Laparoscopic Vertical Sleeve Gastrectomy

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KEYWORDS

• Sleeve • Gastrectomy • Background • Evidence • Technique • Pearls • Pitfalls

KEY POINTS

- Vertical sleeve gastrectomy is a simple, safe, and effective surgical option for obesity.
- Risk of GERD, portal vein thrombosis, strictures, leak, and bleeding are specific considerations in VSG.
- There are key preoperative, perioperative, and postoperative aspects to VSG that every surgeon must know.

OBESITY AND SURGERY

Bariatric surgery has emerged as the most effective means of achieving weight loss, and all of its associated health benefits.[1] According to an obesity expert panel from the American College of Cardiology and American Heart Association, intensive lifestyle changes, such as a reduced-calorie diet, increased physical activity, and behavior therapy, led to an average weight loss of 8 kg at 1 year, whereas commercial-based lifestyle interventions averaged 6.6 to 10 kg at 1 year. Only 35% to 60% of the people who underwent such lifestyle changes maintained a weight loss of greater than 5% of their initial weight at 2 years.[2] Bariatric surgery produces more medically significant and long-lasting weight loss.[1,3,4]

Today, the most commonly performed primary bariatric surgery in the United States is the laparoscopic vertical sleeve gastrectomy (VSG), which accounted for 61.4% of bariatric surgeries in 2018. This number was up from 17.8% in 2011. The second most commonly performed surgery is the laparoscopic Roux-en-Y gastric bypass (RYGB), which accounted for 17% of surgeries in 2018, down from 36.7% in 2011.[5] Other surgical options include the duodenal switch, single anastomosis duodenoileal bypass (SADI), gastric band, gastric balloon, and multiple endoluminal procedures.[1,2,6]

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LAPAROSCOPIC VERTICAL SLEEVE GASTRECTOMY

VSG was initially part of the biliopancreatic diversion with duodenal switch procedure that Douglas Hess devised in 1988.[7] It was not until 11 years later that De Csepel and coworkers[8] performed the duodenal switch laparoscopically. Unfortunately, the laparoscopic duodenal switch was associated with significant complications, especially in patients with high body mass index.[9,10] Thus, Gagner chose to perform a staged duodenal switch, with the VSG being the first step of the procedure. His modification was met with good results, resulting in a 33% average excess body weight loss from this first stage alone. These findings, coupled with promising findings from the Magenstrasse and Mill operation (the decreasing of gastric volume without resection),[11] demonstrated that sleeve gastrectomies may be a viable option as a stand-alone bariatric procedure.[12] In 2012, the American Society for Metabolic and Bariatric Surgery (ASMBS) published a position statement that recognized VSG as an acceptable primary bariatric procedure.[3]

Mechanism of Action

Removing 70% to 80% of the stomach in VSG decreases gastric capacity and caloric intake, making satiety easier to achieve.[13] This restrictive mechanism was initially thought to be the only mechanism of action for VSG. However, emerging literature has shown that the procedure also has several hormonal effects. Decreased ghrelin production from removal of the fundus is one such hormonal reaction implicated with weight loss.[4,14,15] Ghrelin has been found to increase hunger via action on the hypothalamus,[13] and it has also been implicated in the inhibition of insulin.[16–18] VSG is also believed to affect glucagon-like-peptide-1 production. This hormone has antiorexigenic effects and delays gastric emptying.[19,20] VSG has been found to increase the expression of glucagon-like-peptide-1 in the jejunum and ileum.[21,22] Additionally, peptide YY and pancreatic polypeptide are exaggerated after sleeve gastrectomies, leading to decreased hunger and food intake (**Fig. 1**).[23–28]

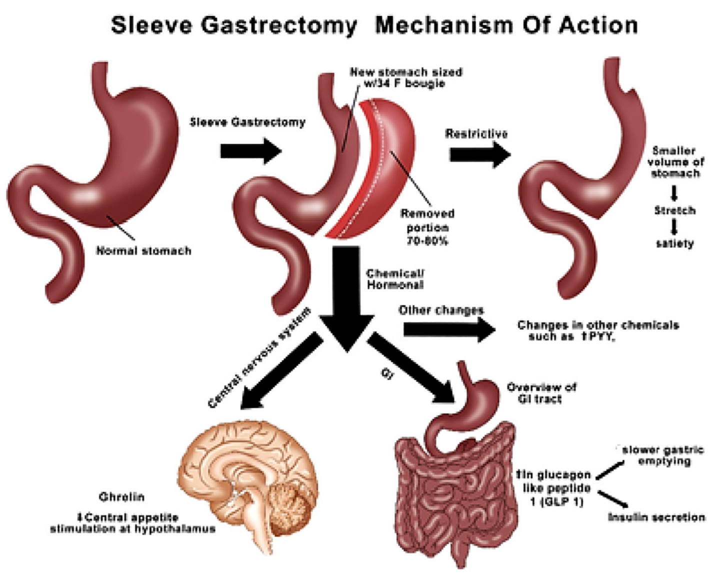

Fig. 1. Overview of VSG mechanisms of action. GI, gastrointestinal.

Weight Loss After Surgery

VSG leads to an average excess body weight loss of about 60% at 5 years and beyond, showing effectiveness and sustainability.[10–12] These same studies have demonstrated that VSG and RYGB have similar weight loss at 1, 4, and 5 years.

Comorbidities

Bariatric surgery is associated with a 19.5% risk difference (that is the relative risk difference between surgical therapy and medical management alone) for hypertension remission. The risk difference for diabetes remission was measured at 42.7%.[29] With specific regards to diabetes, the STAMPEDE trial by Schauer and colleagues[30] showed that the primary end goal of hemoglobulin A_{1c} of less than 6.0 was achieved in only 5% of patients undergoing medical therapy. Twenty-three percent of patients undergoing RYGB and 19% of those undergoing VSG reached this same end point. Several other well-designed, large retrospective studies (which combined looked at thousands of bariatric surgery patients) further support bariatric surgery's positive effects on comorbidities to a significant degree. These findings were reproduced for dyslipidemias, renal function, arthralgia, obstructive sleep apnea, hyperuricemia, depression, and quality-of-life scores.[31–33]

Vertical Sleeve Gastrectomy Versus Roux-en-Y Gastric Bypass

The benefits of VSG have been well-established in the literature. VSG is much simpler relative to an RYGB from a technical aspect, has decreased operative time, and is associated with significantly fewer major complications within 30 days of surgery.[34] A look at the National Surgical Quality Improvement Program data shows that mean operative times (101 vs 131 minutes; $P<.01$), blood loss requiring transfusion (0.6% vs 1.5%; $P = .05$), serious morbidity rate (3.8% vs 5.8%; $P<.01$), and 30-day reoperation rate (1.6% vs 2.5%; $P<.01$) were all significantly lower in VSG than in RYGB.[35] The overall mortality associated with VSG ranged from 0% to 1.2%.[35]

A meta-analysis of long-term and midterm outcomes published in 2017 looked at 14 studies with more than 5000 patients and showed no statistical difference between a VSG and RYGB with regards to resolution of type 2 diabetes, hypertension, hyperlipidemia, and hypertriglyceridemia.[36]

Risks Associated with Vertical Sleeve Gastrectomy

Increased gastroesophageal reflux

The rate of gastroesophageal reflux disease (GERD) development and degree of postoperative severity in the VSG setting is difficult to quantify. The rate of de novo GERD ranged from 7.4% to 26.7%.[37,38] The exact degree of clinical significance varied, with some studies showing that most resolved with proton pump inhibitors alone.[33] Although some studies showed resolution of preexisting GERD symptoms with VSG in up to 15.9% to 64.7% of patients,[38,39] other patients demonstrated worsening symptoms and the need for revisional surgery given the severity of reflux.[40] Thus, it may be prudent to be more liberal in using preoperative manometry, especially if underlying esophageal dysfunction is a concern.

The ASMBS put out a position statement asserting that severe GERD symptoms and Barrett esophagus are relative contraindications to VSG.[3] As always, surgeons should thoroughly evaluate their own comfort with and ability to perform the procedure, and discuss the overall risks and benefits with the patient.

Portal vein thrombosis

Portal vein thrombosis is a known complication linked to laparoscopic VSG that is associated with mortality of 40%.[41] A study that looked at 5706 bariatric surgery patients found that 17 patients (0.29%) developed portal vein thrombosis. Sixteen of these 17 patients had undergone VSG.[42] Another retrospective study that looked at 5951 patients who underwent VSG demonstrated that 18 patients (0.3%) developed portal vein thrombosis.[43] Portal vein thrombosis is typically diagnosed with a computed tomography scan, and it is generally treated with anticoagulation.[41,43] However, the condition can also result in intra-abdominal catastrophe, requiring emergent laparotomy and bowel resection.

The exact action mechanism is complex, but it is attributed to a multitude of factors. The patient's baseline hypercoagulable state given their obesity, and endothelial injury with recent surgery (two of the three elements of Virchow triad) are contributing factors. Other proposed factors include CO_2 insufflation and anesthetics increasing intra-abdominal pressure, causing hemodynamic changes (specifically, decreased splanchnic and portal venous flow). Thermal effects during energy dissection of the gastroepiploic arcade possibly also contribute to this disease process.[44]

Weight regain

Weight regain can occur in all postoperative bariatric patients, including VSG patients. Five important factors identified in weight regain include

1. Nutritional noncompliance[45,46]
2. Hormonal/metabolic imbalance[45,47,48]
3. Mental health[45,47,49]
4. Physical inactivity[45,47,49]
5. Anatomic/surgical factors[45]

A study published in 2016 showed that removal of less than 500 mL of stomach is a predictor of treatment failure/early weight regain.[45] The size of the bougie used, incomplete resection of the fundus, and dilatation of the antrum are also surgical factors associated with weight regain after surgery.[45] Adequate follow-up after surgery, nutrition, and psychiatry, coupled with appropriate surgical technique, could help mitigate all of the previously mentioned factors.[47]

Leak

A systematic analysis of 4888 patients showed that the leak rate associated with VSG was 2.4%.[50] A meta-analysis looking at 40,653 VSG patients identified an overall leak rate of 1.5%,[51] with their reviewed papers citing a leak rate of 0.7% to 2.7%.

Expert opinion from the international VSG consensus conference in 2011 indicated that 77% of surgeons deemed buttressing as an acceptable adjunct[52]; however, the overall utility of buttressing for the specific purpose of decreasing leak rate is still under debate. Typical reinforcement adjuncts used include oversewing, nonabsorbable bovine pericardial strips, tissue sealant, and absorbable polymer membrane. A meta-analysis of 40,653 patients found that, of these adjuncts, the lowest leak rate occurred with absorbable polymer membrane (0.7%; $P<.007$).[51]

Bleeding

A meta-analysis published in 2015 looked at 41,864 postoperative gastrointestinal surgery patients for bleeding complications and identified a bleeding risk of 1.28% (bovine pericardium reinforcement) to 3.45% (no staple line reinforcement).[53] A separate study reviewed 98,142 patients and found that 623 of them had a postop hemorrhage (0.63%) with 181 needing reoperation (0.18%).[54] In this same paper, oversewing, or buttressing the staple line, was found to decrease the rate of postoperative hemorrhage by up to 30%. Risk factors associated with increased rates of hemorrhage were inexperience in bariatric surgery (odds ratio, 2.85) and lack of staple line reinforcement (odds ratio, 3.34). Decreased risk rates were identified in patients without obstructive sleep apnea (odds ratio, 0.22) and lack of hypertension (0.38).[55]

Stricture

Stricture rates ranged from 0% clinical stenosis[56] to 3.5%.[57] Stenosis is anatomic, via inflammation or aggressive surgical narrowing; or functional, via technique error (gastric twisting or incorrect angulation).[58] Management options for stenosis include endoscopic balloon dilation, stenting, and conversion to RYGB, depending on the cause.[56–58]

CONDUCT OF THE OPERATION (PREOPERATIVE, OPERATION, AND POSTOPERATIVE)

Preoperative and Postoperative Considerations

In 2016, ASMBS developed a comprehensive care pathway for laparoscopic sleeve gastrectomy.[59] Their routine recommendations are summarized in **Fig. 2**. Of note, other select considerations may be important based on specific patient factors.

Operative

Although many techniques have been described, we describe the technique used at our institution. The patient is positioned in the supine, arms-out position. Padding is

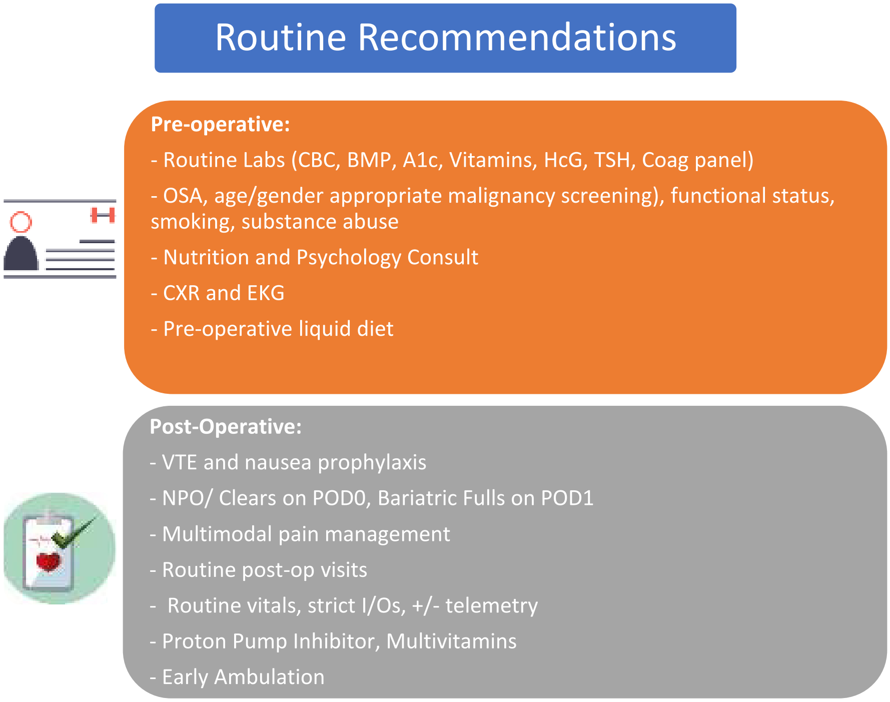

Fig. 2. ASMBS routine recommendations in the preoperative and postoperative setting. CBC, complete blood count; CXR, chest radiograph; EKG, electrocardiogram; NPO, nil per os; POD, postoperative day; TSH, thyroid-stimulating hormone; VTE, venous thromboembolism; BMP, basic metabolic panel; HcG, Human chorionic gonadotropin; OSA, Obstructive Sleep Apnea.

placed over all pressure points and areas where nerve entrapment can occur (axilla, elbows, lateral knee). The patient is given antibiotic and deep venous thrombosis chemoprophylaxis before incision. Sequential Compression Devices (SCDs) are also placed before induction. Our typical trocar placement is presented in **Fig. 3**.

The liver is usually retracted, although that is not a necessity. This retraction is accomplished via a Nathanson retractor; a fan; a paddle; or through more novel means, such as magnets and suture. The patient is then placed in reverse Trendelenburg position. A suction bougie, measuring at least 34F catheter, is placed. This size is important, because smaller bougies, although with higher theoretic percent of removed stomach, have been associated with higher leak rates.[50,60–62]

The pylorus is then identified by pinpointing an area of muscular thickening in the distal stomach or by visualizing the prepyloric vein of Mayo (**Fig. 4**). An area 2 to 6 cm proximal to the pylorus is identified, so as to allow for proper gastric emptying and to avoid stenosis. The lesser sac is entered by dividing the vascular attachments (left gastroepiploics, short gastrics) along the greater curve using an energy device (**Fig. 5**).

The dissection is taken up to the level of the left crus. The hiatus is assessed and hiatal hernias are repaired.[60,63] The left crus must be cleared of all adherent stomach to reveal any hiatal hernia, and the angle of His clearly identified. Typically, hiatal hernias are missed posterior to the esophagus because of inadequate dissection of the left crus.

Using a laparoscopic stapler, gastric transection begins 2 to 6 cm from the pylorus and moves toward the angle of His. Buttressing the staple line has been shown to increase burst pressure and decrease bleeding risk, but it has not been shown to decrease leak rates.[64,65] Staples, their heights, and buttressing are evolving topics of discussion. At our institution, we use 4.1 mm/2 mm (open/closed height) buttressed

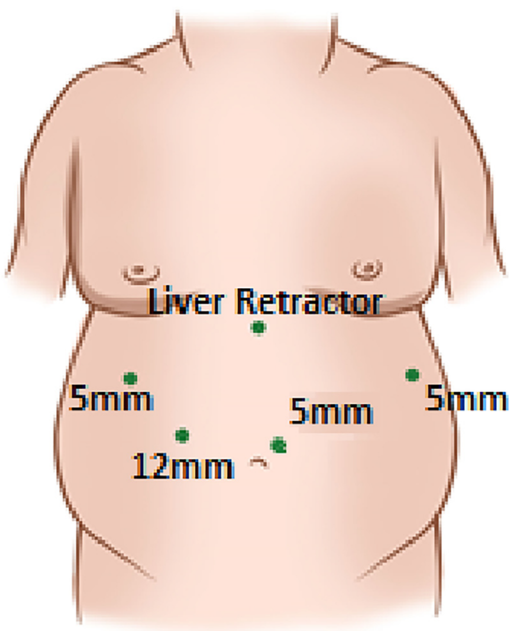

Fig. 3. Trocar placement and their respective sizes.

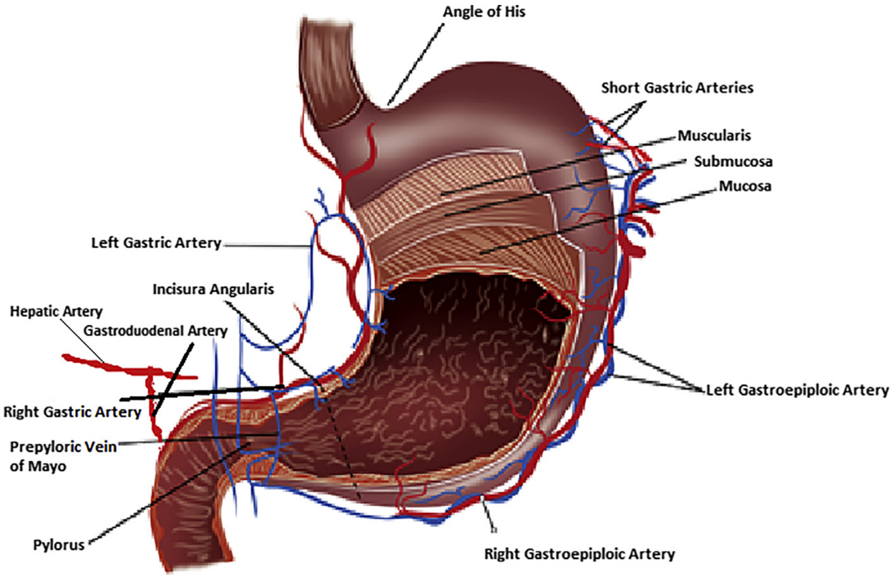

Fig. 4. Stomach anatomy.

staple loads near the pylorus, 3.8 mm/1.8 mm buttressed staple loads over the gastric body, and a 3.5 mm/1.5 mm unbuttressed load over the fundus (Fig. 6).

Although no correlation between leak testing and postoperative complications of a leak[66,67] has been identified, a leak test is a simple adjunct that can identify gross surgical errors/equipment failure at time of surgery. Endoscopy, methylene blue, and a suction bougie can all be used to perform a leak test.

The specimen is then extracted in a protected manner, the fascia is closed over the site of extraction, and the port sites are closed.

ROBOTIC VERTICAL SLEEVE GASTRECTOMY

Evidence or data regarding robotic VSG and how it compares with VSG are limited. The current thought is that, given the straightforward nature of VSG, the robot's

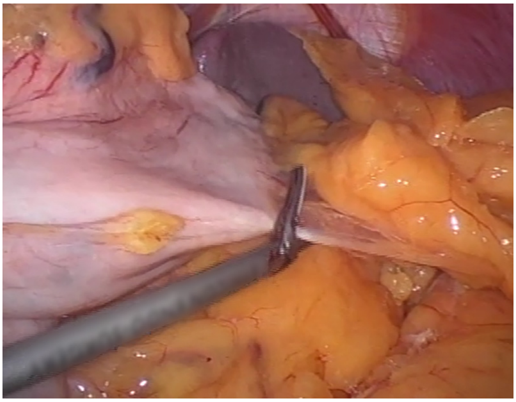

Fig. 5. Taking down of gastroepiploics using an energy device.

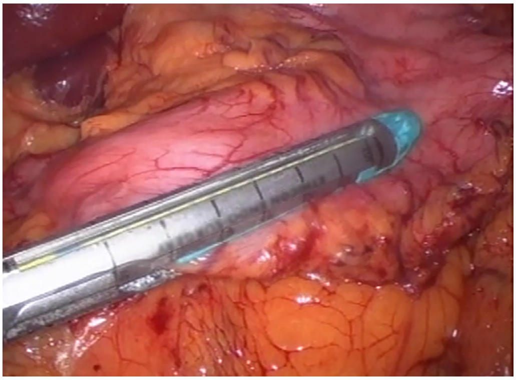

Fig. 6. Stomach stapling.

advantages are not truly realized in terms of increased room times and increased cost. However, as greater experience is gained on the platform and more data are obtained, this thought may change.

FUTURE STEPS/REVISIONAL SURGERY

VSG has proven to be an important surgical tool in the battle against obesity and its associated comorbidities. However, it is not without its issues. Refractory reflux and unintended weight regain are some problems that may warrant reoperation. In fact, the rate of reoperative bariatric surgery is increasing. A systematic review by the ASMBS shows that VSG to RYGB can be performed for patients who are good candidates for additional weight loss surgery.[68] Another emerging surgical technique is the SADI with sleeve gastrectomy. This surgery, as its name implies, involves a sleeve gastrectomy, division of the duodenum post-pylorically, and bringing up an ileal loop. A recent study published shows that the SADI with sleeve gastrectomy is safe and effective in the short term and midterm.[69] Additionally, SADI with sleeve gastrectomy has outperformed the RYGB with regards to weight loss, comorbidity resolution, and potential long-term issues.[70]

SUMMARY

VSG is a great weight loss surgery option. It is exceedingly safe and extremely effective for weight loss, it improves comorbidities, and it is technically straightforward. Still, several factors surrounding the surgery are important considerations for the surgeon and the patient. If properly used, VSG is a powerful tool in combating obesity and its deleterious effects.

CLINICAL CARE POINTS

- A key consideration when stapling the stomach is to ensure that the stomach remains in one plane and that the staple line is truly lateral. This measure prevents spiraling around the sizing bougie, which would create a problematic helical sleeve. Such sleeves can lead to a functional stenosis and reflux.
- Two other important considerations include making sure that the stapler is not impinging on the incisura and that the bougie is not distorting the stomach in such a way that it

unnaturally stretches the stomach. This measure can prevent an obstruction/stenosis in the future.

- Finally, when working at the fundus, it is important to have appropriate lateral traction so that the posterior wall of the stomach does not bowl down. Taking this action lowers the incidence of a retained fundus and thus helps decrease reflux rates.

DISCLOSURE

No author has any competing or conflicting interests to disclose. The views expressed here reflect those of the authors and do not necessarily reflect the views of the US Army, Department of Defense, or the US Government.

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