Conservative treatment of superior mesenteric artery syndrome

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Abstract

Objective. To assess predictive factors for failure in the conservative treatment of patients with superior mesenteric artery syndrome (SMAS).

Materials and methods. A retrospective case-control study was carried out. Cases included pediatric patients diagnosed with SMAS and treated in our institution from 2013 to 2024. Controls included surgically treated SMAS patients under 20 years of age from a PubMed bibliographic review. Of a total of 205 papers, 24 met inclusion criteria. Demographic, clinical, diagnostic, therapeutic, and progression variables were collected. Statistical analysis was performed using chi-square/Fisher and Mann-Whitney U tests.

Results. N= 42 (16 cases and 26 controls). No statistically significant differences were found in terms of BMI (17.25 vs. 14.43; U= 148.5; p= 0.398), progression time (130 vs. 90 days; U= 176.0; p= 0.820), angle (19° vs. 14.1°; U= 159.0; p= 0.206), or aortomesenteric distance (3.5 cm vs. 4.25 cm; U= 62.5; p= 0.068). Cases received conservative treatment, except for one who refused this treatment modality. There were no significant differences regarding final BMI (18.6 vs. 17.9; U= 96.0; p= 0.560), treatment success, or hospital stay (7.0 vs. 6.0 days; U= 168.0; p= 0.308) between both groups.

Conclusions. Conservative treatment is highly successful regardless of progression time, BMI, angle, and aortomesenteric distance. Therefore, surgery is not recommended as the first option in the management of SMAS.

Key Words: Superior mesenteric artery syndorme; Conservative treatment.

Tratamiento conservador en el síndrome de la pinza aorto-mesentérica

Resumen

Objetivo. Evaluar factores predictivos de fracaso del tratamiento conservador en pacientes con síndrome de la pinza aorto-mesentérica (PAM).

Método. Estudio retrospectivo de casos y controles. Los casos incluyeron pacientes pediátricos diagnosticados de PAM entre 2013 y 2024 tratados en nuestro centro. Los controles fueron pacientes con PAM, menores de 20 años y tratados quirúrgicamente, extraídos de una revisión bibliográfica en PubMed. De un total de 205 artículos, se seleccionaron 24 que cumplían con los criterios de inclusión. Se recogieron variables demográficas, clínicas, diagnósticas, terapéuticas y evolutivas. El análisis estadístico se realizó mediante las pruebas de Chi^2/Fisher y U de Mann-Whitney.

Resultados. N= 42 (16 casos y 26 controles). No se observaron diferencias estadísticamente significativas en el IMC (17,25 *vs.* 14,43; U= 148,5; p= 0,398), tiempo de evolución (130 *vs.* 90 días; U= 176,0; p= 0,820), ángulo (19° *vs.* 14,1°; U= 159,0; p= 0,206) ni distancia aorto-mesentérica (3,5 cm *vs.* 4,25 cm; U= 62,5; p= 0,068). Los casos recibieron tratamiento conservador, salvo uno por rechazo del mismo. No hubo diferencias significativas en el IMC final (18,6 *vs.* 17,9; U= 96,0; p= 0,560), éxito del tratamiento, ni estancia hospitalaria (7,0 *vs.* 6,0 días; U= 168,0; p= 0,308) entre ambos grupos.

Conclusiones. El tratamiento conservador muestra un alto índice de éxito independientemente del tiempo de evolución, IMC, ángulo y distancia aorto-mesentérica, por lo que se desaconseja la cirugía como opción inicial en el manejo del síndrome de PAM.

Palabras Clave: Síndrome de la arteria mesentérica superior; Síndrome de la pinza aorto-mesentérica; Tratamiento conservador.

INTRODUCTION

Superior mesenteric artery syndrome (SMAS), also known as Wilkie's syndrome, is a rare cause of abdominal pain stemming from an extrinsic compression of the duodenum, at the level of its third portion, as a result of a reduction in the angle between the aorta and the superior mesenteric artery (SMA)[1-4]. Estimated incidence is below 0.3%[2].

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In can be congenital in patients with a high insertion of the duodenum, a short ligament of Treitz, or intestinal malrotation[4]. When acquired, it is caused by a reduction in the aortomesenteric angle and can stem from a catabolic reduction in retroperitoneal adipose tissue, eating disorders, and malignity, trauma, or surgery[1,2,4,5].

Typical clinical signs such as epigastric pain, vomit, nausea, early satiety, or abdominal distension usually present chronically and intermittently[3]. Given how little specific symptoms are, late diagnosis is frequent, thus perpetuating the syndrome as a result of recurrent abdominal pain, vomit, reduced intake, and weight loss.

Diagnosis is based on barium-contrast studies, which reveal first and second duodenal portion dilatation, compression of the third portion, anti-peristaltic movements proximal to the obstruction, and improvement of clinical signs when on a left lateral position[1,2]. CT-scan is the diagnostic method used to measure the angle and distance between the aorta and the SMA, with angles < 22° and distances < 8 mm being regarded as pathological[1,2]. Other techniques such as ultrasonography, NMR, or endoscopy have been used for diagnostic purposes, with less sensitivity and specificity[1].

Baseline treatment is conservative, with gastric decompression, posture measures, and prokinetics. The primary objective is to gain weight in order to increase the distance between the aorta and the SMA. An oral, nasogastric, or nasoduodenal hypercaloric diet, as well as parenteral nutrition, are typically prescribed[1-4]. Numerous surgical techniques have been reported in the treatment of SMAS. The most commonly used one is open or laparoscopic duodenojejunostomy. Ongoing conservative treatment for over 6 weeks has been suggested to be regarded as treatment failure, but such criteria are not well-defined, which means indications for surgery are not clear[4].

In our experience, non-surgical management is associated with high success rates. Therefore, the objective of this study was to assess predictive factors for conservative treatment failure in SMAS patients.

MATERIALS AND METHODS

A retrospective case-control study of SMAS patients treated in a tertiary hospital from 2013 to 2024 was carried out. The case group consisted of 0-14-year-old patients diagnosed with SMAS and undergoing follow-up in our institution. Patients with clinical and ultrasound suspicion of SMAS in whom diagnosis had not been confirmed by a CT-scan and/or a contrast intestinal transit study were excluded.

The control group was made up of surgically treated patients under 20 years of age diagnosed with SMAS. Control group data was gathered from a bibliographic review in English and Spanish by searching for "Superior mesenteric artery (SMA) syndrome" + "Surgical treatment" + "Case Reports" in the PubMed database (Fig. 1). 476 results were found, but 271 had to be removed as they were duplicated or the full text was not available. 181 papers were excluded because inclusion criteria were not met – whether age > 20 years, overall sample description not featuring case-by-case data, neonatal case reports where diagnosis had been intraoperatively achieved, and conservative treatment of SMAS. This led to 24 papers in total[5-28], with data from 26 patients (Table 1).

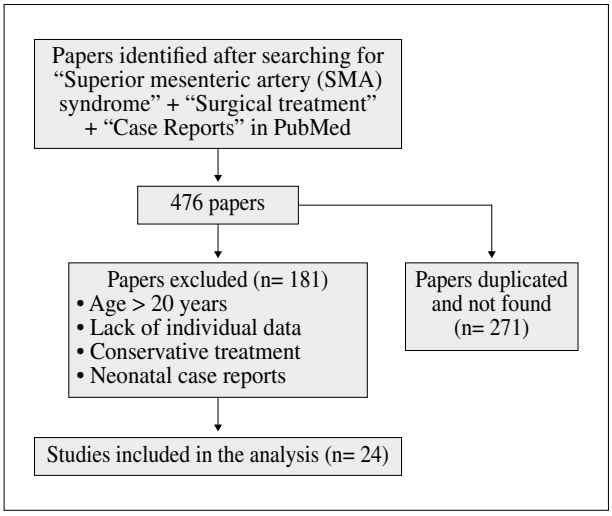


Figure 1. Flow diagram of the paper search strategy, from the first search to the papers eventually included in the analysis.

Demographic (sex, age, weight, and BMI at diagnosis) and clinical (symptoms, progression time, diagnostic technique, treatment type) variables were collected. Aortomesenteric angle at diagnosis, as well as distance (mm) between the aorta and the SMA, were documented. Treatment was classified as either conservative or surgical, with the latter being defined according to the technique used as laparoscopic duodenojejunostomy (LDJ), open duodenojejunostomy (ODJ), robotic duodenojejunostomy (RDJ), gastrojejunostomy (GJ), Ladd's procedure, and Strong's procedure. Gastric decompression, posture measures, drug treatment, hypercaloric diet, and nasoduodenal probe were included as conservative treatment. Result variables included treatment success and duration, hospital stay, weight gain, and progression follow-up.

Statistical analysis was carried out using the IBM SPSS Statistics 30.0.0 software. The Shapiro-Wilk test was employed to identify normal distribution variables. Parametric variables were expressed as mean ± standard deviation (SD), whereas non-parametric variables were featured as median and range. For comparative analysis purposes, Student's t-test was used for parametric continuous variables, and Mann-Whitney U test was employed for non-parametric ones. Qualitative variables were compared

Table 1. Surgically treated patient characteristics (bibliographic controls).

Paper	*No.*	*Sex*	*Age*	*Diagnosis*	*Ao-M angle*	*Ao-M distance*	*Baseline BMI*	*Indication**	*Surgery*	*Final BMI*
Kirby GC, 2017	1	Male	17	CT-scan	34	3.5	14.3	2	LDJ	19.1
Danushka PGN, 2023	1	Female	18	CT-scan	7	8	18.4	2	ODJ	22.3
Aldagher A, 2023	1	Male	8	CT-scan	13.2	4.1	14.1	3	ODJ	
Tewari S, 2022	1	Female	10	US+ITS+CT-scan	21	3	13.58	1	ODJ	15.6
Cullis PS, 2016	1	Female	12	ITS + CT-scan			14.7	2	LDJ	15.9
Badour M, 2021	1	Female	11	ITS + CT-scan	8.1	7		2	ODJ	
Hamidi H, 2019	1	Male	17	CT-scan	6	8		2	GYL	
Record JL, 2015	1	Female	13	ITS + CT-scan	15		14.45	1	LDJ	
Record JL, 2015	1	Female	16	ITS			12.89	1	LDJ	
Haloui N, 2025	1	Female	14	ITS + CT-scan	10		17.3	2	GYL	18.52
Jo JB, 2008	1	Female	19	CT-scan				1	LDJ	
Heidbreder R, 2018	1	Female	20	ITS + CT-scan			19.5	2	LDJ	21.14
Merrett ND, 2009	1	Female	18	ITS + CT-scan	17			2	DY	
Yao SY, 2015	1	Female	17	CT-scan	10	5.5		1	LDJ	
Hanif M, 2022	1	Male	16	CT-scan	20	4.5	11	2	LDJ	
Voleti SPR, 2017	1	Male	17	CT-scan	15	3.9	18.35	1	LDJ	19.3
Martins AR, 2016	1	Female	20	CT-scan	15			2	LDJ	
Rai RR, 2019	1	Female	13	CT-scan			14.89	1	LDJ	16.43
Muñoz-Palomeque SA, 2024	1	Female	18	ITS + CT-scan	12.4	3.59	11.42	1	RDJ	12.32
Muñoz-Palomeque SA, 2024	1	Female	20	ITS + CT-scan	11.4	3.52	14.25	1	RDJ	17.26
Alsulaimy M, 2014	1	Female	17	ITS			22.2	1	Ladd	
Konstantinidis H, 2018	1	Female	14	ITS + CT-scan	11	3		1	Strong	
Ehlers TO, 2018	1	Female	17	CT-scan	24	8	19.4	2	LDJ	22.7
Sato M, 2014	1	Female	6	ITS + CT-scan		5	14.4	1	LDJ	16.6
Rathood T, 2024	1	Male	17	CT-scan	20	4.4	13.8	1	ODJ	
Aneiros B, 2019	1	Male	13	US		3		2	LDJ	

**Surgical indication: 1.- Conservative treatment failure; 2.- Elective surgery; 3.- Social reasons.*

using the chi-square and Fisher's exact tests. Statistical significance was established at $p< 0.05$.

RESULTS

The sample consisted of 42 patients –16 cases treated in our institution and 26 surgically treated bibliographic controls. 93.8% of the cases and 73.1% of the controls were female (chi-square: 2.745; $p= 0.0127$). Mean age in the case group was 11.88 ± 2.44 years vs. 15.39 ± 3.69 years in the control group, with this difference being statistically significant ($p= 0.002$). No statistically significant differences in the remaining baseline characteristics were found between both groups (Table 2).

The most frequent clinical sign in both groups was vomit, followed by postprandial abdominal pain and weight loss. Mean baseline weight (around 40 kg) and

Table 2. Baseline sample characteristics comparing the cases treated in our institution with the surgical bibliographic controls.

Variable	*Cases (n= 16)*	*Bibliographic controls (n= 26)*	*Statistic*	*p value*
Female sex	15 (93.8%)	19 (73.1%)	2.745[a]	0.0127
Age (years)	11.88 ± 2.44	15.39 ± 3.69	42[b]	0.002
Vomit	12 (75%)	23 (88.5%)	4.226[a]	0.061
Abdominal pain	10 (62.5%)	19 (67.9%)	0.518[a]	0.051
Weight loss	12 (75%)	14 (53.8%)	2.569[a]	0.195
Baseline weight (kg)	39.71 ± 10.59	39.50 ± 20.93	29[b]	0.288
Baseline BMI	16.82 ± 3.21	15.06 ± 4.10	32[b]	0.398
Progression (days)	130 ± 46.3	90 ± 55.8	176[b]	0.802
Aortomesenteric angle	17 (5-22)	14.1 (8-18)	159[b]	0.206
Aortomesenteric distance (mm)	3.5 (2-8)	4.25 (3-8)	62[b]	0.068

[a]*Pearson's chi-square;* [b]*Mann-Whitney U.*

baseline BMI (around 15) were similar in both groups. No differences in terms of progression time were found, with 130 days for the cases and 90 days for the controls (Table 2).

In our institution, ultrasonography was carried out as the first diagnostic test in 12 cases (75%), with findings such as second duodenal portion dilatation, anti-peristaltic movements at this level, and third portion collapse. The aortomesenteric angle could be ultrasound-defined in 7 cases (43.75%). An intestinal transit study was performed in 15 cases (93.8%), 11 of whom had previously undergone ultrasonography; in the remaining 4, it was the first diagnostic test. In the case with suspected SMAS at ultrasonography who did not undergo an intestinal transit study, an abdominal CT-scan was conducted to confirm diagnosis.

The comparative analysis showed differences in the use of diagnostic tests between both groups – ultrasonography: 75% cases vs. 7.7% controls (chi-square: 20.192; p< 0.001); intestinal transit study: 93.8% cases vs. 50% controls (chi-square: 8.55; p= 0.014); and CT-scan: 50% cases vs. 88.5% controls (chi-square: 7.580; p= 0.011). No differences in terms of aortomesenteric angle (17º vs. 14º) or aortomesenteric space (3.5 vs. 4.25 mm) were found between both groups (Table 2).

Our whole sample was conservatively treated, except for one case who refused this treatment modality. All patients had an adequate tolerance of their own secretions and had no symptoms in fasting periods. Conservative treatment was carried out in a step-by-step fashion. It first consisted of gastric decompression, posture and diet measures, and oral hypercaloric diet, with 8 patients (50%) experiencing clinical improvement. In the remaining 8, a nasoduodenal probe (without exceeding the stricture area) was placed for enteral nutrition though ongoing gastric feeding. Nasoduodenal probe treatment duration was 18.5 days (1-76 days). The probe was placed by the Pediatric Surgery team in all cases but one, due to the technical difficulties encountered as a result of significant gastric dilatation (Fig. 2). It was transgastrically placed with the help of the Interventional Radiology team (Fig. 3). 4



Figure 2. Patient with great gastric and first and second duodenal portion dilatation.

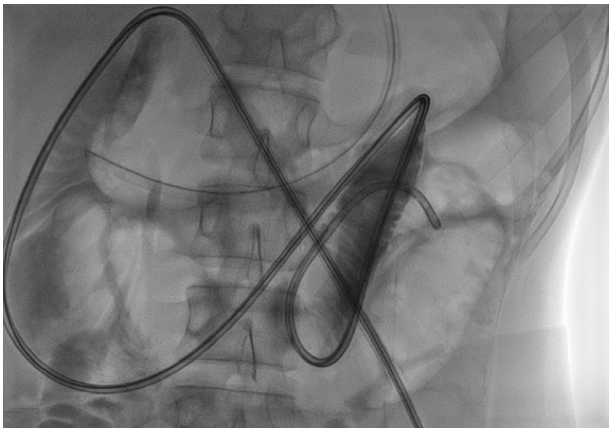


Figure 3. Transtenotic gastroduodenal probe placement through the gastric route in cooperation with the Interventional Radiology Department.

patients (25%) required parenteral nutrition supplements as a result of persistent symptoms. 1 patient refused conservative treatment on the second hospitalization day, following nasoduodenal probe placement. She was uneventfully treated with laparoscopic duodenojejunostomy.

All controls underwent surgery. Indications for surgery included conservative treatment failure in 13 cases (50%), elective surgery as the first therapeutic option in 12 cases (48%), and social reasons in 1 case. LDJ was performed in 15 patients (57.7%), ODJ in 5 patients (19.2%), GJ in 2 patients, RDJ in 2 patients, Ladd's procedure in 1 patient, and Strong's procedure in 1 patient (Table 1).

Conservative treatment duration was 85 days (33-560 days), even though mean hospital stay was 11.6 ± 9.2 days. 5 cases (31.25%) were treated on an outpatient basis, and 11 required hospitalization. All controls required hospitalization, with a mean stay of 7.24 ± 3.27 days. No statistically significant differences in terms of hospital stay were found between both groups (T= –1.54; p= 0.15). Mean weight gain with conservative treatment was 6.18 ± 3.75 kg, with cases' final weight reaching 45.88 ± 11.86 kg and a BMI of 19.27 ± 3.46. In the control group, post-treatment BMI was 18.09 ± 3.03, without statistically significant differences between both groups (U= 96.0; p= 0.560).

The effectiveness of conservative treatment was 100%, with all patients being asymptomatic and experiencing full clinical sign resolution after a 7-month follow-up period (1.7-19.3 months). In the control group, treatment effectiveness was 97.92%, with an 8.13-month (14 days-12.8 months) follow-up period.

DISCUSSION

SMAS is a rare cause of duodenal obstruction stemming from a reduced angle between the aorta and the SMA. Triggering factors include significant weight loss, diet disorders, trauma, and surgery –such as scoliosis repair[5]. It is more prevalent in young women (10-30 years old) and presents with unspecific symptoms, which may cause delayed diagnosis[4]. The most commonly reported symptoms are vomit, epigastric postprandial pain, and weight loss[5-14,18,23-25,28].

Abdominal ultrasonography and X-rays are used in the diagnostic algorithm of SMAS. However, contrast gastrointestinal studies and CT-scan are the most specific techniques today[13,16,29]. However, in our series, the angle was ultrasound-defined in 43.75% of the sample, with subsequent confirmation by means of intestinal transit studies or CT-scans. According to Neri et al., this data suggests that, in the hands of expert personnel, ultrasonography could have a more significant role in the diagnosis of SMAS, thus avoiding more expensive and invasive techniques[30]. When reviewing the literature to identify the control group, no consistency in terms of diagnostic tests was found, since only 7.7% of the controls had been diagnosed with ultrasonography.

Aortomesenteric angles of 25-60° and distances of 10-28 mm[4,13,16,29,30] are considered normal. In this study, no differences in terms of aortomesenteric angle or distance were found between the two populations analyzed. Therefore, these parameters do not prove useful as predictors for medical treatment failure. No literature instances proposing angle or distance values from which surgery should be indicated were found either.

Baseline treatment should be conservative, with success rates of 25-80% according to the series[8,26,27]. In our experience, conservative treatment offers excellent results, with symptoms resolving in half of the cases only with gastric decompression, hygiene-diet measures, and a hypercaloric diet. In the remaining half, transpyloric feeding was needed as a result of poor oral tolerance or persistent symptoms, with half of them requiring parenteral nutrition for caloric delivery. Total treatment duration was long, but this is because the period of hypercaloric supplement administration following discharge was recorded. Hospital stay was 11.6 ± 9.2 days, and treatment was administered on an outpatient basis during most of the follow-up period.

Conservative treatment failure criteria are not well-defined. Even though considering 4-6 treatment weeks without improvements as treatment failure is the most commonly accepted theory[21,26,28], some authors indicate surgery in the absence of improvements after just 2-3 conservative treatment days[14,19]. Certain authors only consider conservative treatment as a preparation for improving the nutritional and hydroelectrolytic status before surgery[18,20]. Similarly, some publications regard elective surgery as the first therapeutic option in cases with long clinical progression times[13,16,18], severe gastric and duodenal dilatation[10,11,28], significant weight loss, or severe

symptoms[5-7,9,10,14,27]. However, when comparing this data with that from our series, no differences in terms of progression time from symptom onset, clinical presentation, or baseline BMI were found between both populations, which means these criteria should be revisited. In addition, certain conservatively treated patients had severe dilatations at diagnosis (Fig. 2), but this had no impact on medical management success.

The primary limitations of this study lie in its retrospective nature and the fact controls were selected from bibliographic data, which may increase the probability of biases in the sample.

In conclusion, and according to our experience, the conservative treatment of SMAS is safe and effective, with high success rates. In addition, it is little invasive and can be performed on an outpatient basis. No differences in terms of baseline patient characteristics allowing treatment failure to be predicted were found. Therefore, surgical treatment should not be regarded as the first therapeutic option, regardless of progression time, weight, clinical severity, or gastric dilatation.

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