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" Post-operative outcome of laparoscopic sleeve gastrectomy in management of morbid obesity and related co morbidities in adolescents"

Authors

Mohamed Mosaad Kandeel [1], Mohamed Mohamed Yousef Omar [2], Ehab Ali Elhanafy [3], Mohamed Ibrahim Naroz [4]

[1] Lecturer of General Surgery, Faculty of Medicine, Port Said University

[2] Faculty of medicine Port Said University

[3] Professor of General Surgery, Faculty of Medicine, Port Said University

[4] Lecturer of general surgery - faculty of medicine –El-azhar University

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https://muj.journals.ekb.egdean@med.psu.edu.eg

vice_dean_postgraduate@med.psu.edu.eg

ABSTRACT:

Obesity is an excessive build-up of body fat (BMI > 30% over the average Optimal Body Weight) to the point that it may pose a health risk. Its prevalence, expenses, and health effects make it a significant public health concern that affects many nations globally.

This article aimed to evaluate Laparoscopic Sleeve Gastrectomy in the management of morbid obesity in adolescents, specifically regarding its impact on weight reduction and Amelioration of related health conditions.

The article also focused on the results of different research and studies on the feasibility and complications of laparoscopic sleeve gastrectomy in cases of morbid obesity and related co-morbidities and the role of advanced laparoscopic surgery in managing such cases.

In conclusion, obesity must be managed promptly to prevent further repercussions. bariatric surgery often becomes the effective alternative. since our research found that LSG is a safe and effective intervention for weight reduction, leading to sustained long-term weight reduction, remission of early Co-morbidities and improve quality of life.

Keywords: Sleeve gastrectomy, laparoscopy, adolescent obesity, body mass index.

Introduction:

Obesity

Body mass index (BMI) is the most commonly used metric for evaluating obesity in both population and clinical settings. It is determined by dividing a person's weight in kilograms by the square of their height in meters (kg/m^2).

Table (1): WHO Classification of Obesity. (Iqbal & Rehman, 2023 [1])

WHO CLASSIFICATION OF WEIGHT STATUS	
WEIGHT STATUS	**BODY MASS INDEX (BMI), kg/m^2**
Underweight	<18.5
Normal range	18.5 – 24.9
Overweight	25.0 – 29.9
Obese	≥ 30
Obese class I	30.0 – 34.9
Obese class II	35.0 – 39.9
Obese class III	≥ 40

Pathophysiology of obesity

Obesity arises from an imbalance between energy expenditure and caloric intake, influenced by environmental and genetic factors. The identification of endocrinal abnormalities in obesity, particularly those related to the leptin-propiomelanocortin system and elevated tumor necrosis factor alpha (TNF-α) has offered valuable insights into the mechanisms underlying obesity **(Flores-Dorantes et al., 2020 [2]).**

Genetic Factors

Specific forms of obesity result from mutations in single genes. These rare and often severe forms typically manifest in childhood and are caused by mutations in one of 11 different genes, including those encoding leptin, the leptin receptor, propiomelanocortin, and the melanocortin-4 receptor (MC4-R) **(Kristina et al., 2017 [3])**

A genome-wide association study has identified over 140 genetic chromosomal regions linked to obesity, suggesting a strong genetic predisposition. **(Fall et al., 2017 [4])**

The central nervous system significantly enriches gene expression associated with BMI and overall adiposity. **(Locke et al., 2015 [5])**

The early origins of the adult disease hypothesis propose that children born to mothers experiencing metabolic challenges, including undernutrition, obesity, or diabetes, are at an increased risk of developing obesity later in life **(Barker, 2010 [6]).**

Environmental and behavioral Factors

Behavior and environment significantly contribute to obesity, as pre-packaged foods, fast food restaurants, and soft drinks are more accessible at the worksite **(Small et al., 2017 [7]).**

Psychological Factors

Major depression and other mood disorders are common in patients with obesity **(Bray, 2014 [8]).**

Eating Disorders

The hallmarks of binge-eating disorder and obesity are frequent periods of uncontrollably excessive eating. **(Fatseas et al., 2017 [9]).**

Endocrine causes of obesity

Obesity is linked to several endocrine conditions, including Cushing's disease and hypothyroidism. **(Baskaran and Kandemir, 2018 [10]).**

Drug-induced obesity

Numerous medications, such as combined oral contraceptives (COCs), antidepressants, steroids, and antiepileptics, can increase body weight by enhancing hunger or changing metabolism. **(Rimessi et al., 2017 [11]).**

Lipoprotein lipase enzyme

A key player in the metabolism of triglycerides (TG) is lipoprotein lipase (LPL). LPL promotes TG utilization and controls circulating TG and TG-rich lipoproteins concentrations by catalyzing the hydrolysis of TGs found in TG-rich lipoproteins (TRLs). **(Arora et al., 2019 [12]).**

Leptin hormone

Most obese subjects in studies have high serum leptin levels, indicating that the main issue is leptin resistance due to receptor deficiency rather than leptin deficiency. The hormone leptin, which is produced by well-fed fat cells, appears to have a central action that prevents obesity. It circulates to specific receptors of the hypothalamus and causes the release of glucagon-link peptide-1 (GLP-1). Among the various metabolic effects of GLP-1 are the glucose-dependent stimulation of insulin secretion, delayed gastric emptying, suppression of food intake, modulation of rodent β-cell proliferation, and increased natriuresis and diuresis. **(Facey et al., 2017 [13]).**

Ghrelin hormone

Ghrelin, an endogenous ligand for the growth hormone secretagogue receptor (GHS-R), is primarily produced in the stomach and acts on GHS-R, which is expressed in various tissues and organs, including the pituitary gland. **(Davis et al., 2017 [14]).**

Ghrelin's most important role appears to be stimulating appetite and regulating energy homeostasis, which favors adiposity and thus contributes to obesity. Ghrelin appears to be an endocrine signal, possibly reaching the central nervous system via the bloodstream. **(Bawudun et al., 2012 [15]).**

Adiponectin

Adipose tissue is the only source of this protein. It appears to have anti-inflammatory and beneficial metabolic qualities; it rises with weight loss and falls with obesity. **(Lewis and Brown, 2017 [16]).**

Cytokines

Increased plasma levels of cytokines (inflammatory factors) such as insulin-like growth factor 1 (IGF-1), tumor necrosis factor (TNF), C-reactive protein (CRP), and interleukins (e.g., IL-6) are linked to obesity.

Adipose tissue produces these cytokines, which are responsible for inflammatory alterations as well as other cardiovascular system disorders. **(Caer et al., 2017 [17]).**

Obesity in adolescents and its risks

Childhood obesity is linked to both short-term and long-term complications, including high prevalence of cardiovascular problems, type 2 diabetes and insulin resistance, hypertension, obstructive sleep apnea, dyslipidemia, psychological issues, asthma, and reduced quality of life. Obese children are more likely to grow up to be obese adults, especially older kids and teenagers. Adult obesity is linked to substantial morbidity as well as early mortality. Individual factors that influence the risk of obesity development and its related comorbidities include lifestyle choices, degree of fitness, and genetic predisposition. **(Balasundaram & Krishna, 2023 [18]).**

The old indications of bariatric surgery

The criteria for bariatric surgery are based on BMI and the presence of comorbidities. Individuals with a BMI of 40 kg/m^2 or higher who do not have severe medical conditions and for whom the procedure presents an acceptable risk are eligible for bariatric surgery. **(Stahl & Malhotra, 2023 [19])**

Persons with a BMI of 35 kg/m^2 or higher, along with one or more severe obesity-related comorbidities, such as T2DM, dyslipidemia, HTN, gastroesophageal reflux disease (GERD), asthma, obstructive sleep apnea, non-alcoholic fatty liver disease (NAFLD), debilitating arthritis, severe urinary incontinence, venous stasis disease, or significantly reduced quality of life, are also eligible for bariatric surgery. Additionally, individuals with a BMI between 30 and 34.9 kg/m^2 who have metabolic syndrome or diabetes might be eligible for weight loss surgery. However, there is limited evidence supporting long-term benefits for this group. **(Stahl & Malhotra, 2023 [19])**

The new guidelines for bariatric surgery after 2022:

Metabolic and bariatric surgery (MBS) is recommended for individuals with a BMI greater than 35 kg/m^2, irrespective of comorbidities' presence, absence, or severity. MBS should be considered for individuals with metabolic disease and a BMI of 30 to 34.9 kg/m^2.

For Asian populations, BMI thresholds should be adjusted, considering a BMI >25 kg/m^2 indicative of clinical obesity. Those with a BMI >27.5 kg/m^2 should be eligible for MBS. Long-term outcomes of MBS consistently confirm its safety and efficacy. **(Eisenberg et al., 2023 [20])**

Management of obesity

All obese individuals should lose weight, as should those who are overweight and have concomitant diseases like prediabetes, diabetes, hypertension, and dyslipidemia. In the first six months, we should see 5% to 10% weight loss for most people who must reduce their body weight for medical reasons. **(Jensen et al., 2014 [21]).**

Lifestyle modification

An extensive, rigorous lifestyle change is required to effectively achieve clinically significant excess weight loss of 5% to 10%. **(Jensen et al., 2014 [21]).**

Effective weight loss interventions can be delivered through both individual and group sessions, incorporating strategies such as prescribing a calorie-reduced diet, promoting increased physical activity, and

using behavioral techniques to foster adherence to dietary and exercise guidelines. Common behavioral methods include goal-setting, self-monitoring of food and exercise, daily or frequent weighing, behavioral contracts, and stimuli management such as restricting eating to specific locations. **(Gadde et al., 2018 [22]).**

Following initial success, maintaining long-term weight loss is challenging, necessitating ongoing participation in comprehensive weight loss programs for one or more years. **(Jensen et al., 2014 [21]).**

The primary objective of treatment during follow-up is to ensure adherence to dietary and physical activity recommendations. Sustaining weight loss requires continuous and consistent direct engagement with experts rather than relying on passive approaches like newsletters **(Wing et al., 2006 [23]).**

Doctors should be able to identify psychological or psychiatric conditions, such as depression, that impede effective obesity management. Treatment and/or psychological support will thus be a crucial management component. In this situation, self-help lay groups and the assistance of the obesity treatment group could both be beneficial. **(Moffitt et al., 2015 [24]).**

Pharmacotherapy

Pharmacotherapy represents the next logical step for patients who have not achieved success with lifestyle changes or struggle to sustain weight loss over time. This treatment is recommended for individuals with a BMI of $\geq$ 30 kg/m^2 and a BMI of $\geq$ 27 kg/m2 accompanied by weight-related comorbidities, including T2D. Patients should be thoroughly counseled on these medications' potential benefits and risks **(Gadde et al., 2018 [22]).**

Phentermine, diethylpropion, phendimetrazine, and benzphetamine are four drugs that have been on the market in the US for more than 50 years. They are all structurally linked to amphetamine and are only permitted for short-term usage. Perhaps because it is inexpensive and simple to administer, phenetheramine is the most prescribed anti-obesity drug in the US. Phenteramine 30 mg/day was linked to more than 6% extra weight loss in two recent 12-week RCTs, both carried out in Korea, compared to placebo. **(Kang et al., 2010 [25]).**

Phentermine 15 mg daily resulted in 4.4% placebo-subtracted weight loss in a 28-week randomized controlled trial conducted in the U.S. **(Aronne et al., 2013 [26]).**

In a 4-year RCT, participants with obesity and pre-diabetes who took orlistat experienced a 2.4% placebo-subtracted weight loss and a lower incidence of diabetes (6.2% vs. 9.0%). **(Lau and Teoh, 2015 [27]).**

A serotonergic medication called lorcaserin selectively agonizes 5-HT2C receptors. At one year, lorcaserin treatment resulted in 3.0% to 3.6% weight reduction subtracted by placebo in three RCTs. According to lorcaserin's prescribing guidelines, if weight loss is less than 5% after 12 weeks, the medication should be stopped. However, in a newly released study, only 28% of lorcaserin-treated individuals lost 5% of their body weight after 12 weeks. **(Martin et al., 2011 [28]).**

Surgical treatment of obesity

Surgery remains the most effective intervention for morbid obesity. It offers significant and sustained weight loss, improved co-morbidities, enhanced quality of life, and lowered total mortality. **(Yumuk et al., 2015 [29])**

Bariatric surgery has become increasingly popular in the past decade. Over half a million surgeries are carried out globally annually. **(Angrisani et al., 2015 [30]).**

Sleeve gastrectomy (SG) accounts for 58% of surgical procedures, followed by Roux-en-Y gastric bypass (RYGB) at 38%, LAGB at 3%, and biliopancreatic diversion with duodenal switch at 1%. **(Khorgami et al., 2017 [31]).**

Leading diabetes organizations now recommend bariatric surgery as effective management for type 2 diabetes, including it in treatment guidelines for patients with class III obesity and those with class II obesity whose hyperglycemia remains poorly controlled by changes in lifestyle modifications and medication. **(Rubino et al., 2016 [32]).**

Recent studies indicate that perioperative morbidity and mortality rates for bariatric surgery have decreased to 5% and 0.3%, respectively, reflecting a decline in serious complication rates over time **(Nguyen and Varela, 2017 [33]).**

Technique of laparoscopic sleeve

The surgery is carried out with the patient on the operation table in a supine position, legs open, and placed in a reverse Trendelenburg position at a 30-degree incline. The lead surgeon operates from between the patient's legs, while the assistant surgeon and scrub nurse stand to the surgeon's right. To avoid falls and improper placement, the patient is securely fastened to the operating table using customized braces around the belly and lower limbs. Pneumoperitoneum is accomplished by inserting a Veress needle directly into the left upper quadrant, positioned at the midclavicular line along the costal margin. This procedure is conducted with a carbon dioxide flow rate of 40 L/min and an inflation pressure of 16 mmHg. **(Ramos, 2015 [34])**

Using the average anatomical xifoumbilical line as a reference, the first 10 mm permanent trocar is placed at the junction of the upper one-third and lower two-thirds, approximately 3 cm to the patient's left, ensuring a direct approach to the gastroesophageal junction while avoiding the round ligament (T1). To facilitate liver retraction, a 5 mm permanent trocar is positioned near the xiphoid process (T2). Another trocar, measuring 12 mm and disposable, is inserted parallel to T1 at the patient's right midclavicular line (T3). A fourth trocar, 5 mm and permanent, is inserted near the costal margin along the left anterior axillary line (T4). Lastly, a fifth 12 mm disposable trocar is positioned also close to the costal margin on the patient's left side at the midclavicular line (T5). **(Ramos, 2015 [34])**

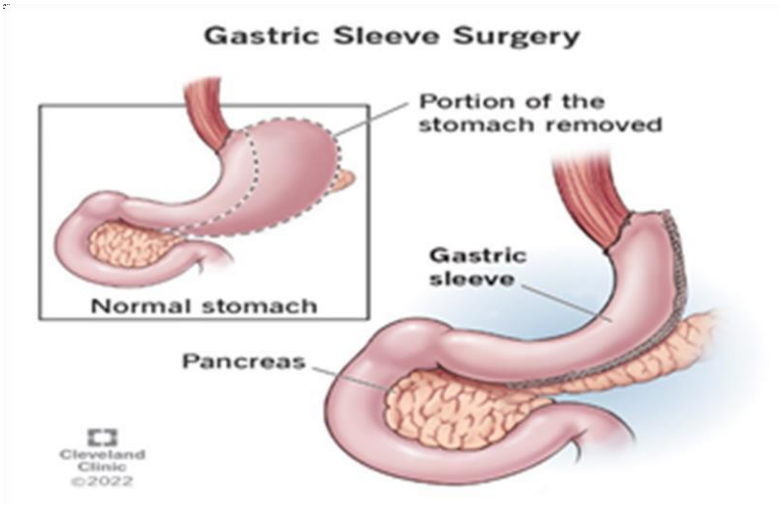

Figure (1): Gastric sleeve surgery. (Salazar & Osorio, 2023 [35])

Dissection starts by splitting the larger omentum near the incisor angularis, approximately 5 cm proximal to the pylorus. The gastroepiploic vessels are then transected with an energy device, progressing along the greater curvature towards the short gastric vessels. Use a bipolar cautery instrument to divide the short gastric veins. This dissection continues until the gastrophrenic ligament is completely divided and the angle of His is mobilized to detect the diaphragmatic left crus. **(Hylke et al., 2017 [36])**

The optimal distance for the pylorus for the initial staple load remains a subject of debate. Current practices involve distances ranging from 2 to 6 cm, with clinical significance determined by the amount of antrum retained. A 2 cm gap allows for greater antrum resection and a smaller gastric residual. In principle, this will result in more excess weight loss, but it may also lead to additional difficulties as distal intragastric pressure increases. Studies comparing a 2 cm gap to a 4-6 cm distance had varied results. One exhibited identical results when examining weight reduction and complications, whilst the other indicated higher weight reduction with no rise in complications for the 2 cm length. **(Hylke et al., 2017 [36])**

Access to the lesser sac is achieved after detaching the omentum from the greater curvature. The stomach is then grabbed and elevated anteriorly, exposing its posterior wall. Any adhesions within the lesser sac are carefully dissected, extending to the most medial part of the stomach along the lesser curvature. **(Hylke et al., 2017 [36])**

A 32 to 40 French Bougie is carefully advanced under laparoscopic guidance until it extends past the divided omental attachments after the orogastric tube is withdrawn.

The selection of Bougie size for sleeve gastrectomy is primarily based on two outcomes: the risk of proximal staple line leaks and the percentage of expected weight loss. Historically, evidence has shown that using smaller French bougies increases both the leak rate and weight loss. This implies that a larger bougie may reduce the risks of leaks, but it does not account for other potential complications or their effects. Additional studies are necessary to understand these factors fully. **(Yuval et al., 2013 [37])**

This step requires using a 60 mm-long endoscopic stapler. The stapler is fired approximately 5 cm before the pylorus, maintaining alignment with the lesser curvature, and guided by the bougie. To prevent the "spiraling" of the sleeve, the stapler must evenly cover both the anterior and posterior stomach walls. Sequential staple firings

are performed along the bougie toward the angle of His, ensuring that the fundus is divided 0.5 to 2 cm away from the esophagus. The residual portion of the cardia is then folded inward at the gastroesophageal (GE) junction with intermittent Lembert sutures. Finally, the resected stomach is extracted through the 15 mm port. **(Seeras et al., 2023 [38])**

A flexible endoscope is cautiously introduced into the esophagus to examine the staple line for hemostasis and integrity. To detect potential leaks, the remaining parts of the stomach can be immersed in an irrigation fluid while being insufflated using the endoscope. **(Yuval et al., 2013 [37])**

The intraoperative leak test is up to the surgeon's decision because the findings are variable. A multicenter retrospective investigation published in 2017 found that the intraoperative leak test had minor sensitivity for predicting postoperative leaks. The study revealed that 91% of patients who developed a staple line leak had a negative intraoperative leak test. **(Yuval et al., 2013 [37])** All sites undergo skin closure, whereas the 15mm port site undergoes fascial closure. **(Seeras et al., 2023 [38])**

Table (2): Early and late complications associated with laparoscopic sleeve gastrectomy. (Woźniewska et al., 2021 [39])

Early complications (< 30 days)	Late complications (> 30 days)
Hemorrhage	Gastric stenosis
Staple line leak	Nutrient deficiency
Intra-abdominal abscess	Gastroesophageal reflux disease
Wound infection **Acute pancreatitis** **Pulmonary embolism** **Thrombophlebitis** **Rhabdomyolysis** **Acute kidney injury (AKI)** **Partial spleen infarction**	Trocar-related hernia Mediastinal pouch migration Mental health issues Eating disorders

Recommendations and Conclusion

- Inform the patient's parents and child on leading a healthy lifestyle by using their personal experiences as well as an interview regarding diet and exercise levels.
- Inform parents about the dangers of obesity and its consequences.
- Working together with practitioners of other medical specialties, such as psychologists, physiotherapists, and dieticians, can improve the effectiveness of treatment for an obese child.
- Adjust the family's diet and exercise habits if necessary to reduce excess and avoid the accumulation of overweight and obesity.
- Ensure that the child's sleep time is adequate for their age;
- Laparoscopic sleeve gastrectomy is an excellent long-term obesity management option.
- Childhood obesity has long-term consequences for a patient's well-being.

In conclusion, obesity must be managed promptly to prevent further repercussions. since our research identified LSG as a safe and effective weight reduction intervention, resulting in sustained long-term weight loss, remission of early Co-morbidities and improve quality of life.

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