Original Article

SAGE Open Medicine

SAGE Open Medicine
Volume 11: 1–6

DOI: 10.1177/20503121231176636
journals.sagepub.com/home/smo
Sage

Evaluation of a pain management program for patients with median arcuate ligament syndrome

Suzanne J Rose[1], Josette Hartnett[1], Brandon Madris[2] and Richard Hsu[3]

Abstract

Objectives: Median arcuate ligament syndrome is a complex disorder potentially caused by variation in the position of the median arcuate ligament. Symptomology involves chronic abdominal pain, nausea, and malnourishment. Pain management modalities and short-term outcomes for patients undergoing operative surgery for median arcuate ligament syndrome have yet to be fully evaluated. Our hospital implemented a pain management consultation program in 2017 focused on perioperative pain management. The objective of this study is to assess if the introduction of a pain management consultation program concurrent with median arcuate ligament syndrome surgery impacts patient outcomes and post-operative pain management strategies in these patients.

Methods: De-identified data was collected retrospectively from our hospital's electronic medical records system, identifying median arcuate ligament syndrome patients and using International Classification of Diseases (ICD) and Current Procedural Terminology (CPT) codes from September 2017 to August 2021. Patients were grouped into the "consultation" cohort if they had scheduled and attended a pre-operative pain consultation. Pre-operative and discharge medications, pain scores, and demographics were collected to evaluate if the initiative impacted outcomes.

Results: Median arcuate ligament syndrome patients who had a pre-operative pain management consultation had higher rates of pre-operative opioid (35.5%; $p = 0.01$) and non-opioid use (60.7%; $p < 0.001$). Patients without a pre-operative consultation that did not use opioids pre-operatively were more likely to be discharged on one or more opioids. Differences were also found for psychiatric medication at discharge ($p < 0.001$) with patients receiving pain consultation indicating higher percentages of use.

Conclusion: Special consideration on prescribing pain medication should be part of discharge planning for median arcuate ligament syndrome patients. Addition of a pain management consultation can aid in these decisions.

Keywords

Median arcuate ligament syndrome, pain management, psychological comorbidities, chronic abdominal pain, celiac artery compression, opioid analgesics

Date received: 3 January 2023; accepted: 2 May 2023

Introduction

Median arcuate ligament syndrome (MALS) is a rare disorder caused by variation in the anatomic position of the median arcuate ligament.[1–3] The low-lying median arcuate ligament exerts compression on the celiac nervous plexus that surrounds the artery and its branches. This compression and chronic irritation of the nerve plexus may cause significant pain and anorexia. In addition, psychological conditions

[1]Department of Research and Discovery, Stamford Hospital, Stamford, CT, USA
[2]Department of Surgery, Stamford Hospital, Stamford, CT, USA
[3]The Vascular Experts, Darien, CT, USA

Corresponding author:
Suzanne J Rose, Department of Research and Discovery, Stamford Hospital. One Hospital Plaza, PO Box 9317, Stamford, CT 06902, USA.
Email: SRose@stamhealth.org

are present in many patients diagnosed with MALS,[1,4] a common finding among those with chronic abdominal pain.[5,6] For patients with MALS, pre-existing psychiatric diagnoses are associated with poorer clinical outcomes for both adult[4] and pediatric patients.[7]

Our hospital (Stamford Hospital), a 305-bed community teaching hospital, has provided MALS corrective surgery for individuals from around the country. MALS patients often undergo extensive workup ruling out gastrointestinal causes of their symptoms.[8] Initial workup for the diagnosis of MALS begins with a noninvasive mesenteric duplex ultrasound evaluating for elevated velocities in the celiac artery with normalization of the velocities during deep inspiration, suggesting dynamic arterial compression.[2] The MALS anatomy can be demonstrated by magnetic resonance imaging or computed tomography imaging showing the diaphragmatic crus (including the median arcuate ligament) surrounding the main trunk of the celiac artery. This may create the appearance of a "J-hook" of the celiac artery.[3,8,9]

Through rigorous patient selection and refinement of operative techniques to resect the median arcuate ligament and celiac plexus, our hospital has reported positive patient outcomes on postprandial pain, nausea, and vomiting.[10,11] Even with prudent patient selection for the procedure, this surgery is complex and requires aggressive pain management and control.[12] As widely reported, many MALS patients are considered chronic pain patients, and require effective pain management before, during, and after surgery to reduce acute postoperative pain.[13]

A pain management program at our hospital was implemented in 2017 to formulate and execute a plan for perioperative pain management, including education, presentation of options, and discussion of expectations. The post-operative pain control strategy is multi-modal, with initiatives implemented with the goals of decreasing postoperative narcotic use and early return to mobilization and activities of daily living. The purpose of this study is to retrospectively review the medical records of patients who underwent MALS corrective surgery at our hospital to observe if there are differences in patient outcomes before and after the implementation of pain management consultations and changes in pain management practices.

Methods

Ethics and informed consent statement

Prior to study initiation, the protocol was determined as exempt by our Institutional Review Board, Western Copernicus Group (WCG IRB Work Order #1-1440620-1).

This study was a retrospective review, including assessing the implementation of a post-operative pain management consult, among patients with MALS, who underwent corrective surgery at our 305-bed community hospital. Patients were included if they had been diagnosed with MALS and also received corrective surgery at our hospital. They were not eligible if they did not receive corrective surgery at our institution or had prior MALS corrective surgeries. There was no age limit imposed for the study.

Data was collected via electronic medical record extraction using the MALS corrective surgery International Classification of Diseases-10 (ICD-10) procedural codes, including all patients who received MALS surgery at SH from September 2017 to August 2021. De-identified data was collected into a database and analyzed using SPSS version 28.01. After the pre-operative MALS-based pain management program at our hospital was implemented in 2017, patients scheduled for MALS surgery were encouraged to attend a pain consultation visit, though not all patients chose to attend. Patients were grouped into the "consultation" cohort if they had attended a pre-operative pain consultation with a unique visit number and documentation of the visit.

Statistical analysis

Baseline demographics and clinical variables of interest were compared across the cohorts divided by pain consultation (yes/no). Medications prescribed pre-operatively and at discharge were grouped by drug class and categorized by opioids, non-opioid pain relievers, psychiatric medications, and others. For discrete variables, count and percentages are presented for the univariate chi-square tests of association analyses. Fisher's exact tests were used when expected cell frequencies were less than five patients. For continuous variables, group *t*-tests were used to compare differences between those patients who did and did not have a pre-operative pain management consultation. As an exploratory analysis, there were no corrections applied to the data for multiple comparisons and missing value imputation was not used for this research. A *p*-value of 0.05 ($p < 0.05$) defined reaching statistical significance for each analysis.

Results

A total of 340 patients met inclusion criteria and were included in the current analysis (214 = pain consultation group, 126 = non-consultation group). Results were not found to be significantly different between groups for baseline demographics and comorbidities including gender, race, prior surgical history, comorbidities, rectal sheath block use, and mean American Society of Anesthesiology scores which allows clinicians to categorize a patient's physiological status as a prediction of operative risk[14] (Table 1). Furthermore, results for patient age, procedure duration, length of stay (LOS), first and last documented pain scores, and estimated blood loss had non-significant results with *p*-values greater than 0.05 (Table 2).

Table 3 presents the results of patient medication use both prior to their MALS procedure as well as for medications prescribed on discharge between the defined groups. Higher

Table 1. Demographics and descriptive between pain consultation cohorts (chi-square tests of association, unless otherwise noted).

Variable	Category	Did the patient have a pain consultation?				*p*-Value
		No		Yes		
		Count (%)		Count (%)		
Gender	Female	105 (83)		176 (82.2)		0.798
	Male	21 (16.7)		38 (17.8)		
Race	Other	11 (8.7)		27 (12.6)		0.272
	White	115 (91.3)		187 (87.4)		
Prior surgeries	No	124 (98.4)		214 (100.0)		0.137*
	Yes	2 (1.6)		0 (0.0)		
Co-morbid: GI	No	86 (68.3)		128 (59.8)		0.120
	Yes	40 (31.7)		86 (40.2)		
Co-morbid: Nutritional	No	111 (88.1)		194 (90.7)		0.453
	Yes	15 (11.9)		20 (9.3)		
Co-morbid: Other	No	108 (85.7)		187 (87.4)		0.661
	Yes	18 (14.3)		27 (12.6)		
Rectus sheath block	No	8 (6.6)		12 (5.6)		0.723
	Yes	114 (93.4)		202 (94.4)		
ASA score	1	3	2.4	4	1.9	0.755
	2	101	80.2	166	77.6	
	3	22	17.5	44	20.6	

ASA: American Society of Anesthesiology; GI: gastrointestinal; Co-morbid: comorbidity.
*Fisher's exact test.

Table 2. Means-based *t*-test for reported pain scores, age in years, and outcome variables by group.

Variable	No pain consultation $n=126$		Pain consultation $n=214$		*p*-Value
	Mean	SD	Mean	SD	
Age	26.91	14.81	27.92	15.34	0.556
Cut to close*	105.13	24.87	101.19	22.37	0.134
LOS	5.50	1.83	5.58	2.31	0.727
First pain score	5.37	2.44	5.38	2.35	0.970
Last pain score	4.56	1.99	4.43	2.08	0.573
EBL (ml)	76.75	66.21	77.92	132.14	0.933

EBL: estimated blood loss; LOS: length of stay.
*Minutes.

percentage of patients who had a consultation used opioid medications (35.5%, $p=0.016$) and non-opioid pain medications (60.7%, $p<0.001$) pre-operatively, with more non-opioid pain relievers documented. No significant differences were found for pre-operative use of psychiatric medications or other medications between cohorts.

Despite the higher percentage of patients utilizing prescription opioids pre-surgery, opioid use on discharge was found to be significantly lower among patients with a pain consultation (64.5%) compared to 81.7% of patients discharged with a prescription for opioids without a pain consultation ($p<0.001$). Significant differences were also seen for discharge psychiatric medicine ($p<0.001$), and other medications on discharge ($p=0.006$), with pain consultation patients showing a higher percentage of medication use in both cases. No significant differences were found regarding non-opioid medication use on discharge (Table 3).

Lastly, the results of the $2\times2\times2$ chi-square analysis (Supplemental Table 1) were highly significant. Patients without a pain consultation that did not take opioid medication pre-operatively were more likely to be discharged on one or more opioid medications ($p<0.01$). Similarly, patients without pre-operative opioid medication use who had a consultation were more likely (51.91%) to be prescribed one or more opioid at discharge. On the contrary, patients with a pain consultation that were pre-operatively using one or more opioid medications were less likely to be prescribed one or more opioids at discharge (15.24%).

Table 3. Chi-square analysis on home medications and discharge medications by consultation cohort.

Variable	Category	Did the patient have a pain consult?		*p*-Value
		No	Yes	
		Count (%)	Count (%)	
Home meds: Opioids	None	97 (77.0)	138 (64.5)	0.016
	1 or more	29 (23.0)	76 (35.5)	
Home meds: Non-opioid pain relievers	None	72 (57.1)	84 (39.3)	0.001
	1 or more	54 (42.9)	130 (60.7)	
Home meds: Psych	None	45 (35.7)	62 (29.0)	0.196
	1 or more	81 (64.3)	152 (71.0)	
Home meds: Other	None	15 (11.9)	13 (6.1)	0.059
	1 or more	111 (88.1)	201 (93.9)	
Discharge meds: Opioid	None	23 (18.3)	76 (35.5)	<0.001
	1 or more	103 (81.7)	138 (64.5)	
Discharge meds: Non-opioid pain relievers	None	43 (34.1)	78 (36.4)	0.666
	1 or more	83 (65.9)	136 (63.6)	
Discharge meds: Psych	None	34 (27.0)	119 (55.6)	<0.001
	1 or more	92 (73.0)	95 (44.4)	
Discharge meds: Other	None	28 (22.2)	78 (36.4)	0.006
	1 or more	98 (77.8)	136 (63.6)	

Meds: medications; Consult: consultation; Psych: psychiatric.

Discussion

In this study, we retrospectively reviewed available medical records of patients who underwent MALS corrective surgery at our hospital to observe if there were differences in patient outcomes before and after the implementation of pain management consultations in addition to changes in pain management practices. To the best of our knowledge, this is the first reported observation of this interaction in the literature. Due to the rarity and complexity of this disease, previous research has relied on small sample sizes, and loss to follow-up is common.[8] There is also limited research on long-term outcomes after corrective surgery, and pain management among this population is under-studied.[15,16] Our findings suggest that patients who were already prescribed opioids prior to surgery were more likely to receive a pain consultation. In addition, opioid prescribing on discharge was found to be lower among patients with a pain consultation. Of potentially greater importance is the finding that patients without a pain consultation who did not take opioid medication pre-operatively were more likely to be discharged on one or more opioid medications but patients with a pain consultation who were already prescribed one or more home opioid medication were less likely to be prescribed opioids at discharge.

Inadequately managed chronic pain may lead to adverse physical and psychological outcomes for both patients and their families. As the diagnosis of MALS is already complicated by a high incidence of psychopathology,[1,4] choosing an effective pain management strategy is essential for improving recovery after surgery. The use of analgesics, particularly opioids, is the foundation of treatment for most types of pain following surgery.[17] However, recent research suggests an association between the risk of adverse health care events with higher opioid doses and longer duration of utilization.[18]

In addition, an increased LOS in patients with preoperative opioid use has been noted previously in the literature following elective abdominal surgery,[19] which is of particular concern for our study population already receiving opioids prior to surgery. However, it is encouraging that even in our higher risk MALS population, patients were more likely to be discharged without opioid medications if they receive a pain management consultation in the perioperative period. LOS was not significantly different between the groups.

For patients with existing preoperative psychological conditions, such as the MALS population described here, prior research suggests increased risk for chronic opioid use after surgery for opioid-naïve patients.[20] This is highly relevant to our findings as higher percentages of our patients who were opioid-naïve were prescribed opioids upon discharge when a pain consultation was not obtained. Studies have shown adverse health outcomes in patients receiving long term opioid treatment for pain after surgery.[17,21] Therefore, the decreased narcotic requirement in our patients receiving perioperative pain management consultations may decrease risk of adverse health events.

Limitations

The retrospective observational study design of this report limits the applicability of results, such as potential confounders not controlled for as well as differing documentation practices

among providers, possibly resulting in misclassification bias. In addition, this was a single hospital report using a smaller sample size, although all surgeries included were conducted by a single operator to maintain institutional operating consistency. In addition, as this was a retrospective analysis, there was no predetermined sample size estimation for a formal power calculation to determine the number of subjects required for statistical significance in each group. Also, we acknowledge that causality cannot be established due to the retrospective nature of the study design without patient follow-up after discharge. While our results are promising, they may not be generalizable to other programs at smaller community hospitals or larger, non-teaching medical centers.

Conclusion

Patients with a MALS diagnosis are considered chronic pain patients, and require effective pain management modalities before, during, and immediately after surgery to reduce acute postoperative pain. Healthcare providers therefore need to improve pain management strategies for patients who are transitioning from chronic preoperative pain to acute postoperative pain to limit opioid utilization and duration. As many patients' first opioid exposure follows a hospitalization, the prescribing practices on discharge can have implications in future opioid consumption. This study highlights a vulnerable surgical MALS population already experiencing chronic pain, and perioperative pain management may decrease the opioid prescribing and requirements at postoperative discharge. Future research should be directed at assessing pain control, opioid usage, long-term postoperative symptom improvement, and evaluation of symptom recurrence in this patient population.

Acknowledgements

The authors would like to acknowledge Shweta Karki for her statistical expertise, as well as Charlotte Fager and Kaly Houston for assisting with data collection.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethics and informed consent statement

Prior to study initiation, the study protocol was determined as exempt by Stamford Health's Institutional Review Board (IRB), Western Copernicus Group (WCG IRB Work Order #1-1440620-1). Data was collected in a de-identified manner via electronic medical record extraction. Informed consent was waived due to the retrospective study design and proper HIPAA compliant confidentiality protocols in place.

Data availability statement

Due to confidentiality agreements, supporting data can only be made available to researchers subject to a non-disclosure agreement. Details of the data and how to request access can be requested from the corresponding author.

Supplemental material

Supplemental material for this article is available online.

ORCID iDs

Suzanne J Rose https://orcid.org/0000-0001-5770-826X
Josette Hartnett https://orcid.org/0000-0002-7475-4265

References

1. Stiles-Shields C, Skelly CL, Mak GZ, et al. Psychological factors and outcomes in the surgical treatment of pediatric patients with median arcuate ligament syndrome. *J Pediatr Gastroenterol Nutr* 2018; 66(6): 866–871.
2. Reuter SR and Bernstein EF. The anatomic basis for respiratory variation in median arcuate ligament compression of the celiac artery. *Surgery* 1973; 73(3): 381–385.
3. Duffy AJ, Panait L, Eisenberg D, et al. Management of median arcuate ligament syndrome: a new paradigm. *Ann Vasc Surg* 2009; 23(6): 778–784.
4. Skelly CL, Stiles-Shields C, Mak GZ, et al. The impact of psychiatric comorbidities on patient-reported surgical outcomes in adults treated for the median arcuate ligament syndrome. *J Vasc Surg* 2018; 68(5): 1414–1421.
5. Shelby GD, Shirkey KC, Sherman AL, et al. Functional abdominal pain in childhood and long-term vulnerability to anxiety disorders. *Pediatrics* 2013; 132(3): 475–482.
6. King S, Chambers CT, Huguet A, et al. The epidemiology of chronic pain in children and adolescents revisited: a systematic review. *PAIN* 2011; 152(12): 2729–2738.
7. Stiles-Shields C, Osos S, Heilbrun A, et al. Targeting coping to improve surgical outcomes in pediatric patients with median arcuate ligament syndrome: feasibility study. *Front Psychol* 2021; 12: 695435–695435.
8. Rodriguez JH. Median arcuate ligament syndrome: a clinical dilemma. *Cleve Clin J Med* 2021; 88(3): 143–144.
9. Columbo JA, Trus T, Nolan B, et al. Contemporary management of median arcuate ligament syndrome provides early symptom improvement. *J Vasc Surg* 2015; 62(1): 151–156.
10. Barbon DA, Hsu R, Noga J, et al. Clinical response to celiac plexus block confirms the neurogenic etiology of median arcuate ligament syndrome. *J Vasc Interv Radiol JVIR* 2021; 32(7): 1081–1087.
11. Barbon D, Hsu R, Noga J, et al. Abstract No. 219 Rethinking median arcuate ligament syndrome: the role of celiac plexus block for diagnosis. *J Vasc Interv Radiol* 2021; 32(5, Supplement): S96.
12. Romero-Velez G, Barajas-Gamboa JS, Pantoja JP, et al. A nationwide analysis of median arcuate ligament release between 2010 and 2020: a NSQIP Study. *Surg Endosc* 2023; 37(1): 140–147.
13. Kazmi SSH, Safi N, Berge ST, et al. Laparoscopic surgery for median arcuate ligament syndrome (MALS): a prospective cohort of 52 patients. *Vasc Health Risk Manag* 2022; 18: 139–151.

14. Doyle DJ, Hendrix JM and Garmon EH. American Society of Anesthesiologists Classification. In: *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK441940/ (2022, accessed 20 March 2023).
15. Oderich G. A Study of long-term symptom improvement and recurrence after operative management of median arcuate ligament syndrome, https://www.mayo.edu/research/clinical-trials/cls-20456518 (2019, accessed 28 July 2022).
16. Zierler RE, Jordan WD, Lal BK, et al. The Society for Vascular Surgery practice guidelines on follow-up after vascular surgery arterial procedures. *J Vasc Surg* 2018; 68(1): 256–284.
17. Hah JM, Bateman BT, Ratliff J, et al. Chronic opioid use after surgery: implications for perioperative management in the face of the opioid epidemic. *Anesth Analg* 2017; 125(5): 1733–1740.
18. Kurteva S, Abrahamowicz M, Gomes T, et al. Association of opioid consumption profiles after hospitalization with risk of adverse health care events. *JAMA Netw Open* 2021; 4(5): e218782–e218782.
19. Waljee JF, Cron DC, Steiger RM, et al. Effect of preoperative opioid exposure on healthcare utilization and expenditures following elective abdominal surgery. *Ann Surg* 2017; 265(4): 715–721.
20. Sun EC, Darnall BD, Baker LC, et al. Incidence of and risk factors for chronic opioid use among opioid-naive patients in the postoperative period. *JAMA Intern Med* 2016; 176(9): 1286–1293.
21. Lawal OD, Gold J, Murthy A, et al. Rate and risk factors associated with prolonged opioid use after surgery: a systematic review and meta-analysis. *JAMA Netw Open* 2020; 3(6): e207367.