

# Splenic infarction as a complication of laparoscopic sleeve gastrectomy

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## Abstract

**Introduction:** Laparoscopic sleeve gastrectomy (LSG) as a stand-alone or a first step in the biliopancreatic diversion – duodenal switch (BPD-DS) procedure is frequently the surgery of choice for the 21<sup>st</sup> century's epidemic of morbid obesity. To date, LSG as a relatively new method has few complications reported and analysed.

**Aim:** The article describes splenic infarction, not reported so far, a potentially serious complication of LSG, analyses its causes, and suggests a considerate treatment and follow-up protocol.

**Material and methods:** During the observation period between March and November 2008, 24 LSG patients (20 female and 4 male) were enrolled with mean body mass index of 44 kg/m<sup>2</sup>. All LSG procedures were recorded. Computerized statistical software Statistica 7 StatSoft, Krakow, Poland was used for analysis. Statistical significance was calculated with nonparametric tests ( $p < 0.05$ ).

**Results:** In 4 patients (17%) splenic infarction was diagnosed intraoperatively. Consecutive angio-CT scan confirmed infarction of the upper splenic pole with 12% to 33% of the splenic pulp affected. Two out of 4 patients had one minor perioperative complication. There were no significant differences between patients. Video analysis excluded possible technical errors.

**Conclusions:** The described analysis suggests short gastric vessels and upper terminal splenic artery branch dissection as possible causative factors of splenic infarction in the course of LSG. We suggest a considerate protocol with abdominal cavity inspection at the beginning and end of the procedure, angio-CT scans, prophylactic LMWH, initial broad spectrum intravenous antibiotics, and appropriate follow-up with neither splenectomy nor related immunization.

**Key words:** splenic infarction, laparoscopic sleeve gastrectomy

## Introduction

Morbid obesity is often called the first global epidemic of the twenty-first century [1]. As in all epidemics, obesity raises wide concerns and represents a great challenge for current medical practice. Conservative therapy of obesity is based on pharmacological and behavioural strategies which as well as dietary regimens are believed to have limited effec-

tiveness. After many years of limited success, surgery is now considered to be one of the main methods of effective and durable treatment of obese patients [2]. One of the surgical interventions that has been proved to be effective in bariatric surgery is sleeve gastrectomy (SG). This was developed in the 1990s and was first described by Hess and Marceau *et al.* [3, 4]. In 1999 Ganger performed the first laparoscopic sleeve gastrectomy (LSG) and a year later he sugges-

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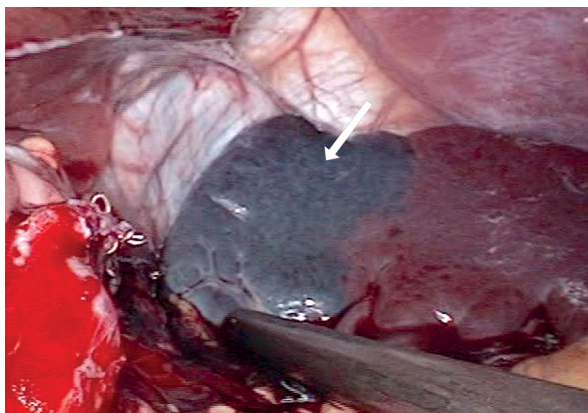
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ted this procedure to be the first stage in treatment of patients with a body mass index (BMI) higher than 60 kg/m<sup>2</sup> [5, 6]. Laparoscopic sleeve gastrectomy was adopted in 2003 as an initial surgical intervention of choice for patients with super morbid obesity (BMI greater than 50 kg/m<sup>2</sup>). The LSG induced rapid body mass loss and distinctly improved the technical capabilities of a final procedure, such as gastric bypass or duodenal switch. Recently, numerous data have supported the treatment of obesity with LSG as a stand-alone and final procedure, because of its good results and permanent effects. Nowadays such a view is supported by numerous health care professionals [7-10].

### Material and methods

The LSG procedure was introduced in the Department of General and Vascular Surgery of Ceynowa Hospital, Wejherowo, Poland in January 2006, after several years of experience with other bariatric and general surgical laparoscopic procedures.

During the observation period between March 2006 when the first splenic infarct was recorded intraoperatively and November 2008, a total of 24 LSG due to morbid obesity were performed after obtaining informed consent. Twenty women and 4 men were enrolled with a mean BMI of 44 kg/m<sup>2</sup>. In 2 patients LSG was performed as the second stage treatment, after failure of laparoscopic gastric banding. All patients received a subcutaneous enoxaparin sodium injection (40 mg) 12 h prior to procedure and intravenous antibiotic prophylaxis with 1.2 g of amoxicillin-clavulanate directly before the procedure.



**Figure 1.** Splenic infarction recognised intraoperatively (arrow points to the infarcted splenic pulp)

All LSG were recorded on a DVD disc for later review. When intraoperative disturbance of the splenic blood supply was noted (Figure 1), an angio-CT was performed the day following surgery (Figure 2). Each patient with radiologically confirmed splenic infarction was empirically given intravenous antibiotic treatment with amoxicillin-clavulanate 1.2 g three times a day for the length of the hospital stay. These patients were also given clinic review appointments, 7 days, 28 days and 3 months after surgery.

### Surgery technique

The procedures were performed with five trocars (three 11 mm and two 5 mm trocars) placed in the epigastric region. After dissection of the omental sac, the greater curvature was freed by section of the gastrocolic ligament very closely to stomach surface, starting 6 cm from the antrum up to the angle of His using a 5 mm harmonic scalpel (Harmonic ACE® Curved Shear Ethicon Endo-Surgery, Inc.). The short gastric vessels were clipped when necessary. Longitudinal gastric resection of the fundus and greater curvature was performed using the linear stapler system (Echelon™60 ENDOPATH® Stapler Ethicon Endo-Surgery, Inc.) Occasional bleeding from the staple line was controlled using single hand-tied sutures. During every procedure the condition of the spleen was assessed twice: firstly when examining the peritoneal cavity at the beginning of the procedure, and secondly after removal of the excised part of the stomach before abdominal closure.



**Figure 2.** CT-angiography scan of splenic infarction (arrow points to the infarcted splenic pulp)

## Results

In the 24 patients treated by the LSG method since March 2008, 4 patients (16.6%), all female (no co-morbidities), were diagnosed with an infarct of the upper splenic pole. All splenic infarcts were diagnosed intraoperatively and then confirmed radiologically using angio-CT. This identified infarction of the upper splenic pole involving 12% to 33% of the total splenic pulp. Analysis of the course of treatment has shown no significant differences between patients with splenic infarct and the group with no complications. Video analysis of all performed procedures excluded the possibility of technical failure. However, this analysis identified that short gastric vessels and dissection of the upper terminal splenic artery branch whilst mobilising the stomach's greater curvature represented likely causative factors of splenic segmental infarction. No major differences could be identified when comparing the group characteristics of splenic infarct patients with those who did not develop complications (Table I).

One of the patients with iatrogenic post-LSG splenic infarction complained of pain in the left hypochondrium which radiated to the left loin, during the first 24 h following the procedure. There were no other complications following LSG in the group of 24 patients. Both on the day of the discharge, and during the routine follow-up appointments until the present time, none of the patients presented symptoms related to splenic infarction, either surgical or infective. To date no deaths have been recorded.

## Discussion

Laparoscopic sleeve gastrectomy provides not only a restrictive mechanism by reducing the intake

of excessive food, but also causes a decrease in ghrelin serum concentration and causes a statistically significant reduction in hunger sensation when compared with other bariatric procedures [4, 11-13].

Laparoscopic sleeve gastrectomy like other similar procedures includes some risk. To date, the following complications of LSG have been described in the available literature [6, 8, 10, 14-18]:

- staple line leakage,
- stricture of the created tube,
- dilatation of the created tube,
- haemorrhage from the short gastric vessels or staple line,
- trocar site bleeding,
- splanchnic vessel thrombosis,
- pulmonary embolism,
- delayed stomach emptying,
- intraperitoneal abscess,
- iatrogenic splenic injury,
- postoperative wound infection,
- postoperative hernia.

The perioperative mortality after LSG is reported at levels of up to 0.6% [14, 15].

When the first splenic infarct during LSG was diagnosed, we conducted a comprehensive literature search using the following search engines, databases and websites: PubMed, the Cochrane Library, EBSCO, ProQuest/Medline, Embase, ScienceDirect, Wiley InterScience, and Medpilot. The key words used were: surgery, laparoscopy, bariatry, obesity, iatrogenic, complication, sleeve resection, sleeve gastrectomy, splenic infarct, laparoscopic sleeve resection, and laparoscopic sleeve gastrectomy, as well as combinations of the above words and MeSH terms. The search did not identify any previous descriptions of splenic infarct as a complication of sleeve gastrectomy. Splenic infarction in bariatric patients has potentially serious consequences. In the absence of case reports in the medical literature, we deemed it necessary to analyse and present the frequency of splenic infarction in our own material.

As mentioned above, to date there have been no reports of post-LSG splenic infarcts. In general, splenic infarct is a rare pathology, described usually as a complication of left upper quadrant abdominal surgery or minimally invasive procedures e.g. colonoscopy, and has been shown to be associated with a heterogeneous group of medical conditions (collated in Table II) [19-26].

**Table I.** Comparison of patient groups

	No complications group	Splenic infarct group
Number	20	4
Mean age [years]	34.80 (20-50)	34.25 (25-46)
Mean surgery time [min]	75.52 (45-95)	47.50 (45-50)
Mean hospitalization time [days]	3.94 (2-6)	3
Mean BMI [kg/m <sup>2</sup> ]	42.68 (30.99-53.63)	42.40 (36.71-53.63)
Prior abdominal surgery	10 (50%)	2 (50%)

The LSG is impeded by the close proximity of the upper part of the stomach body, its fundus and the spleen. The procedure is further complicated by the diverse course of vessels running within the stomach's ligaments, which are dissected during the surgery. The left and right gastric arteries supply the lesser curvature of the stomach. In contrast, the greater curvature of the stomach derives its arterial blood supply from three to six short gastric arteries running through the gastrophrenic ligament and the upper part of the gastrosplenic ligament up to the splenic hilum, also providing blood supply to the upper pole of the spleen. The remaining part of the greater curvature is supplied by anastomosed gastroepiploic arteries known as Hyrtl's arterial arc and their branches, run-

ning in the gastrosplenic and gastrocolic ligaments. The gastroepiploic arteries usually occur about 1-2 cm from the stomach wall. Their course is tortuous and shows high individual variability. In general, there is considerable anastomotic communication between the stomach arteries and the blood supply systems of other organs such as the spleen, oesophagus, adrenals and diaphragm (Figure 3) [27].

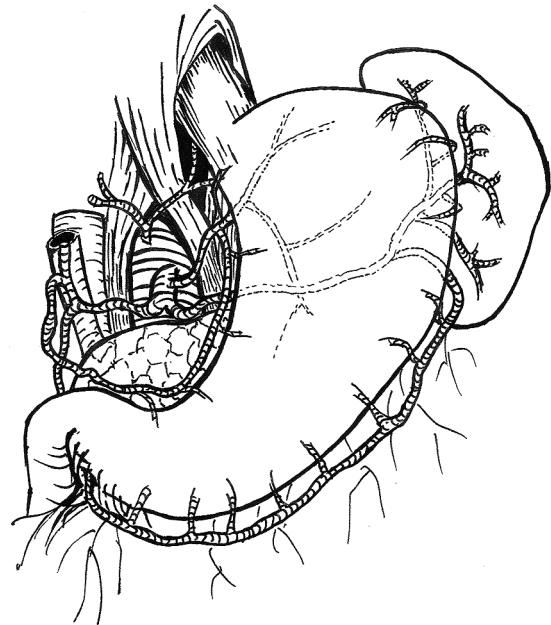
Physiologically, splenic segmental arteries are terminal arteries without any collateral circulation. Therefore, closure of a segmental artery usually leads to infarction of the vascularised splenic segment or splenic pole. The possible anatomical variants of upper splenic pole arterial blood supply are shown in Figure 4 [28, 29].

**Table II.** Causes of splenic infarction

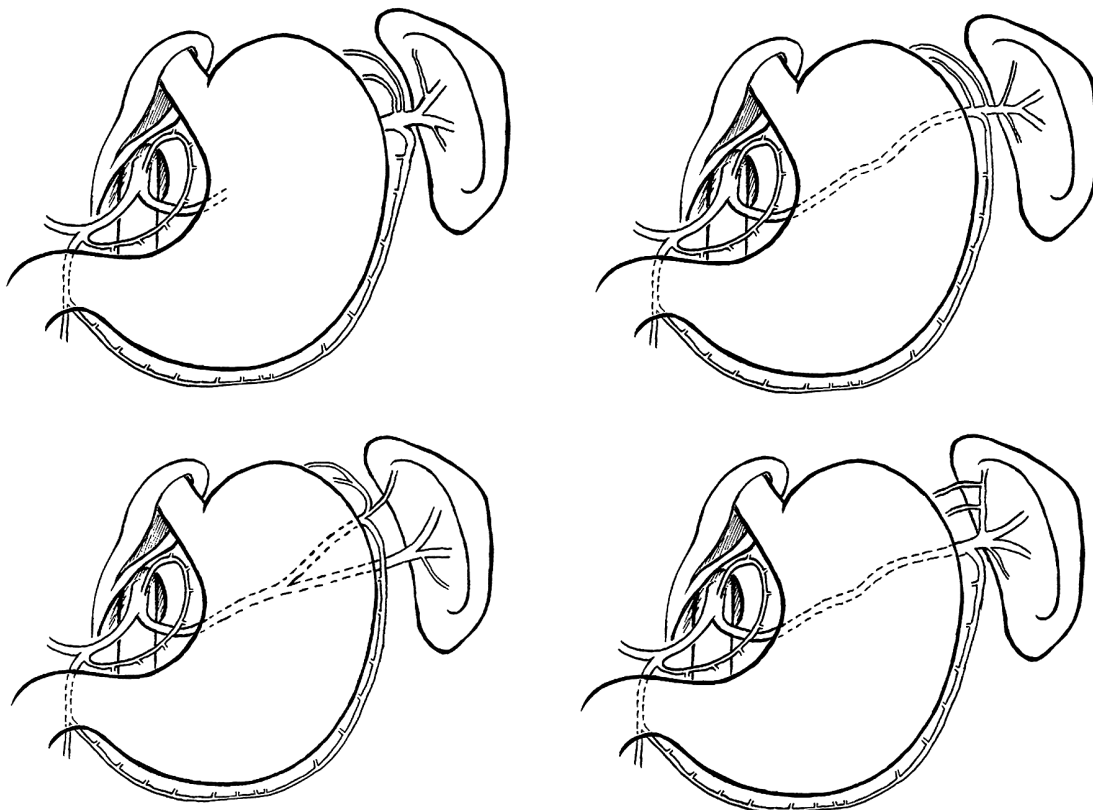
<b>Surgical</b>	Total gastrectomy	<b>Traumatic</b>	Blunt and penetrating abdominal trauma	
	Antrectomy		Chest trauma (especially of the left side)	
	Vagotomy		<b>Cardiac</b>	Endocarditis
	Hemicolectomy			Valvular diseases
	Salpingectomy		<b>Vascular</b>	Superior mesenteric artery or coeliac axis thromboembolism
	Pancreatic resections			Portal vein or splenic vein thrombosis
	Liver transplantation			Cirrhosis with portal hypertension
	Oesophagectomy			Atherosclerosis
	Aortic aneurysms			
<b>Haematological</b>	Leukaemia	<b>Connective tissue diseases</b>	SLE	
	Myelofibrosis		Polyarteritis nodosa	
	Lymphoma	<b>Drugs</b>	Cocaine	
	Sickle cell anaemia		Vasopressin	
	Sickle cell trait		Erythropoietin	
	Haemoglobin SC disease		Clofazimine	
	Polycythemia vera		<b>Others</b>	Sarcoidosis
<b>Infectious</b>	Mononucleosis	Amyloidosis		
	AIDS	Wegener's granulomatosis		
	Malaria	Pancreatitis or pancreatic cancer		
	Disseminated varicella	Gaucher's disease		
	Sepsis			
	Pyelonephritis			

The majority of patients with partial splenic infarcts have an asymptomatic or mildly symptomatic clinical course usually without significant complications and do not typically require surgical treatment. In these cases conservative management of the associated symptoms is usually adequate. Specifically, antibiotics, analgesia, intravenous fluids and anticoagulation may be required depending on the status of the patient. Occasionally there is a need for transfusion of blood products. Sometimes, a splenic infarct undergoes fibrosis of the malperfused segment or leads to complications such as the development of a haematoma, splenic rupture, abscess, or pseudocyst formation [30]. In such cases surgical intervention should be considered. There is an ongoing discussion concerning the advantages and disadvantages of partial and total splenectomy in these patients, but at the present time there is no consensus on the patient management guidelines [31, 32].

Widespread splenic infarctions are associated with potentially serious immunological and haema-



**Figure 3.** Arterial blood supply of stomach and spleen



**Figure 4.** Variants of upper splenic pole arterial blood supply

tological implications. Affected patients require frequent and regular haematological tests in addition to necessary immunisations including meningococcus, pneumococcus and haemophilus influenzae vaccinations with prolonged prophylactic antibiotic treatment [31-33].

In the presented cases only one or two upper pole splenic segments were observed to be affected. Only minor complications such as nausea, vomiting and left epigastric pain were encountered by two patients during the first postoperative day and no subsequent late complications were observed. All affected patients received antibiotic prophylaxis during the perioperative period, though there were no other specific alterations to their medical treatment. The patients in this study who encountered splenic infarction during LSG did not develop sufficiently widespread damage to require splenectomy or further operative intervention. The only extra measure taken in this group was the use of angio-CT to investigate the extent of splenic infarction. All patients were assigned to regular outpatient follow-up to monitor their clinical status and introduce appropriate treatment if required. We decided not to immunise our patients as the infarcts they developed were relatively small, with the largest accounting for 33% of the total splenic pulp.

In Poland, there are only a few bariatric centres, so some of the patients are hospitalised longer for social reasons (to ensure full recovery before long travel back home). That explains the situation of longer hospitalization periods in some of the patients with no complications.

## Conclusions

Based on the observations we conclude that splenic infarction is an under-reported and frequent complication of laparoscopic sleeve gastrectomy as well as many other laparoscopic procedures. We observed that splenic infarction occurred in 16.6% of these procedures performed at a longstanding laparoscopic surgical centre. We believe that the presence of splenic infarction in obese subjects is under-diagnosed due to the spleen's location (usually behind the stomach, covered with intra-abdominal fat) and lack of guidelines on detailed inspection of the abdominal cavity after the procedure with little emphasis currently being placed on the status of the spleen.

Retrospective analysis of video recordings of the relevant LSG ruled out technical errors as the cause of splenic infarction. However, this analysis identified that short gastric vessels and dissection of the upper terminal splenic artery branch whilst mobilising the stomach's greater curvature represented likely causative factors.

The collective experience at the centre led us to create a rule of detailed abdominal cavity inspection with special emphasis on the spleen at the beginning and at the end of every procedure as well as a local protocol for patients with intraoperatively recognised splenic upper pole infarction which comprises:

- angio-CT scan the day following the procedure to assess the extent of splenic pulp damage and at 3 months if symptomatic,
- low molecular weight heparin in thrombo-prophylactic doses,
- if asymptomatic – regular discharge,
- review and follow-up on the 7<sup>th</sup> and 28<sup>th</sup> day and the 3<sup>rd</sup> month after surgery,
- no splenectomy and no related immunization in cases of infarct < 33% of total splenic pulp.

Further evaluation of the above protocol on a larger group of patients is currently underway. We hope that other centres will share their experience in this matter to enable coprocedure on improving the outcomes and safety of laparoscopic sleeve gastrectomy as one of the few effective treatments for morbid and super morbid obesity.

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