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Authors' Affiliation:
[1]Faculty of Medicine, Medical University of Gdańsk, Gdańsk, Poland
[2]Faculty of Medicine and Health Sciences, Collegium Medicum of the University of ZielonaGóra, Zielona Góra, Poland

***Corresponding author:**
Marta Urszula Marciniak,
Faculty of Medicine, Medical University of Gdańsk, Gdańsk, Poland;
e-mail: marta.marciniak2707@gmail.com

Contact list:

Marta Urszula Marciniak	marta.marciniak2707@gmail.com
Marta Tortyna	marta.tortyna@gmail.com
Julia Sztubińska	juliasztubińska@wp.pl
Danuta Borowska	d_borowska@gumed.edu.pl
Julia Urbańska	juula522@gmail.com
Maciej Trzciński	maciejt99@interia.pl
Kamil Nieczaj	kamilnieczaj22@gmail.com
Olga Samsel	olga.samsel.13@gmail.com
Natalia Sioch	sioch.natalia@gmail.com
Julia Krotofil	krotofil.julia@gmail.com
Paula Szarek	paula.szarek.1@gmail.com

ORICD list:

Marta Urszula Marciniak	0009-0000-2409-4935
Marta Tortyna	0009-0002-8230-6929
Julia Sztubińska	0009-0005-2503-1158
Danuta Borowska	0009-0002-0136-0182
Julia Urbańska	0009-0007-8897-7877
Paula Szarek	0009-0002-1102-5783
Olga Samsel	0009-0008-5291-7570
Natalia Sioch	0009-0001-4812-6206
Julia Krotofil	0009-0009-8309-4615
Maciej Trzciński	0009-0008-2514-3493
Kamil Nieczaj	0009-0001-3812-8523

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The Association Between Excessive Weight Loss and the Development of Superior Mesenteric Artery Syndrome - A Systematic Review of Recent Evidence

Marta Urszula Marciniak[1]*, Marta Tortyna[1], Julia Sztubińska[1], Danuta Borowska[1], Julia Urbańska[1], Paula Szarek[2], Olga Samsel[1], Natalia Sioch[1], Julia Krotofil[1], Maciej Trzciński[1], Kamil Nieczaj[1]

ABSTRACT

Superior Mesenteric Artery Syndrome (SMAS), is a rare but potentially serious condition resulting from compression of the third portion of the duodenum between the superior mesenteric artery and the abdominal aorta. A significant reduction in retroperitoneal fat due to excessive weight loss most often precipitates this compression. This systematic review demonstrates the association between excessive weight loss and SMAS. It also gives an overview of the etiology, symptoms, diagnosis, and treatment options. The authors used the PubMed and Google Scholar databases to search for articles published between 2020 and the present. Fitting studies for this article include systematic reviews and case reports that describe patients with excessive body weight loss (defined as ≥5% in 6–12 months), characterizing clinical presentation, diagnosis, and treatment resultants. Most of the patients who had been diagnosed with SMAS had experienced excessive weight loss, primarily as a result of eating disorders (e.g., anorexia nervosa). The most frequent symptoms are postprandial abdominal pain, nausea, vomiting, and early satiety. Clinicians typically make the diagnosis based on computed tomography, which reveals a narrow aortomesenteric angle (<25o) and a short aortomesenteric distance (≤8 mm). Most patients demand only conservative treatment such as nutritional support. Nonetheless, more involved presentations ultimately need operative management, with duodenojejunostomy being the surgery of choice. To summarize, the diagnosis of superior mesenteric artery syndrome may endanger life when a recent past of substantial weight reduction coincides with vague bowel symptoms. Swift verification of the pathology, paired with prompt surgical correction, remains essential for averting sequelae.

Keywords: Superior Mesenteric Artery, SMAS, Excessive weight loss

1. INTRODUCTION

The superior mesenteric artery syndrome (SMA syndrome, SMAS) is a relatively rare diagnosis in which the third portion of the duodenum is externally compressed by the narrowed angle between the superior mesenteric artery (SMA) and the aorta (Watters et al., 2020). The superior mesenteric artery (SMA) originates anatomically from the aorta at the level of the first lumbar vertebra. As it branches from the aorta, it forms an aortomesenteric angle (AOM) that ranges from 38° to 65°, allowing the small intestine to pass freely between these vessels (Jawed et al., 2023).

The SMA syndrome is typically identified in patients after excessive weight loss that causes loss of retroperitoneal and visceral fat. The median age at presentation is usually very young, between 17 and 23 years (Bozzola et al., 2024). More frequently, a patient may experience gastrointestinal symptoms such as postprandial nausea and abdominal pain, and in rare cases, subacute small bowel obstruction.

2. REVIEW METHODS

This article reviews the literature on an uncommon condition, specifically superior mesenteric artery syndrome, in association with excessive weight loss. The authors searched Google Scholar and PubMed databases. They restricted the search to articles published in the past five years. Most findings are systematic reviews and case reports. The authors did not find any meta-analyses or observational studies eligible for inclusion in this article. They find articles for this review by searching databases with keywords superior mesenteric artery syndrome, SMA syndrome, and Wilkie's syndrome, along with terms like weight loss or excessive weight loss. The review includes studies considered eligible for this revision if they contain a description of weight loss exceeding 5% of body mass within a maximum period of 6-12 months, provide a complete clinical case description, and are full-length articles. The exclusion criteria were as follows: irrelevance to the field of study and lack of clinical description of the patient. The article selection followed the PRISMA guidelines (Figure 1).

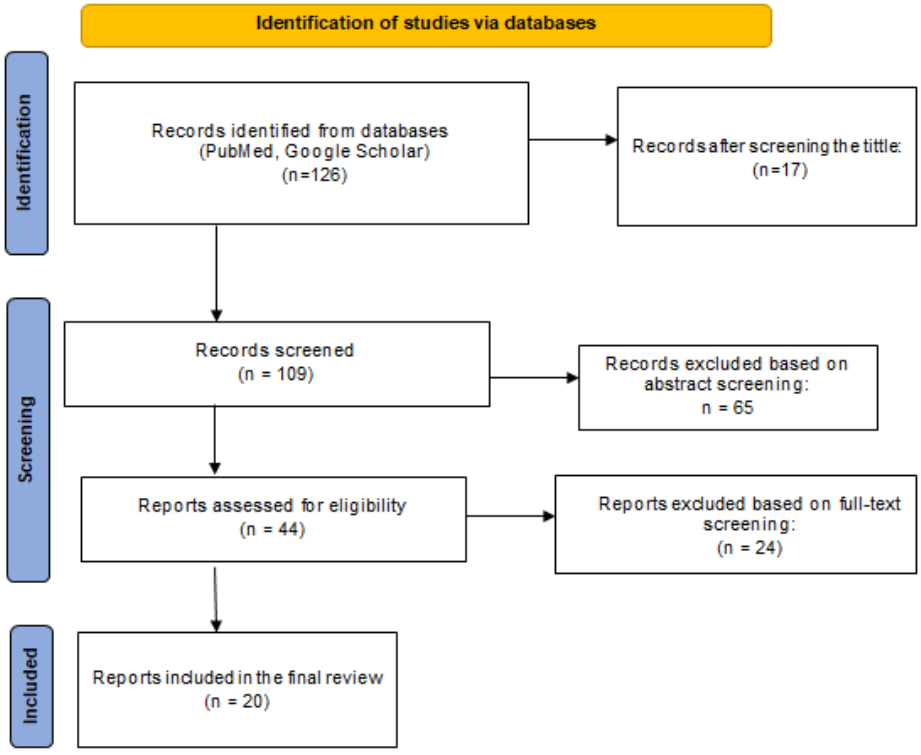

Figure 1. PRISMA diagram

The purpose of this article is to highlight the connection between SMA syndrome in patients with excessive weight loss, to show a wide spectrum of this syndrome, to avoid potential serious complications, and to manage this affliction.

3. RESULTS & DISCUSSION

Superior mesenteric artery syndrome was initially described in 1861 by the Austrian professor Carl von Rokitansky (Oka et al., 2023). In 1927, Sir David Wilkie described the pathophysiology and treatment of this syndrome, which is why SMAS is also known as Wilkie's syndrome (Danushka et al., 2023). Young, thin females are most commonly affected by the condition, with women being more predominant than men at a ratio of 3:2. The median age of onset of SMAS is around 20 years. However, it is worth remembering that this syndrome can occur regardless of age and gender, especially in people with a slim build and initially low body mass. The literature describes cases of people diagnosed over the age of 50 (Vakil et al., 2024). The underlying cause of this affliction is due to compression of the third part of the duodenum by the superior mesenteric artery anteriorly and by the abdominal aorta posteriorly (Watters et al., 2020). It is prompted by the narrowing of the aortomesenteric angle due to a lack of fatty tissue that surrounds the SMA.

The proper angle between the SMA and the aorta ranges between 38 ° and 65 °, and the typical aortomesenteric (AOM) distance ranges from 10 to 34 mm, which allows the duodenum to pass unobstructed between the SMA and aorta. The lack of visceral and retroperitoneal fat causes a reduction in the angle to as little as 6 °. However, an angle below 25° and an aortomesenteric distance equal to or lower than 8 mm in radiological findings is highly suggestive of making a diagnosis of SMA syndrome (England and Li, 2021). In patients described in the literature, the AOM angle ranges from approximately 9° to 30°, which is below the normal range but above the range suggestive of a diagnosis. The AOM distance in patients varies between 3 and 8 millimetres, which falls within the range suggestive of a SMAS diagnosis.

Excessive weight loss, as clinically defined, typically means unintentional weight loss of more than 5% over a 6-12 month period. This is a significant risk factor for SMAS. The weight loss in SMA patients can reach as much as 35 kg or more. The median weight loss is 16.5 kg on average (Bozzola et al., 2024). There is no specific time frame for patients to lose weight. Some people lose body mass rapidly over a period of two weeks, while others lose it in a few months or years. However, there is a case described where a patient lost 42kg in 2 years, representing a total loss of 50% of his body mass (Díaz-Martínez et al., 2024). Literature describes the correlation between the aortomesenteric angle and body mass index (BMI) (England et al., 2021). Patients are usually found to be underweight (<18.5 kg/m²) based on their BMI, which, depending on the patient, ranges from 11 kg/m² to even a normal BMI of 23.46 kg/m² (normal range of BMI: 18.5 to 24.9), despite experiencing weight loss (Berken et al., 2022).

Statistically, this disease most often occurs in teenagers and young women as a result of conscious dieting and excessive weight loss. It is often associated with the diagnosis of anorexia nervosa (AN), which is one of the most common causes of this syndrome. It is worth noting that in young men suffering from this eating disorder, the diagnosis may be delayed due to the predominance of anorexia in women. The correlation between AN and SMA syndrome can be described as a vicious circle. Initially, large weight loss due to AN may cause the onset of SMA syndrome. On the other hand, symptoms of SMA syndrome, such as gastroparesis and nausea, lead to aversion to food and thus further weight loss. As a result, the aortomesenteric angle becomes further narrowed and the symptoms of the syndrome become more severe.

Etiology And Risk Factors

The etiology of SMA syndrome may be congenital or acquired. Congenital etiologies include spinal deformities, a low origin of the SMA, intestinal malrotation, and either shortening or hypertrophy of the ligament of Treitz - the primary cause of this syndrome in children (Oka et al., 2023; Vakil et al., 2024). As for acquired causes, it can be the result of many medical conditions leading to excessive weight loss and a malnourished state. The contributing factors include, among others, eating disorders such as anorexia nervosa, which is one of the most common causes; as well as malabsorption syndromes, trauma, burns, substance abuse, malignancies, tuberculosis, AIDS, and chronic infections, and surgical intervention, like spinal correction procedures or bariatric surgery, are also potential causes of the SMA syndrome (Watters et al., 2020; Vakil et al., 2024).

Symptoms

The SMA syndrome may occur clinically in acute and chronic forms. Symptoms are usually unspecified. In the acute form of this disorder, the most repeated symptoms are abdominal pain, distention, and bilious vomiting. Potentially life-threatening epigastric distention may also occur. In the chronic form, the most frequently reported symptom is postprandial abdominal pain, primarily in the epigastric area, which is aggravated by oral intake of food and relieved by emesis. Patients also report early satiety, loss of appetite, heartburn, bloating, and weight loss. All of the above lead to inadequate food intake, resulting in excessive weight loss, cachexia, and the exacerbation of the SMA syndrome (Bozzola et al., 2024).

Table 1 provides a summary of the complaints reported by patients, as documented in the reviewed literature. The SMA syndrome is frequently mistaken for functional dyspepsia, peptic ulcer disease, gastroesophageal reflux disease (GERD), or pancreatitis. A severe or unrecognized form of the syndrome may cause many complications, including life-threatening ones. The most commonly reported complications are electrolyte abnormalities (hypokalemia, hyponatremia), metabolic alkalosis, severe malnutrition, gastrointestinal complications (inflammation, bleeding, mucosal necrosis), arrhythmia, acute kidney injury, aspiration pneumonia, pancreatitis, hypovolemic shock, and even sudden death. Other vascular compression disorders may also coexist with SMA syndrome. One of them is the Nutcracker syndrome, where the left renal vein is compressed between the aorta and the superior mesenteric artery. The clinical picture of this disease is often similar to that observed in SMA syndrome (Oka et al., 2023).

Table 1. Summary of clinical characteristics, diagnosis, and final treatment in patients.

Reference	Symptoms	Abnormalities in physical examination	Diagnosis	Final Treatment
Bozzola et al., 2024	Postprandial nausea, gastric-biliary vomiting, eating disorder (AN).	Bradycardia, hypotension, cachectic state, pale skin, subungual cyanosis, cold extremities; mild tenderness in the periumbilical area and the left iliac fossa.	Barium X-ray, GI	Conservative
Seo et al., 2023	Excessive bilious vomiting, severe abdominal pain, eating disorder (AN).	Distension, diffuse tenderness to palpation, decreased bowel sounds.	X-ray, CT	Conservative
Bloomberg et al., 2022	Nausea, vomiting, abdominal pain.	Distension, diffuse tenderness to palpation with guarding in abdomen.	CT, GI	Conservative
Soqia et al., 2024	Vomiting, chronic abdominal pain, severe cramping.	No abnormalities.	CT	Conservative
Karki et al., 2020	Vomiting, vague abdominal discomfort.	No abnormalities.	GI, CT	Conservative
Jawed et al., 2023	Nonbilous postprandial vomiting, decrease in appetite, diarrhea, anorexia, intermittent episodes of fever.	-	CT	Surgical
Khan et al., 2024	Vomiting, loss of appetite.	Hypotension, tachycardia.	CT	Surgical
Hirai et al., 2020	Nausea, loss of appetite, epigastric pain.	Upper abdominal tenderness, no bowel sounds.	CT	Conservative
Gharti et al., 2024	Intermittent vomiting, loss of appetite, abdominal pain.	No abnormalities.	CT	Conservative
England et al., 2021	Vomiting, severe epigastric pain, constipation.	Tachycardia, epigastric tenderness to palpation.	CT	Conservative
Díaz-Martínez et al., 2024	Decrease in appetite, early satiety, nausea, vomiting,	-	GI, CT	Surgical

	gastroesophageal reflux.			
Vakil et al. 2024	Bilious vomiting, intermittent epigastric pain.	Mildly distended abdomen.	CT	Surgical
Jacobs et al., 2022	Intractable vomiting, poor oral intake, diarrhea.	Tachycardia.	CT	Surgical

Diagnosis

Physical examinations offer little help in diagnosis. In most patients, the abdomen looks perfectly normal. Occasionally, a tenderness point will be found after the abdomen is palpated. Sometimes bowel sounds are reduced or absent (Hirai et al., 2020; Seo et al., 2023). As a result, the doctor has to turn to various imaging techniques in order to establish a definite diagnosis. Some of the more common imaging methods are: abdominal ultrasound; endoscopic ultrasound; X-ray of bowel (Upper GI series); a plain film CT scan without contrast on the abdomen and pelvis; chair with an illuminated room (CT angiography). An upper GI series of X-rays and a scan are generally the most helpful. The GI series uses ingested barium to visualize its passage through the gastrointestinal tract. In cases of SMA syndrome, it may reveal obstruction at the distal duodenum and delayed progression of barium through the small intestine. Abdominal computed tomography (CT) typically reveals compression of the distal duodenum, with associated distention of the stomach and proximal duodenum. A narrowed AOM angle and reduced AOM distance, both key diagnostic criteria, are also commonly observed (Bloomberg et al., 2023).

Routine laboratory tests also do not help in making a diagnosis. Complete blood counts, inflammation markers, kidney and liver function, and urine tests are usually normal. If there are abnormal results, they often relate to other health issues the patient has.

Medical Intervention

Management of SMA syndrome varies depending on its etiology and the severity of symptoms. The present is based largely on conservative treatment. Gain of adequate weight due to reconstruction of the fat pad of viscera and mechanical stricture of the duodenum should be the goal. Nutritional assistance is provided to achieve this (Watters et al., 2020).

Oral Liquid Diet: Initially, use a high-calorie, low-volume oral liquid diet.

Enteral Feeding: If oral ingestion of food is not possible, then enteral feeding can be initiated by passing a nasogastric tube (NGT) or nasojejunal tube past the obstruction. Additionally, insertion of an NGT may offer relief of symptoms and treatment of gastroparesis through gastric and duodenal decompression. A complete, solid food diet is eventually indicated once symptoms have resolved.

Parenteral Nutrition: Peripheral parenteral nutrition and total parenteral nutrition are considered as alternatives if enteral nutrition is insufficient (Oka et al., 2023).

Pain Management: In order to relieve pain, patients may assume postural therapy in the prone position, the genupectoral position, or flex their thighs and knees toward the chest while lying in the left lateral decubitus position (Muñoz-Palomeque, 2024).

Recommended medications: Management also includes pharmaceutical administration of prokinetic agents (e.g., Metoclopramide) that result in enhanced gastrointestinal motility and faster movement of foodstuffs from the stomach, alleviating the symptoms of gastroparesis. Literature has it that the mentioned drugs are prescribed to patients with partial SMA syndrome.

Surgical Treatment: Surgery is considered in the setting of chronic disease or for haemorrhage, perforation, or ischemia. It is also preferable to switch to surgical treatment after 4 to 6 weeks of conservative treatment if weight gain and symptom relief have been unsuccessful. The most widely performed intervention is laparoscopic duodenojejunostomy, with reported success rates in the literature ranging from 80% to 100% (Oka et al., 2023). Other performed techniques include: laparoscopic gastrojejunostomy, infrarenal transposition of the SMA, vascular reconstruction, and Strong's operation-division of Treitz ligament and rotation of the duodenum to release it from the compression (Wasef et al., 2023).

Convalescence: The literature does not specify a standard convalescence period for these patients. An individualized approach is necessary to help patients gain weight, restore fat tissue, and alleviate symptoms of SMAS (Bozzola et al., 2024).

Psychological support: It's also worth remembering that SMAS is often linked to diagnoses of eating disorders. Providing psychological assessment and support is crucial for patients of this kind (Bloomberg et al., 2023).

4. CONCLUSION

Superior mesenteric artery syndrome is an uncommon disorder. It may occur irrespective of age, sex, or comorbidity, first and foremost in patients with excessive loss of body weight and malnutrition. It can lead to upper gastrointestinal tract obstruction and, consequently, to various complications. The diagnosis of SMA syndrome requires a high index of clinical suspicion due to non-specific clinical symptoms and non-specific or non-deviating from the norm laboratory test results, especially when patients present with nausea, vomiting, and excessive loss of body mass. There is no single, specific way to deal with this syndrome.

There is no clear recommendation on how to treat the SMA syndrome. Treatment is generally conservative. Nonetheless, some patients need surgery.

In closing, SMA syndrome presents both diagnostic and therapeutic difficulties. Keeping the link between the entity and substantial caloric deficit in mind directs thoughtful management and averts prolonged diagnostic odysseys, catastrophic complications, and death.

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Author contributions

Methodology, Formal analysis, Investigation, Writing – original draft: Marta Urszula Marciniak, Marta Tortyna, Danuta Borowska, Kamil Nieczaj, Natalia Sioch

Writing – review and editing: Julia Sztubińska, Paula Szarek, Maciej Trzciński

Visualization: Julia Urbańska, Julia Krotofil, Olga Samsel

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Conflict of interest

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Data and materials availability

All data associated with this study are present in the paper.

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