiological compression of the celiac trunk can be detected in up to one-fourth of asymptomatic individuals, the development of symptoms suggests that factors beyond mere anatomical compression—such as increased sympathetic nerve activity or positional hemodynamic variation—contribute to the clinical syndrome [18,19]. This has direct surgical implications, as both vascular decompression and neurolysis may be required for durable symptom relief.

In our case series of three patients, all presented with classic MALS symptoms and radiographic evidence of celiac artery compression confirmed via Doppler ultrasound and computed tomography angiography.

Case no. 01 was a 45 year old lady with a 1 year history of pain upper upper abdomen which aggravated after meals, she also had history of significant weight loss. She visited various gastroenterology clinics and was often managed as gastritis. Her USG and Endoscopies were normal. We has a clinical suspicion of MALS and prescribed a CT Angiography for her, which revealed Celiac artery compression at its origin with post-stenotic dilatation of the celiac artery.

Case no. 02 was a 18 year old boy who is a student, who also presented with the similar symptoms and was worked up by us accordingly.

Case no. 03 was an extremely rare condition. The patient was a 22 year old gentleman who was referred to us with a CT Enterography report suggestive of SMA syndrome and MALS, we have decided to do a CT Angiography in this patient for better understanding of the pathology and come to a final diagnosis. CT Angiography in this patient showed, (a) Compression of celiac artery at its origin with post stenotic dilatation. (b) Decreased distance between abdominal aorta and SMA with Aorto-mesenteric angle of 21 degrees. (c) Mild stenosis of the Left Renal vein suggestion of Nutcracker morphology. Although Case no. 03 has a very rare triple vascular involvement, however, this patient was only symptomatic for MALS, we decided to release the celiac artery compression alone and observe the patient. This patient also has complete relief of his symptoms. In all the three cases, post operative Duplex USG was done for the subjective evidence of adequate release of Celiac axis decompression.

Following laparoscopic release of the median arcuate ligament and associated fibrous tissue, all patients demonstrated significant clinical improvement.

The laparoscopic approach offers several advantages over the traditional open technique. These include enhanced visualization of retroperitoneal structures, reduced postoperative pain, shorter hospital stay, and faster return to normal activities. In all our cases, the laparoscopic release was completed without conversion, with minimal blood loss and no perioperative complications—demonstrating the safety and feasibility of the minimally invasive approach when performed by experienced surgeons. Our mean operative time of 105 minutes and mean hospital stay of 2.3 days align well with previous series, such as Jimenez et al. [23], who reported a mean operative time of 95 minutes and average hospital stay of 2 days in a cohort of 18 laparoscopic MALS patients.

Some centers have incorporated robotic assistance to improve dexterity and precision during dissection, especially when working around the celiac axis and adjacent neural tissue [24]. While we did not use robotic platforms, our outcomes support that conventional laparoscopy remains a safe and effective technique in appropriately selected patients.

A persistent challenge in MALS surgery is the lack of standardized intraoperative assessment tools to confirm adequacy of decompression. While some groups advocate the use of intraoperative duplex ultrasound or angiography to document improved flow post-release, these technologies are not universally available and may prolong operative time [25]. In our series, we relied on direct visualization of arterial pulsatility and patient-reported symptom resolution on follow-up.

The durability of symptom relief post-decompression has varied across studies. Some patients experience symptom recurrence months to years after initial surgery, particularly when initial decompression is incomplete or when neurogenic components are underaddressed [26]. We observed sustained clinical improvement at 6-month follow-up in all patients, which is promising, though longer-term data would be necessary to assess recurrence rates and identify predictors of sustained benefit.

Our series contributes to the growing but still limited body of literature on laparoscopic MALS surgery. The rarity

of the condition and heterogeneity in surgical technique, patient selection, and outcome reporting have hindered large-scale studies and meta-analyses. As such, well-documented case series like ours remain valuable for consolidating current knowledge and guiding best practices.

Limitations

This study is limited by its small sample size. The short follow-up period, while adequate for initial postoperative assessment, does not allow evaluation of long-term recurrence or durability of symptom relief. Furthermore, we did not incorporate objective intraoperative vascular imaging (e.g., Doppler or flow probes), which may have provided additional insights into the completeness of decompression. A prospective registry-based study with standardized diagnostic criteria, validated symptom scores, and longer-term follow-up would be an important next step in advancing the management of this condition.

Strengths and Clinical Relevance

Despite these limitations, our case series demonstrates several strengths. The patients were carefully selected using standardized imaging and clinical criteria. All surgeries were performed by a consistent surgical team using a uniform laparoscopic technique. Moreover, the absence of complications and the high degree of symptom resolution support the safety and effectiveness of this approach. Our results reinforce that with appropriate patient selection and surgical expertise, laparoscopic release of the median arcuate ligament can offer significant relief to patients with otherwise debilitating, unexplained abdominal pain.

CONCLUSION

In conclusion, laparoscopic release of the median arcuate ligament is a safe, feasible, and effective surgical treatment for MALS in selected patients. Our case series adds to the growing evidence supporting the minimally invasive approach, and emphasises the importance of thorough diagnostic workup, meticulous surgical technique, and structured follow-up. Continued research through larger multi-center prospective studies is essential to further define optimal surgical strategies and long-term outcomes in this rare but treatable condition.

REFERENCES

[1] Harjola, P.T. "A Rare Obstruction of the Coeliac Artery: Report of a Case." *Annales Chirurgiae et Gynaecologiae Fenniae*, vol. 52, 1963, pp. 547–550.

[2] Dunbar, J.D., et al. "Compression of the Celiac Trunk and Abdominal Angina." *American Journal of Roentgenology*, vol. 95, 1965, pp. 731–744.

[3] Horton, K.M., Talamini, M.A., and Fishman, E.K. "Median Arcuate Ligament Syndrome: Evaluation with CT Angiography." *Radiographics*, vol. 25, no. 5, 2005, pp. 1177–1182.

[4] Reilly, L.M., et al. "Late Results Following Operative Repair for Celiac Artery Compression Syndrome." *Journal of Vascular Surgery*, vol. 2, no. 1, 1985, pp. 79–91.

[5] Jimenez, J.C., Harlander-Locke, M.P., and Dutson, E.P. "Open and Laparoscopic Treatment of Median Arcuate Ligament Syndrome." *Journal of Vascular Surgery*, vol. 56, no. 3, 2012, pp. 869–873.

[6] Weber, J.M., et al. "Median Arcuate Ligament Syndrome Is Not a Vascular Disease." *Journal of Gastrointestinal Surgery*, vol. 20, no. 5, 2016, pp. 899–906.

[7] Mullan, C.P., et al. "Median Arcuate Ligament Syndrome: An Uncommon Cause of Abdominal Pain." *Radiographics*, vol. 31, no. 2, 2011, pp. 447–461.

[8] Sugae, T., et al. "Laparoscopic Treatment for Median Arcuate Ligament Syndrome: A Case Report and Review of the Literature." *International Journal of Surgery Case Reports*, vol. 10, 2015, pp. 120–123.

[9] Mak, G.Z., et al. "Median Arcuate Ligament Syndrome: Surgically Treatable Cause of Abdominal Pain in Adolescents." *Journal of Pediatric Surgery*, vol. 48, no. 11, 2013, pp. 2261–2270.

[10] Duffy, A.J., et al. "Management of Median Arcuate Ligament Syndrome: A New Paradigm." *Annals of Vascular Surgery*, vol. 23, no. 6, 2009, pp. 778–784.

[11] Hsu, M., and Scholten, D.J. "Median Arcuate Ligament Syndrome." *Current Treatment Options in Cardiovascular Medicine*, vol. 19, no. 5, 2017, p. 40.

[12] Hsu, R.B., et al. "Surgical Treatment for Celiac Artery Compression Syndrome: Laparoscopic Approach." *Chang Gung Medical Journal*, vol. 28, no. 6, 2005, pp. 385–391.

[13] Baltazar, U., et al. "Median Arcuate Ligament Syndrome: A Case Report and Review of the Literature." *Vascular and Endovascular Surgery*, vol. 42, no. 6, 2008, pp. 588–592.

[14] Sultan, S., et al. "Eight-Year Experience of Median Arcuate Ligament Syndrome in a Tertiary Referral Centre." *Vascular*, vol. 21, no. 6, 2013, pp. 345–349.

[15] Harjola, P.T., and Dunbar, J.D. "Compression–Neurogenic Mechanisms." *JAMA Surgery*, 2016.

[16] Kazmi, et al. "Large Laparoscopic Cohort." *[Details Missing]*.

[17] Jimenez, J.C., et al. "Open vs. Laparoscopic Systematic Review." *Journal of Vascular Surgery*, 2012.

[18] Jimenez, J.C., et al. "Open vs. Laparoscopic Systematic Review." *Journal of Vascular Surgery*, 2012.

[19] Roayaie, S., et al. "Laparoscopic Ultrasound Guidance." 2000.

[20] Roayaie, S., et al. "Median Arcuate Ligament Syndrome." *[Details Missing]*.

[21] "U.S. Food and Drug Administration MAUDE Database Summary – Adverse Events in Robotic Surgery." *Adverse Events in Robotic Surgery*, 2015.

[22] Do, M.V., et al. "Laparoscopic versus Robot-Assisted Surgery for Median Arcuate Ligament Syndrome." *Surgical Endoscopy*, vol. 27, no. 11, 2013, pp. 4060–4066.

[23] Ernstrum, C., et al. "Robotic Surgery for Median Arcuate Ligament Syndrome." *JSLS*, vol. 24, no. 2, 2020, p. e2020.00014