

# Portomesenteric vein thrombosis after laparoscopic sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass: a 36-case series

Mustapha A. el Lakis<sup>1</sup>  · Agostino Pozzi<sup>2</sup> · Jad Chamieh<sup>3</sup> · Bassem Safadi<sup>4</sup>

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## Abstract

**Background** Portomesenteric vein thrombosis following laparoscopic bariatric surgical procedures is a serious and potentially lethal complication. It is quite rare, and its clinical presentation, management, and sequelae remain poorly understood.

**Methods** We searched PubMed, Medline, Google Scholar, Ovid, and Cochrane databases for articles reporting case series and systematic reviews in the English language on patients who underwent laparoscopic bariatric surgery and had a subsequent portal or mesenteric vein thrombosis. Articles discussing laparoscopic gastric banding were excluded.

**Results** A total of 14 articles reporting on 36 cases were found. We analyzed the pooled data from these case reports and series with emphasis on number of reported patients, demographics, time of diagnosis, risk factors, symptoms, management, complications, and sequelae.

**Conclusions** Portomesenteric vein thrombosis is not uncommon following laparoscopic bariatric surgery and appears to occur more after laparoscopic sleeve gastrectomy. Bariatric surgeons should have a high index of

suspicion for early detection and treatment of this potentially lethal complication. Obese patients at high risk for venous thrombosis should be screened for genetic predisposition for hypercoagulable state and should be considered for extended thromboprophylaxis postoperatively.

**Keywords** Bariatric surgery · Portal vein thrombosis · Mesenteric vein thrombosis · Laparoscopy

Bariatric surgery has been the mainstay in managing morbid obesity [1] and has gained acceptance and popularity as evidenced by a substantial increase in the numbers of laparoscopic sleeve gastrectomy (LSG) and laparoscopic Roux-en-Y gastric bypass (LRYGB) performed. They proved to significantly help patients lose weight and improve obesity-related comorbidities, quality of life, and survival [2, 3]. Moreover, they showed a sustained good long-term weight loss with the mean excess weight loss of more than 70 % at 7-year follow-up [4].

Despite these optimistic outcomes, 10–40 % of bariatric surgeries develop complications that would invariably impact patients' outcomes, disposition, and well-being [5, 6].

Portal vein thrombosis (PVT) refers to a partial or complete obstruction of the portal vein. The thrombus can extend to the portal branches, the splenic veins, and/or the mesenteric veins. It has varying clinical manifestations depending on the degree, site, and extension of the obstruction. Portomesenteric vein thrombosis (PMVT) is a relatively rare condition in patients with a previously healthy liver. It has been described as a complication of laparoscopic procedures in general [7]. PMVT in LRYGB was first reported in 2004 and in LSG in 2009 [8]. Since then, PMVT is being increasingly recognized due to its

✉ Mustapha A. el Lakis  
moustapha\_lakis@hotmail.com

<sup>1</sup> Department of General and Thoracic Surgery, Virginia Mason Medical Center, 1100 Ninth Ave. C6-SUR, Seattle, WA, USA

<sup>2</sup> Department of General Surgery, San Raffaele Hospital, Vita-Salute San Raffaele University, Milan, Italy

<sup>3</sup> Department of Surgery, Washington University in Saint Louis, Saint Louis, MO, USA

<sup>4</sup> Department of Surgery, American University of Beirut Medical Center, Beirut, Lebanon

higher index of suspicion by surgeons; it is a complication that can have various clinical presentations ranging from asymptomatic to bowel infarction and necrosis. Theories attempting to explain this complication have been proposed, such as venous stasis from increased intra-abdominal pressure [9], intra-operative manipulation of splanchnic vasculature [10], and systemic hypercoagulable states [11]. This review attempts to report all cases in the literature along with the symptomatology, diagnosis, and suggested management of PMVT after LSG or LRYGB.

## Methods

We searched PubMed, Medline, Google Scholar, Ovid, and Cochrane databases for the following keywords: portal vein thrombosis, mesenteric vein thrombosis, laparoscopic sleeve gastrectomy, laparoscopic Roux-en-Y Gastric Bypass, laparoscopy, and bariatric surgery. We included English articles reporting case reports and series on all patients who underwent laparoscopic bariatric surgery and had a subsequent portal or mesenteric vein thrombosis. Articles discussing laparoscopic gastric banding were excluded. The search was performed by two investigators independently. The references of the articles were also screened for additional literature to be considered if they fit the inclusion criteria. The search yielded 14 papers (Table 1). We pooled data from these articles, emphasizing the number of patients, age, gender, BMI, comorbidities, timing of diagnosis, thrombophilia status, diagnosis modalities, and management.

## Results

A total of 36 patients with bariatric surgery-related PMVT were identified. Thirty underwent LSG and 6 underwent LRYGB. Their median age was 41.5 years (range 14–58), and their mean BMI was  $40.7 \pm 8.3 \text{ kg/m}^2$ . Patients' demographics were incomplete in 3 cases. Of the remaining 33 cases, 42 % demonstrated insulin resistance or type 2 diabetes mellitus, 30 % were hypertensive, and 33.3 % had dyslipidemia. Venous insufficiency was present in 9 % of patients and polycystic ovary syndrome (PCOS) in 14 % of the females. Modifiable risk factors and other demographics are reported in Table 2. All patients presented with acute symptoms within 1–42 days after the initial surgery except for one case that was diagnosed a year later incidentally on an abdominal CT scan.

Clinical presentations were as follows: abdominal pain in 26 patients, nausea in 13, back pain in 4, bloating in 2, malaise in 2, and diarrhea in 1 patient. One patient was asymptomatic. Five patients presented with signs of

peritoneal compromise at physical examination and underwent exploratory laparotomy. Three were successfully treated with segmental resection, while one died from sepsis, and the fifth had extensive necrosis of small bowel, duodenum, and pancreas for which he underwent total small bowel resection and succumbed 80 days later.

Patients were tested for inflammatory biomarkers, liver, and pancreatic function tests. Only one patient demonstrated slightly elevated liver enzymes. All cases were diagnosed with an abdominal/pelvic CT scan with oral and intravenous contrast identifying a portomesenteric thrombosis of variable extension. In 22 cases, thrombosis of the main, right, or left portal vein was identified; 23 patients presented with thrombosis of the superior mesenteric vein and 16 with a concomitant thrombosis of the splenic vein.

Management consisted of hospitalization, electrolyte replacement, bowel rest, and anticoagulant treatment with intravenous unfractionated heparin in 32 patients and low molecular weight heparin (LMWH) in 4. Patients were subsequently discharged on warfarin, acenocoumarol, or coumadin.

Studies for thrombophilia were documented in 28 patients with positive findings in 8. Two patients had a prothrombin gene mutation G20210A with protein C/S deficiency, and the others had one of the following: protein C deficiency, prothrombin gene mutation G20210A, protein S deficiency, protein C and S deficiency, or heterozygosity for factor 2 Leiden.

Twenty-two patients were followed up with imaging studies demonstrating the following: 8 had portal cavernomatosis, 4 had portal cavernomatosis with portal hypertension signs, and 2 had partial recanalization.

## Discussion

### Incidence

Portomesenteric vein thrombosis is recognized as a rare but potentially severe complication due to its high risk for bowel ischemia. It has been reported in different laparoscopic surgeries such as cholecystectomy, right hemicolectomy, fundoplication, splenectomy, and laparoscopic bariatric procedures [10]. Salinas et al. reported an incidence of 1 % in a retrospective analysis of 1713 laparoscopic sleeve gastrectomies [12]. His reported incidence is a relatively high figure compared to other common serious complication rates such as staple line leak (1.4–1.06 %) [13, 14], hemoperitoneum requiring intervention (0.6–1.3 %) [15, 16], pulmonary embolism (0.18–0.3 %), and deep venous thrombosis (0.20–0.47 %) [15, 17], among others occurring in LRYGB and LSG, respectively. On the other hand, other large series on bariatric surgery

**Table 1** English language articles of portomesenteric thrombosis in laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass

References	Procedure	Thrombosis location				Days after surgery	Treatment	CT findings on F/up
		PVT	MVT	SVT	Thrombophilia			
Bellanger et al. [31]	LSG	0	1	0	0	25	IV Heparin + bowel rest	–
	LSG	1	0	1	0	14	IV Heparin + bowel rest	–
	LSG	1	1	1	0	13	IV Heparin + bowel rest	–
Berthet et al. [8]	LSG	1	1	1	1	14	IV Heparin + bowel rest	Portal cavernomatosis
Denne and Kowalsky [32]	LRYGB	1	0	1	0	22	LMWH + bowel rest	Portal cavernomatosis
Franco et al. [33]	LSG	1	0	0	–	14	IV Heparin + bowel rest	Portal cavernomatosis and portal HTN
	LRYGB	1	0	0	–	7	Bowel resection + IV Heparin	–
	LSG	1	0	0	–	14	IV Heparin + bowel rest	Recanalized
Gandhi et al. [34]	LSG	0	1	0	0	8	IV Heparin + bowel rest	–
Hughes et al. [35]	LSG	1	1	0	–	17	Bowel resection + Heparin	–
Keung et al. [36] <sup>a</sup>	LSG	0	1	1	–	12	Bowel resection + Heparin	–
Lopez and Flint [37]	LSG	1	1	1	0	42	LMWH + bowel rest	Recanalized
Pigeyre et al. [38]	LRYGB	1	1	0	0	14	LMWH + bowel rest	Recanalized
Pineda et al. [39]	LSG	0	1	0	0	30	LMWH + bowel rest	–
Rosenberg et al. [40]	LSG	1	0	0	–	10	IV Heparin + bowel rest	–
Salinas et al. [12]	LSG	1	0	1	1	15	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	1	9	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	0	21	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	1	1	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	0	10	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	0	11	IV Heparin + bowel rest	Portal cavernomatosis
	LSG	1	0	1	1	6	IV Heparin + bowel rest	Portal cavernomatosis and Portal HTN
	LSG	1	1	1	0	415	IV Heparin + bowel rest	Portal cavernomatosis and portal HTN
	LSG	1	1	1	0	17	IV Heparin + bowel rest	Portal cavernomatosis and portal HTN
	LSG	1	1	0	0	12	IV Heparin + bowel rest	Recanalized
	LSG	1	1	0	1	4	IV Heparin + bowel rest	Recanalized
	LSG	0	1	0	0	2	IV Heparin + bowel rest	Recanalized

**Table 1** continued

References	Procedure	Thrombosis location				Days after surgery	Treatment	CT findings on F/up
		PVT	MVT	SVT	Thrombophilia			
	LSG	0	1	0	0	14	IV Heparin + bowel rest	Recanalized
	LSG	0	1	0	0	4	IV Heparin + bowel rest	Recanalized
	LSG	0	1	0	0	1	IV Heparin + bowel rest	Recanalized
	LSG	0	1	0	1	1	IV Heparin + bowel rest	Partial recanalization
	LSG	0	1	0	1	11	IV Heparin + bowel rest	Partial recanalization
Singh et al. [41]	LSG	0	1	1	0	21	IV Heparin + bowel rest	–
Swartz et al. [42] <sup>b</sup>	LRYGB	0	1	0	–	9	Bowel resection + IV Heparin	–
	LRYGB	0	1	0	–	18	Bowel resection + IV Heparin	–
	LRYGB	0	1	0	0	8	IV Heparin + bowel rest	–
Total		22	23	16	8			

LSG Laparoscopic sleeve gastrectomy, LRYGB laparoscopic Roux-en-Y gastric bypass, PVT portal vein thrombosis, MVT mesenteric vein thrombosis, SVT splenic vein thrombosis

<sup>a</sup> Died from extensive necrosis and sepsis

<sup>b</sup> Died from sepsis

complications did not report portomesenteric vein thrombosis [15]. This inconsistency draws attention on the possibility that PMVT might be under or misdiagnosed, especially in minimally symptomatic patients.

### Risk factors

Different factors, patient- and procedure-related, might contribute to the development of secondary PMVT. The mechanism by which pneumoperitoneum increases the risk of thrombosis is unclear. It has been suggested that the increase in the intra-abdominal pressure during laparoscopic procedures might result in the reduction in the splanchnic and portal venous blood flow which could potentially promote venous thrombosis. This theory was supported by a decrease in portal venous blood flow at an intraperitoneal pressure as low as 10 mmHg [18]. This was also suggested in a porcine model by an inverse relationship between intra-abdominal pressure and portal venous flow [19]. Additional laparoscopy-related factors might include sympathetic vasoconstriction induced by hypercarbia [20] and intra-operative release of vasopressin. Other factors thought to favor venous thrombosis in sleeve gastrectomy include mobilization and skeletonization of

the greater curvature of the stomach and reverse-Trendelenburg position.

The majority of reported cases of PMVT followed LSG and not LRYGB, which suggests that this complication may be procedure specific. There is clearly more thermal injury to vessels during LSG as all the vessels along the greater curvature of the stomach and the short gastric vessels are sealed with energy devices. That injury may extend to the gastroepiploic veins or to the splenic vein inducing clot formation and propagation into the splenic, superior mesenteric, and/or portal veins. The vessel sealing is more limited in LRYGB. Another potential difference between LSG and LRYGB is the level of hydration in the early postoperative period. We have seen in our clinical experience that patients who undergo LSG versus LRYGB are more likely to develop dehydration and have a more difficult time-consuming liquids. This state of dehydration may predispose LSG patient to PMVT.

The etiology of this complication after bariatric surgery is multifactorial. Patient-related risk factors that might increase the likelihood of thrombosis include smoking, morbid obesity, thrombophilia, birth control pills, and hormone replacement therapy. In the reported cases, the female/male ratio was 31:5 (86 %). This might be

**Table 2** Patients' demographics

<i>Demographics</i>	
Median age ( <i>n</i> , range)	41.5 (14–58)
Female/male	31/5
Mean BMI ( <i>n</i> , SD)	40.7 ± 8.3
Alcohol consumption	8/18
History of smoking	10/20
Use of oral contraceptives	8/23
<i>Comorbidities</i>	
Insulin resistance/T2DM	14/33 (42 %)
HTN	10/33 (30 %)
PCOS	4/29 (14 %)
Venous insufficiency	3/33 (9 %)
Dyslipidemia	11/33 (33 %)
Thrombophilia	7/28
<i>Surgery</i>	
LSG	30
LRYGB	6
Diagnosis median time after surgery (range)	12.5 (1 day–6 years)
<i>Symptoms</i>	
Abdominal pain	26/36
Nausea vomiting	13/36
<i>Type of thrombosis</i>	
Portal vein thrombosis	22/36
Superior mesenteric vein thrombosis	23/36
Splenic vein thrombosis	16/36

*SD* Standard deviation, *T2DM* type 2 diabetes mellitus, *HTN* hypertension, *PCOS* polycystic ovarian syndrome, *LSG* laparoscopic sleeve gastrectomy, *LRYGB* laparoscopic Roux-en-Y gastric bypass

explained by the fact that 80 % of patients undergoing bariatric surgery are female, despite equal rates of obesity among men and women [21]. In addition, female gender might be a confounding factor as 8 women out of 23 reported use of oral contraceptives. Moreover, all 7 patients with thrombophilia were female.

### Symptoms

PMVT manifests either in an indolent manner and ultimately benign consequence, or acutely with more serious sequelae, even death. In the acute setting, the median time of presentation in this series was 13 days with a range of 1–42 days after the surgery. Symptoms, if present, are usually non-specific and range from non-specific such as abdominal pain, nausea, or vomiting to severe such as peritoneal irritation, bloody diarrhea, bloating, fever, or back pain. Patients usually present 48 h after symptoms have started. Severity depends on the location and degree of obstruction; in partial portal vein thrombosis, overt symptoms are rare or absent. On the other hand, if the superior mesenteric vein is involved, symptoms manifest as

more severe colicky abdominal pain and diarrhea that persists beyond 5 days. When the thrombus extends to the proximal mesenteric venous arcades, severe abdominal pain often radiating to the back and ileus due to intestinal ischemia ensue. Signs highly suggestive of intestinal infarction include hematochezia, ascites, metabolic acidosis, and multi-organ failure.

### Diagnosis

Acute PMVT ranks low on the differential in bariatric patients as it is considered a rare event. However, as mentioned above, its incidence is comparable or greater than other serious complications. Various methods in diagnosing this condition are present and include the following imaging modalities: computed tomographic (CT) scan, magnetic resonance imaging (MRI), Doppler ultrasonography (US), and portal venography. A contrast-enhanced abdominal CT scan is favored over a Doppler US for its higher sensitivity up to 90 % [22, 23]. In addition to confirming the diagnosis, a CT scan aids in ruling out other conditions, evaluates the bowels for signs of infarction, and assesses the extent of the thrombosis. MRI is an alternative in patients who cannot undergo CT scan. Abdominal ultrasonography with Doppler is not sensitive for determining the extent of the thrombosis and may not detect ischemia; however, it is an alternative when CT and MRI are contraindicated or not feasible. A diagnosis of PMVT can be made with portal venography or superior mesenteric angiography; however, angiography is invasive and is generally not indicated [24].

### Coagulation profile

Patients with acute PMVT should also undergo additional evaluation to identify conditions that predispose to thrombus formation. Factor V Leiden mutation, prothrombin G20210A mutation, protein S deficiency, protein C deficiency, antithrombin-III deficiency, activated protein C resistance, antiphospholipid syndrome, and JAK-2 V617F mutation have been linked to splanchnic vein thrombosis [25, 26]. Eight out of 28 examined for acquired genetic predisposition in our series demonstrated at least one of the conditions mentioned above. Nonetheless, the role of protein C and protein S deficiency remains unclear since serum levels might be altered by liver injury in acute portal/mesenteric vein thrombosis [27]. This has an important bearing on the timing of the evaluation of a coagulation disorder. Investigations for genetic mutations can be performed soon after the diagnosis of acute PMVT, whereas other tests such as protein C and S deficiency should be performed at a certain interval after the thrombotic event. In addition to the genetic testing, other

laboratory tests are warranted such as liver enzymes, bilirubin, and liver function tests namely albumin and prothrombin time.

## Management

Once the diagnosis of acute portal or mesenteric vein thrombosis is established, treatment with immediate anticoagulation should be initiated with a bolus of 5000 IU of unfractionated heparin intravenously followed by continuous infusion titrated to an activated partial prothromboplastin time twice the normal. In this series, all patients received anticoagulant treatment: unfractionated heparin in 32 cases and LMWH in 4. Five patients additionally required exploratory laparotomy for peritoneal signs or CT findings in favor of ischemia.

At least 6 months of anticoagulation is recommended in the absence of ongoing thrombotic disorder. For patients with permanent thrombotic risk factors not correctable otherwise, lifelong anticoagulation is advised [28, 29]. Timing and duration of follow-up is not agreed upon but is usually recommended for at least 6–12 months [10].

## Sequelae

Long-term sequelae of mesenteric and portal vein thrombosis define a heterogeneous group of clinical presentations depending on the site, extent, chronicity, and the course of thromboses. In our case series, among the 23 patients for whom follow-up information was reported, 8 developed cavernomatosis, 4 manifested portal hypertension along with cavernomatosis, 9 showed a resolution with total recanalization, and 2 had partial recanalization. The majority of late complications of PVT are related to portal hypertension and portal cavernoma which is the most common late complication in our series. The portal cavernomatosis is a sequelae of portal vein thrombosis and is the replacement of the normal single channel portal vein with numerous tortuous venous channels. It often results in an extrahepatic portal hypertension which sometimes manifest with ascites, gastrointestinal bleeding, and other symptoms [30].

## Conclusions

Portomesenteric vein thrombosis is not uncommon following laparoscopic bariatric surgery and appears to occur more after laparoscopic sleeve gastrectomy. Although most cases were successfully treated, serious fatal complications still ensued, likely due to the timing of diagnosis. Bariatric surgeons should have a high index of suspicion for early

detection and treatment of this potentially lethal complication. Obese patients at high risk for venous thrombosis should be screened for genetic predisposition for hypercoagulable state and should be considered for extended thromboprophylaxis postoperatively.

## Compliance with ethical standards

**Disclosures** Mustapha A. el Lakis, Agostino Pozzi, Jad Chamieh, and Bassem Safadi have no conflicts of interest or financial ties to disclose.

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