Median Arcuate Ligament Syndrome with Orthostatic Intolerance: Intermediate-Term Outcomes following Surgical Intervention

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Objectives To report the intermediate-term outcome following surgical intervention for median arcuate ligament syndrome (MALS) in adolescents and young adults with orthostatic intolerance (OI) to assess clinical improvement in the gastrointestinal and 5 other functional domains and if relief of arterial obstruction is associated with resolution of clinical symptoms.

Study design Thirty-one patients were given 2 dysautonomia-designed questionnaires to assess changes in symptoms following operative intervention in 6 functional domains and underwent postoperative repeat abdominal ultrasound examinations.

Results Average follow-up after surgery was 22.4 ± 14.8 months. Self-assessed quality of health on a Likert scale (1-10 with 10 being normal) improved from 4.5 ± 2.1 preoperatively to 5.3 ± 2.4 postoperatively (*P* = not significant). Gastrointestinal symptoms of abdominal pain, nausea, and vomiting improved in 63% (*P* = .007), 53% (*P* = .040), and 62% (*P* = .014) of patients, respectively. Cardiovascular symptoms of dizziness, syncope, chest pain, and palpitations improved in 45% (*P* = not significant), 50% (*P* = not significant), 54% (*P* = .043), and 54% (*P* = .037) of patients, respectively. Transabdominal ultrasound peak supine expiratory velocity decreased from 348 ± 105 cm/s preoperatively to 251 ± 109 cm/s at 6 months or more after a ligament release procedure. Decrease of the postoperative celiac artery Doppler velocity was not associated with an improvement in gastrointestinal symptoms (*P* = .075).

Conclusions Adolescent and young adult patients with median arcuate ligament syndrome and OI have a good response to surgical intervention. About two-thirds of patients report significant improvement in symptoms of abdominal pain, nausea, and vomiting. Despite these encouraging data, many patients with MALS and OI continue to have an impaired quality of health. *(J Pediatr 2021;231:141-7)*.

Children, adolescents, and young adults presenting with orthostatic intolerance (OI) and postural orthostatic tachycardia syndrome (POTS) often have symptoms attributable to the cardiovascular, gastrointestinal, and central nervous systems. Although the symptoms could be limited in some, often they are complex with a wide distribution throughout multiple body regions.[1]

Median arcuate ligament syndrome (MALS) has been thought to be a rare disorder that results in compression of the celiac artery by a fibrous attachment to the diaphragmatic crura. A celiac ganglion neuropathy is frequently associated with the intermittent arterial compression (worse on expiration). Most reports describe MALS as occurring as an isolated clinical entity. Surgical intervention seems to result in significant symptomatic improvement in about two-thirds of the patients.[2-8]

MALS may not be uncommon and can be detected in 2%-5% of the population with POTS (Bandakar A, Cielma T, Moak JP, personal communication, 2020). Limited data suggesting a potential short-term benefit after surgical intervention for MALS in patients with POTS has been reported previously.[9,10] We reviewed the intermediate outcome of patients with OI/POTS with MALS to evaluate whether MALS surgery resulted in clinical improvement only in gastrointestinal symptoms or whether improvement was noted in symptoms from other organ domains, and if relief of the arterial obstruction is associated with the resolution of clinical symptoms.

Methods

The Children's National Institutional Review Board approved this prospective research study. The research population consisted of adolescents and young adults (13-22 years of age) with OI/POTS and MALS. The diagnosis of OI/POTS was confirmed by correlating hemodynamic changes during bedside orthostatic (standing) or tilt table testing and changes in patient symptoms. Only patients with a positive orthostatic challenge test and abnormal imaging studies revealing MALS were eligible for

ADM	Antroduodenal manometry
hEDS	Hypermobile Ehlers-Danlos syndrome
MALS	Median arcuate ligament syndrome
OI	Orthostatic intolerance
POTS	Postural orthostatic tachycardia syndrome

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inclusion in this study. Patients were recruited for this study between October 2014 and September 2019.

The initial patient evaluation consisted of a detailed clinical and family history supplemented by the patient completing the Children's National POTS Questionnaire. A physical examination was performed with a special focus on evidence for an abdominal bruit during held expiration, and skin and joint examination assessing for the presence of joint hypermobility (Beighton score) and skin elasticity.[11-13] Three major criteria were assessed to make a presumptive diagnosis of hypermobile Ehlers-Danlos syndrome (hEDS, subtype 5): a Beighton score of 5 or greater (criterion 1); the presence of excessive skin laxity, stria, family history of joint hypermobility, musculoskeletal pain, or recurrent joint dislocations (criterion 2) and exclusion of other connective tissue disorders (criterion 3).[14] All patients with hEDS underwent a 2-dimensional echocardiogram to assess for the cardiovascular manifestations associated with the cardiac-valvular subtype (type 3) of Ehlers-Danlos syndrome, and were referred to the genetics clinic for confirmation. A pediatric 15-lead electrogram was performed on all the patients assessing the QT interval using Bazett formula. A QTc of greater than 0.44 was considered above the upper limit of normal.[15] A prolonged QTc interval may reflect an autonomic imbalance, predisposing to symptoms associated with POTS.

As we have described previously, the following clinical criteria were used for OI: (1) a 30 bpm or more increase in the heart rate within 10 minutes of assuming the upright position, (2) the development of cardiovascular, neurologic, and gastrointestinal symptoms consistent with OI, (3) the symptoms that occurred when upright were reproduced the patient's clinical indication for study, and (4) the symptoms resolved or improved markedly when placed supine at the end of the testing. POTS was defined using the same criteria as used for OI, except the heart rate increase of 40 bpm or more within 10 minutes of assuming the upright position in patients under 18 years of age.[16,17] Orthostatic testing consisted of an initial orthostatic standing test and a subsequent tilt table test in patients in whom the diagnosis of OI/POTS was unclear from the results of the orthostatic standing test. When orthostatic testing was performed in the upright standing position, the patients were asked to move from a supine position to standing upright without any physical support and with as little lower extremity movement as tolerated.

When suspected from either the patient's clinical history of gastrointestinal symptoms or the presence of an abdominal bruit augmented in intensity on expiration, an abdominal ultrasound examination with celiac artery imaging and Doppler assessment of flow dynamics was performed. Celiac artery imaging was performed supine and upright during held inspiration and expiration. Given the lack of a uniform consensus in the literature, the ultrasound criteria used to diagnosis MALS at our institution were the following: (1) supine celiac artery peak systolic expiratory velocity of more than 300 cm/s, (2) celiac artery/aortic peak systolic ratio of more than 3:1, (3) celiac artery peak systolic velocity of more than 200 cm/s in the neutral position, and (4) a change in the celiac artery deflection angle of more than 50° between inspiration and expiration.[18,19] If abnormal, a contrast-enhanced computed tomography scan was performed to image inspiratory and expiratory changes in the celiac artery deflection angle, the area of stenosis, poststenotic dilation, and the collateral blood vessels. If either the results of the abdominal ultrasound examination or computed tomography scan were discrepant or unclear, a celiac arterial angiogram was performed for definitive confirmation. Once confirmed with 2 positive imaging studies, the patient was referred for surgical intervention.

Thirty-one median arcuate ligament release operations were performed for MALS (30 laparoscopic and 1 open approach). The general outline of the laparoscopic approach was the following. A 5-mm trocar technique was used with the umbilical trocar being placed by cut down and open technique. The insufflation pressure was 15 mm Hg of CO_2. Next, 4 additional trocars were placed in the left and right upper quadrant under direct vision after infiltration of 0.25% bupivacaine. The umbilical trocar was exchanged for a 10-mm port. A liver retractor was used to elevate the left lobe of the liver up from the gastrohepatic ligament. The gastrohepatic ligament was divided all the way up to the right diaphragmatic crus using hook electrocautery. Subsequently, the left gastric artery and vein were freed from peritoneal attachments toward the retroperitoneum. Laparoscopic ultrasound imaging was used to confirm that the origin of the celiac artery was narrowed. The median arcuate ligament was divided from its attachment to the celiac artery and the celiac ganglion with electrocautery, past the origin of the celiac artery. Repeat ultrasound interrogation of the celiac artery velocity was performed to assess if a significant decrease in or disappearance of the gradient was achieved by the operative intervention. Once ultrasound imaging confirmed that the celiac artery flow velocity had normalized, the surgical intervention was completed.

Patients were requested to fill out 2 Children's National Dysautonomia Patient Questionnaires for the measurement of quality of health, presenting symptoms, symptom severity in multiple organ systems, and change in symptoms after MALS surgery. Questionnaire 1 was administered at the time of initial patient evaluation, and questionnaire 2 assessed changes in POTS symptoms since MALS surgery (**Appendix 1** and **Appendix 2**, respectively; available at www.jpeds.com). The second questionnaire assessed changes in the patient's quality of health, symptoms, and changes in symptoms since surgery in each of the following domains: neurologic, psychological, sleep function, cardiovascular, gastrointestinal, musculoskeletal, and educational. Quality of health was rated on a scale of 1-10 (1 = poor to 10 = normal).

An assessment of the number and type of medications used (preoperatively and postoperatively) for the management of cardiovascular, gastrointestinal, and psychological symptoms were detailed. A decrease in the postoperative use of medications in certain physiologic categories could reflect functional improvements in these domains that might not be reflected by the patient responses as to whether they felt improved.

A follow-up postoperative abdominal ultrasound examination reassessing the celiac artery flow velocities and anatomy was recommended for all patients.

The absolute changes in the patient's quality of life and symptoms in each of the 7 domains described elsewhere in this article were assessed. To normalize the changes in symptoms, either secondary to spontaneous improvement or the placebo effect, the changes in symptoms were compared with changes in musculoskeletal symptoms, because it was thought these changes were the least to be affected by MALS surgery.

Descriptive summary statistics were applied to describe the overall study population. A Kolmogorov-Smirnov test of normality was initially performed revealing our data to be normally distributed. Data were reported as mean ± SD. When comparing changes in symptom variables within the same subjects, paired *t* testing was used. To compare changes in the different symptom domains with changes in musculoskeletal symptoms, 2 categorical population proportional testing was performed. All proportional testing was referenced to the improvement observed in combined symptoms of muscle and joint pain. To compare changes in postoperative ultrasound Doppler velocity with changes in gastrointestinal symptoms, χ^2 testing was used. The change in the postoperative Doppler velocity was dichotomized into 2 groups, a decrease in postoperative systolic Doppler velocity in the supine expiratory position of 100 cm/s or more or less than 100 cm/s. The χ^2 testing was performed by comparing the decrease in postoperative systolic Doppler velocity in the supine expiratory position of 100 cm/s or more or less than 100 cm/s against clinical or lack of improvement in gastrointestinal symptoms. A 2-tailed *P* value of less than .05 was considered statistically significant. Statistical testing was performed using 2 software packages, namely, the Social Science Statistics (www.socscistatistics.com) and MedCalC (www.medcalc.org).

Results

Thirty-one patients ranging in age at the time of surgery from 13.1 to 21.5 years (mean, 16.6 ± 2.1 years) were included in this study; 28 were female. The racial composition consisted of Caucasian (n = 27), African American (n = 3), Asian (n = 1), and Hispanic (n = 1). The mean body mass index was 21.6 ± 4.5 and 7 patients had a body mass index of less than 18.5. Twenty-three patients had seen either a gastroenterologist (n = 19) or mental health provider (n = 15) before surgery, including 6 of the 7 patients with a low body mass index. A feeding disorder was not raised by either specialty in this subset of patients.

Orthostatic testing was performed either using an in-clinic standing test (18 patients) or an independent tilt table test (13 patients). Testing revealed the heart rate to increase on average by 47 ± 16 bpm with symptomatic responses on standing from the supine position. The heart rate increased between 30 and 40 bpm in 15 and by 40 bpm or more in 16 patients. The QTc was greater than 0.44 in 10 of 28 patients (reflecting cardiovascular dysautonomia; upper normal QTc 0.44).[15] The mean QTc was 0.43 ± 14.00 seconds. An abdominal bruit that worsened in expiratory in the supine position was heard in 12 patients. Thirteen patients had clinical findings of hEDS. Symptom occurrence and distribution preoperatively are displayed in the **Figure**.

The length of hospital stay was 1.5 ± 0.5 days. No early postoperative complications were reported in 24 patients. Data were missing for 7 patients.

The preoperative transabdominal ultrasound peak supine expiratory velocity decreased from 348 ± 105 cm/s to 251 ± 109 cm/s, 6 months or more after the laparoscopic ligament release procedure. The average decrease in velocity was −126 ± 83 cm/s (n = 20 patients who had both preoperative and postoperative paired ultrasound studies). The peak supine expiratory velocity in the celiac artery decreased in 16 patients, increased in 1 patient, and did not change in 3 patients. Data were not available for 11 patients.

The average interval of follow-up after surgery to completion of the questionnaire was 22.4 ± 14.8 months. Self-assessed quality of life on a Likert scale of 1-10, with 10 being normal, improved from 4.5 ± 2.1 preoperatively to 5.3 ± 2.4 postoperatively (*P* = not significant). The total number of responses was 30; 1 patient did not provide a response. We assessed changes in medication use postoperatively for symptoms in the cardiovascular, gastrointestinal, and psychological domains. There was not a noteworthy decrease in medication burden after surgery.

The 6 symptom domains include gastrointestinal symptoms (**Table I**), cardiovascular symptoms (**Table I**), neurologic symptoms (**Table I**), psychological symptoms (**Table II**), changes in musculoskeletal symptoms (**Table II**), and changes in school or work attendance (**Table III**). Abdominal pain, nausea, and vomiting, which are the more classic symptoms associated with MALS, were improved in 63%, 53%, and 62% of patients, respectively. Eight patients gained significant weight postoperatively. Dizziness, syncope, chest, pain and palpitations, which are more classic POTS symptoms, were improved in 45%, 50%, 54%, and 54% of patients, respectively.

Because we anticipated little change in joint or muscular pain after MALS surgery, we compared postoperative changes in symptoms from the other 5 domains with changes in joint pain or muscular pain. Postoperative improvements in abdominal pain (*P* = .007), nausea (*P* = .040), vomiting (*P* = .014), and constipation (*P* = .040) were statistically significant when compared with the musculoskeletal pain. Changes in diarrhea were not statistically significant (*P* = .192). Postoperative improvements in chest pain (*P* = .043), palpitations (*P* = .037), and exercise tolerance (*P* = .022) were statistically significant. Changes in dizziness (*P* = .131), syncope (*P* = .106), and dyspnea (0.333) were not statistically significant. No statistical differences were noted in neurologic symptoms.

Our data revealed that 26 of 31 patients (84%) reported either a positive response to surgery and would recommend surgical intervention to other patients with OI/POTS with MALS or had clinical improvement in gastrointestinal symptoms.

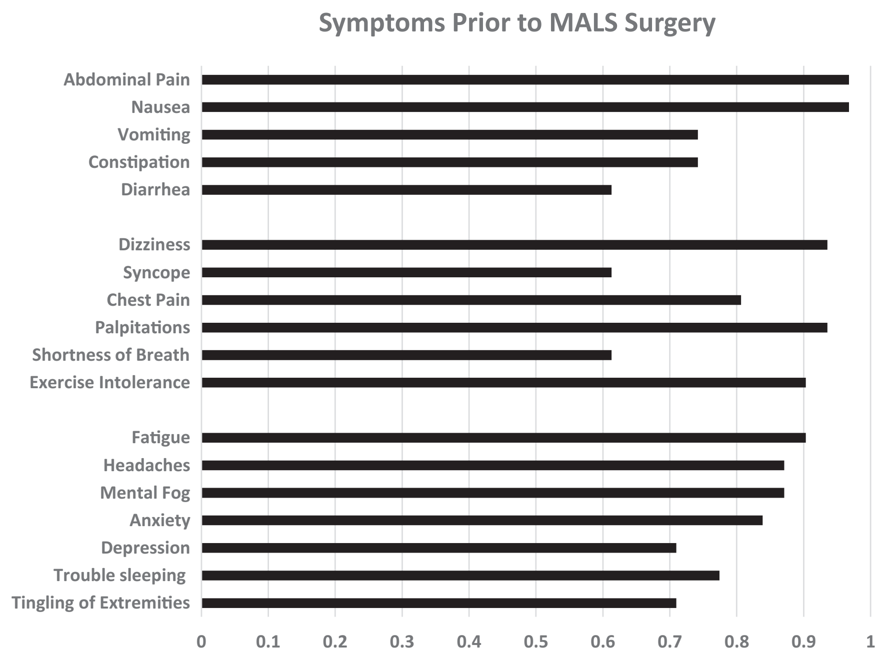

Figure. Prevalence of clinical symptoms from 3 domains (gastrointestinal, cardiac, and neurologic) before MALS surgical intervention. Clinical symptoms are listed on the ordinate, and percent of reported occurrence of each symptom is listed on the abscissa. The prevalence of occurrence is presented as percent. As is evident from the bar graph, the patients exhibited multiple symptoms in multiple functional domains.

We assessed whether the direction of change in the postoperative celiac artery Doppler velocity correlated with changes in gastrointestinal symptoms. Twenty patients had matched preoperative and postoperative celiac artery ultrasound Doppler studies. A decrease in 1 or more of the 3 dominant gastrointestinal symptoms (abdominal pain, nausea, and vomiting) was considered an improved symptom complex. Postoperative celiac artery Doppler velocity decreased in 16 patients; gastrointestinal symptom improvement was noted in 12, and did not change in 4 subjects. In the group of patients that experienced no change in postoperative celiac artery Doppler velocity, 1 patient improved and 1 exhibited no change in symptoms. Two patients were found to have an increase in the postoperative celiac artery Doppler velocity, with no gastrointestinal symptom improvement in either. Our data did not reveal a statistically significant relationship between a decrease in the postoperative celiac artery velocity and improvement in gastrointestinal symptoms; see Limitations.

Table I. Changes in gastrointestinal, cardiovascular, and neurologic symptoms postoperative MALS intervention

Symptoms	No. with symptom preoperatively	No. Improved postoperatively (%)	No. with no change postoperatively (%)	No. worsened postoperatively (%)	*P* value
Gastrointestinal symptoms					
Abdominal pain	30	19 (63)	5 (17)	6 (20)	.007
Nausea	30	16 (53)	8 (27)	6 (20)	.040
Vomiting	21	13 (62)	8 (38)	0 (0)	.014
Constipation	22	12 (55)	7 (33)	3 (14)	.040
Diarrhea	18	8 (44)	5 (28)	5 (28)	.192
Cardiovascular symptoms					
Dizziness	29	13 (45)	13 (45)	3 (10)	.131
Presyncope/syncope	16	8 (50)	6 (38)	2 (13)	.106
Chest pain	24	13 (54)	9 (38)	2 (8)	.043
Shortness of breath	21	8 (38)	8 (38)	5 (24)	.333
Palpitations	28	15 (54)	9 (32)	4 (14)	.037
Exercise intolerance	28	16 (57)	9 (32)	3 (11)	.022
Neurologic symptoms					
Headache	27	11 (41)	12 (44)	4 (15)	.221
Mental fog	25	10 (40)	12 (48)	3 (12)	.254
Fatigue	25	10 (40)	13 (52)	2 (8)	.311
Trouble sleeping	22	11 (50)	8 (36)	3 (14)	.082
Paresthesia	20	9 (45)	8 (40)	3 (15)	.162

For *P* value testing, a comparison was made with the average improvement observed in musculoskeletal symptoms.

Table II. Changes in psychological and musculoskeletal symptoms postoperative MALS intervention

Symptoms	No. with symptom preoperatively	No. improved postoperatively (%)	No. with no change postoperatively (%)	No. worsened postoperatively (%)	*P* value
Psychological					
Anxiety	25	7 (28)	12 (48)	6 (24)	.761
Depression	20	9 (45)	7 (35)	4 (20)	.162
Musculoskeletal					
Muscle pain	19	5 (26)	9 (47)	5 (26)	NA
Joint pain	22	5 (23)	13 (59)	4 (18)	NA

NA, not applicable.
For *P* value testing, a comparison was made with the average improvement observed in musculoskeletal symptoms.

Discussion

There were minimal improvements in neurologic or psychological symptoms after MALS surgery, despite their common occurrence among patients with POTS.[1] Psychiatric diagnoses were found to be common (28%) among adults undergoing MALS surgery and a psychiatric diagnosis predicted a significantly lower postsurgical quality of health, implying that the degree of improvement noted after MALS surgery may be limited by associated comorbidities.[20]

Previous reports in children undergoing surgical intervention for MALS (without associated POTS) have described a comparable degree of symptomatic improvement rate of 50%-67%, as we found in this study.[2-8] In these studies, most patients enjoyed a normal quality of life after MALS surgery, as opposed to what we observed in our study population.

One common association of OI/POTS is with joint hypermobility syndromes, such as hEDS. POTS has been estimated to occur in 15%-41% of patients with hEDS.[12] Previous reports suggest that hypermobile patients demonstrate greater heart rate increases in response to orthostatic challenge, take more medications, and have more chronic pain symptoms, compared with those who have POTS without hEDS. The postoperative outcome in our study population was complicated by the continued presence of POTS and joint hypermobility symptoms. The dysautonomia that accompanies hEDS may persist despite any improvements in autonomic and gastrointestinal function that may follow celiac ganglion resection.

Quality of Health on a 10-point scale improved 15%, but most patients continued to have mild to moderate disability with a significant presence of comorbid symptoms. Continued symptomatic status was reflected in the high prevalence of continued medication use, with little decrease in medication administration in the intermediate-term postoperative period. The persistent residual disability noted in our report of patients with OI/POTS with MALS contrasts with reported improvement of physical functioning, mental health, and self-esteem categories after laparoscopic median arcuate ligament release in the isolated population with MALS.[4] The average decrease in preoperative celiac artery peak velocities in that study was very similar to our observations; therefore, the comparatively blunted clinical response in our patients with OI/POTS seems to be related to secondary factors and not to inadequate relief of celiac artery obstruction or celiac ganglion denervation. Our results highlight the overlap in both spectrum and presentation of gastrointestinal symptoms in the OI/POTS and MALS population making it difficult to determine the primary cause of these symptoms. If secondary to coexisting MALS, as our data show, gastrointestinal symptoms may improve postoperatively.

Notwithstanding a good technical outcome from surgery and improvement in abdominal pain and nausea, many of the patients with POTS still have ongoing OI and other gastrointestinal symptoms. Postoperative abdominal ultrasound scans revealed a decrease in celiac artery Doppler velocity in 84% of those undergoing a repeat postoperative study. Celiac artery velocity either did not change or increased in 11% and 5% of patients, respectively. In this report, 16% of patients continued to demonstrate impaired celiac arterial flow in the postoperative period, secondary to either fibrous regrowth of the disrupted median arcuate ligament or a reactive endothelial dysplasia resulting from the surgical intervention. Patel et al reported a favorable clinical response to MALS release surgery in two-thirds of their patients (study population = 19 patients, none with POTS).[21] These authors were unable to define preoperative ultrasound findings or changes in postoperative celiac artery velocity as predictive of the clinical outcome. Our data did not reveal a statistically significant relationship between a decrease in the postoperative celiac artery velocity and improvement in gastrointestinal symptoms.

Table III. Changes in school or work attendance postoperative MALS intervention

Symptoms	No. with symptom preoperatively	No. improved postoperatively (%)	No. with no change postoperatively (%)	No. worsened postoperatively (%)	*P* value
Limited school attendance	9	6 (67)	3 (33)	0 (0)	.028
Limited work attendance	11	11 (100)	0 (0)	0 (0)	.000

For *P* value testing, a comparison was made with the average improvement observed in musculoskeletal symptoms.

In a vulnerable patient population, surgical interventions can have a placebo effect. In a meta-analysis of 47 trials (involving 1744 participants) eligible for inclusion, Wartolowska et al showed that the pooled effect in the placebo arm of studies measuring subjective outcomes was large (hazard ratio, 0.64; 95% CI, 0.5-0.8), whereas for objective outcomes, the effect was small (hazard ratio, 0.11; 95% CI, 0.04-0.26).[22] Wartolowska et al did not find a temporal change in the placebo response, that is, an increasing effect over time. The magnitude of changes we observed in gastrointestinal responses (abdominal pain, nausea, and vomiting) were greater than would be anticipated if due only to the placebo effect. In our study, we incorporated a control element that would not be anticipated to change with surgery, and could measure the placebo effect in this population, namely, changes in musculoskeletal symptoms. Improvement in musculoskeletal symptoms occurred in 24% of the intervention patients, again revealing a significant effect of the surgical intervention over and above the placebo effect on gastrointestinal symptoms (abdominal pain, nausea, and vomiting).

Our study was limited by the relatively small study population (31 patients). Although we had a high response for patient enrollment in the study, some patients did not completely fill out all parts of the study questions. We analyzed the data using the number of responses recorded rather than the total number of total patients enrolled in the study. Four variables—age, year of surgery, postoperative quality of life score, and whether there was clinical improvement in gastrointestinal symptoms—were used to assess for differences between patients who completed the questionnaire vs provided incomplete responses. For all 4 measures, no differences were detected between the 2 groups.

The study questionnaires have not been validated externally. An inability to demonstrate a statistical relationship between a postoperative decrease in celiac artery Doppler velocity and improvement in clinical symptoms may have been secondary to the small number of patients who had follow-up ultrasound data. A control group of patients with OI and MALS who did undergo surgery would have provided a better assessment of the effect magnitude of surgical intervention on patient symptoms. We had 3 patients who did not elect MALS surgery and continued on medical therapy alone. All 3 patients continued with gastrointestinal symptoms without spontaneous resolution. A decrease in medication use postoperatively as a surrogate of clinical improvement can be difficult to interpret. Immediately after the surgery, most patients were discharged on minimal medications, and then only restarted back on medications as required, based on cardiovascular and gastrointestinal symptoms. The administration of psychotropic medications were controlled by outside physicians.

Adolescent and young adult patients with OI/POTS and MALS have a good response to surgical intervention, with roughly two-thirds of patients reporting a moderate improvement in abdominal pain, nausea, and vomiting. Many patients with decreased gastrointestinal symptoms demonstrated weight gain in the postoperative period, and a decrease in their cardiovascular symptoms of OI/POTS. Despite these encouraging data, many patients with OI/POTS with MALS continue to have impaired quality of health. ■

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Data Statement

Data sharing statement available at www.jpeds.com.

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50 Years Ago in *The Journal of Pediatrics*

Routine Ambulatory Blood Pressure Monitoring to Detect Hypertension in Early Life

Londe S, Bourgoignie JJ, Robson AM, Goldring D. Hypertension in Apparently Normal Children. J Pediatr 1971;78:569-77.

Fifty years ago, Londe et al reported elevated systolic and/or diastolic blood pressures in asymptomatic children, after meticulous repeated measurements and follow-up (3-8 years). The majority of the children did not have any cause for hypertension; however, 54% of the hypertensive children were overweight and 44% had a hypertensive parent. The authors proposed that the elevated blood pressure may be early display of essential hypertension. This report reiterated the importance of proper technique of routine blood pressure measurement in children and raised several questions: whether obesity in children truly resulted in hypertension and whether loss of weight would lead to a decrease in blood pressures. The effects of diet and regular exercise on blood pressure in such children and control of other factors like hypercholesterolemia might also decrease the risk of subsequent cardiovascular disease.

It is now well-established that elevated blood pressure is related directly to higher values of body mass index, with the OR of hypertension being 2.6 in children with obesity compared with children without obesity. The American Academy of Pediatrics updated normative blood pressure percentiles for boys and girls have excluded children with overweight or obesity, which constituted nearly 20% of the population used for obtaining the previous charts.[1] The American Academy of Pediatrics also recommends annual blood pressure recording for children ≥3 years and more frequently in high-risk groups, including children with obesity. Ambulatory blood pressure monitoring is now recommended for the diagnosis and management of hypertension, including suspected white coat hypertension or masked hypertension. The Dietary Approaches to Stop Hypertension diet (DASH diet) is a vegetable and fiber-rich diet with decreased sodium, meat, and fat intake and can decrease blood pressure. At least 60 minutes per day of moderate to strong aerobic training for normalization of body weight and a body mass index below the 85th percentile for sex and age is recommended.[2]

Because childhood hypertension is directly associated with left ventricular hypertrophy and increased arterial wall thickness, implementation of a program advocating a healthy diet and physical activity are mandatory and should start in early childhood. A program of ambulatory blood pressure monitoring is essential to the early detection of hypertension.

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