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ORIGINAL ARTICLE

Laparoscopic Sleeve Gastrectomy in the Treatment of Morbidly Obese Child and Adolescent: A Single-center Experience

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Abstract

Background: **Obesity affects children and adults across all age groups. The prevalence of obesity is as high as 21.4 % in the pediatric age groups. This increase in prevalence is associated with significant health implications and necessitates effective interventions. The results of weight loss surgery in children and adolescents are still scarce, despite recent studies suggesting favorable short- and intermediate-term outcomes that are comparable to those in adults. However, evidence continues to emerge, as this solution is still denied to children. This study evaluates the safety and efficacy of laparoscopic sleeve gastrectomy (LSG) in children and adolescents.**

Methods: **This a prospective study conducted at the Pediatric Surgery Department, Al-Azhar University Hospitals (from Jan 2018 to Jun 2022) included all pediatrics with class 2 and class 3 obesities and have obesity-related comorbidities. All patients were submitted to LSG and then followed up for 1 year to assess changes in preoperative body weight, comorbidities, and detect any adverse outcomes.**

Results: **The study included 20 patients: 15 females and 5 males. Patient ages ranged from 12 to 18 years; (mean = 15.25) all of them underwent LSG at our center. There was marked reduction in preoperative body mass index (BMI) from 47.13 ± 4.60 to 29.17 ± 3.40 (n = 20) along the postoperative first year, with improvement of most of preoperative comorbidities. We had no significant intraoperative or postoperative complications.**

Conclusion: **LSG is a safe and effective management of obesity in pediatrics, resulting in effective weight reduction and resolution of most of obesity-related comorbidities.**

Keywords: Bariatric surgery, Laparoscopic sleeve gastrectomy, Pediatric obesity, Pediatrics, Weight loss

1. Background

Over the last few years, the dramatic increase in overweight and obesity in childhood and adolescence has become a major problem and is now considered an epidemic problem.[1] In the United States, it increased from 6 % to 12 %, and in Spain, morbid obesity increased by more than 200 % over 13 years. This growing pattern also applies to pediatric obesity, and if it is maintained, by 2030, nearly 38 % of the world's adults will be overweight, and another 20 % will be obese.[2] The prevalence of pediatric obesity has increased markedly during the past few years, and the related behavioral and environmental factors have been negatively affected by the coronavirus disease 2019 (COVID-19) pandemic, including the limitation of daily activities.[3] Pediatric obesity is associated with complications affecting nearly every system in the body, including the endocrine, gastrointestinal,

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pulmonary, cardiovascular, and musculoskeletal systems. Many of the complications associated with obesity that occur in youth, such as type 2 diabetes mellitus, dyslipidemia, obstructive sleep apnea, and steatohepatitis, used to be previously considered adult diseases. The severity of these complications typically rises with the severity of obesity.[4] While obesity prevention should take priority, once it has occurred, there are several therapeutic options available, from behavioral interventions to pharmacotherapy and metabolic and bariatric surgery (MBS). However, lifestyle modifications and medical treatment usually fail to provide clinically significant or sustainable weight loss. In recent years, there has been a growing trend toward MBS as a safe and effective intervention for adolescents with severe obesity. Reports show the accepted outcomes regarding weight loss and resolution of obesity complications with a low rate of morbidity.[5] Sleeve gastrectomy (SG) is an effective intervention for the management of adolescent obesity. It has been recognized to provide clinically significant weight loss while carrying a minimal risk of major complications and/or malnutrition or vitamin deficiencies, particularly when compared with Roux-en-Y gastric bypass (RYGB).[6]

2. Methods

This study was conducted on 20 pediatric patients who suffered from obesity with failed nonsurgical management. All patients underwent LSG at the Pediatric Surgery Department, Al-Azhar University Hospitals, and then were followed up for 1 year. The study was of 36 months' duration (January 2018–June 2022).

Inclusion criteria included patients with class 2 and class 3 obesity and obesity-related comorbidities with failed weight reduction by lifestyle modification. All patients showed psychological and physical maturity.

Exclusion criteria included patients with secondary obesity (as a result of hypothyroidism or cortisol therapy), syndromic obesity, and monogenetic obesity.

All patients were subjected to a complete history taking, including age of onset of weight gain, family history, and type of eating behavior. Physical examination (including assessment of obesity using the BMI growth chart (WHO growth chart)) and physiological evaluation were also done.

Serum measurements of the lipid profile, liver enzymes, thyroid hormones, cortisol level, complete blood count, coagulation profile, and HbA1C were all taken. Other investigations, such as respiratory function tests and abdominal ultrasounds, were also done.

All patients were submitted to LSG (as described by Ingram, M.C. et al.) and then followed up for 1 year to assess changes in preoperative body weight and comorbidities and detect any adverse outcomes.

2.1. Statistical analysis

The normality of distribution was verified by the Kolmogorov–Smirnov test. Using range (minimum and maximum), mean, standard deviation, median, and interquartile range (IQR), the quantitative data were described. Friedman test was used for abnormally distributed quantitative variables. The interval of confidence was set to 95 %, and the margin of accepted error was set to 5 %. So, the *P* value was considered to be significant if: *P* value less than 0.05: non-significant; *P* value more than 0.05: significant; *P* value less than 0.01; highly significant.

3. Results

There was a female predominance of approximately 3:1. The ages ranged from 12 to 18 years (mean ± SD = 15.25 ± 1.97; Table 1). The mean preoperative BMI±SD was 47.13 4.60, and after 1 year it became 29.17 ± 3.40 (Table 2).

Preoperative complications included psychological complications (depression, social isolation, low self-esteem, and social embarrassment) in 90 % of patients (18 cases), decreased daily activity in 85 % of patients (17 cases), obstructive sleep apnea (OSA) in 70 % of patients (14 cases), stress urinary incontinence in 20 % of patients (4 cases), arthralgia in 10 % of patients (10 cases), prediabetes (detected by measuring HBA1C) in 25 % of patients (5 cases), bone deformity in 10 % of patients (2 cases), chronic ankle pain in 5 % of patients (1 case), and menstrual irregularities in 1 female patient (about 6.67 % of female patients) (Table 3).

The mean operative time (SD) was 63.95 ± 30.78 min (Table 4). There was one case of leakage detected intraoperatively by the methylene

Table 1. Distribution of the cases in the study according to demographic data (n = 20).

Demographic Data	Number (%)
Sex	
Male	5 (25.0)
Female	15 (75.0)
Age (years)	
Min– max	12.0–18.0
Mean ± SD	15.25 ± 1.97
Median (IQR)	15.0 (13.50–17.0)

Table 2. Descriptive analysis of the cases in the study according to BMI (n = 20).

BMI (kg/m^2)	Min–max.	Mean ± SD.	Median (IQR)	% of decrease in BMI
Preoperative	38.10–54.36	47.13 ± 4.60	47.75 (44.50–50.86)	
Postoperative				
2 Weeks	34.84–50.71	43.56 ± 4.19	44.05 (41.47–45.91)	7.56 ± 1.60
1 Month	32.66–48.27	41.49 ± 4.07	41.92 (38.58–44.67)	11.95 ± 1.67
2 Months	31.57–43.40	39.12 ± 3.59	39.61 (37.14–42.14)	16.94 ± 2.22
4 Months	29.76–40.44	35.79 ± 3.14	35.84 (33.33–39.03)	23.81 ± 3.84
6 Months	27.22–40.89	33.14 ± 3.34	33.11 (31.04–35.45)	29.60 ± 4.38
9 Months	24.98–37.33	30.73 ± 3.34	30.83 (28.62–32.55)	34.69 ± 4.83
1 year	24.31–36.22	29.17 ± 3.40	29.76 (26.42–30.84)	37.95 ± 5.61

blue test. It was the first case in the study, and due to iatrogenic stabling of the nasogastric tube within the stomach, the operation was converted to an open one to extract the nasogastric tube and repair the leaking point. This patient recovered well with no other complications. There were no other complications (such as bleeding or iatrogenic injury).

Postoperative complications included hair loss in about 80 % of all patients (100 % of female patients and 20 % of male patients). It had started in the 3rd month after the operation and gradually decreased in severity till the 9th month postoperatively. After 1 year, it returned to its preoperative status. Skin redundancy occurred in about 40 % of patients (8 cases), mainly at 9 months postoperatively with redundancy of the skin of the abdomen and arms. All patients were investigated for nutritional deficiencies 9 months postoperatively by measuring serum levels of iron, calcium, folate, and vitamin B12, as well as a full blood count. Of the patients, 15 % (3 cases) had low serum iron and iron deficiency anemia. Of the patients, 5 % (1 case) had low serum calcium. No detectable decrease in serum folate or vitamin B12 was observed. Intermittent symptoms of gastroesophageal reflux, such as heartburn and nausea, occurred in one patient only 9 months after surgery. (Table 5).

There was marked improvement in preoperative comorbidities except in two patients (10 % of cases) who had a bone deformity (due to malunion of a previous femur fracture) (Table 6).

Table 3. Distribution of pre-complications in the studied cases.

Preoperative complications	Number (%)
Bone deformity	2 (10.0)
Decreased daily activity	17 (85.0)
Psychological	18 (90.0)
Stress incontinence	4 (20.0)
Menstrual irregularity	1 (5.0)
OSA (snoring)	14 (70.0)
Arthralgia	10 (50.0)
Prediabetes	5 (25.0)
Chronic ankle pain	1 (5.0)
Intertrigo	1 (5.0)

Table 4. Descriptive analysis of the operative time in the studied cases.

Operative time (min)	Number (%)
<1 h	12 (60.0)
1–2 h	6 (30.0)
>2 h	2 (10.0)
Min–max	32–167
Mean ± SD	63.95 ± 30.78
Median (IQR)	55.0 (50–65)

4. Discussion

The prevalence of obesity in pediatrics has increased worldwide in the past few years, and it is associated with many life-threatening complications, including cardiovascular disease and some major psychological disorders. That's why it is recommended to focus on its management.[7] Because nonsurgical management treatment is ineffective in producing sustained weight loss in overweight or obese children, there has been an increase in interest in metabolic and bariatric surgery for this age group. Many studies have reported good outcomes as regards weight loss and resolution or improvement in most comorbidities in adolescents undergoing sleeve gastrectomy (SG) or gastric bypass (GB); therefore, the American Society of Metabolic and Bariatric Surgery (ASMBS) and the American Academy of Pediatrics have recently recommended metabolic and bariatric surgery as the standard treatment for adolescents with morbid obesity.[8] LSG has gained increasing popularity, and some authors consider it the new gold standard of management for severe pediatric obesity.[9] Instead of these recommendations, there are still concerns as to the

Table 5. Distribution of intraoperative and postoperative complications in the studied cases.

	Number (%)
Intraoperative complications (leakage)	1 (5.0)
Postoperative complications	
Skin redundancy	8 (40.0)
Hair falling	16 (80.0)
GERD symptoms	1 (5.0)
Iron-deficiency anemia	3 (15.0)
Calcium deficiency	1 (5.0)

Table 6. Distribution of preoperative complications in the studied cases.

Preoperative complications	Number (%)	Result
Bone deformity	2 (10.0)	Same
Decreased daily activity	17 (85.0)	Improved
Psychological	18 (90.0)	Improved
Stress urinary incontinence	4 (20.0)	Improved
Menstrual irregularity	1 (5.0)	Improved
OSA	14 (70.0)	Improved
Arthralgia	10 (50.0)	Improved
Prediabetes	5 (25.0)	Improved
Chronic ankle pain	1 (5.0)	Improved
Intertrigo	1 (5.0)	Improved

safety of bariatric surgery for adolescents. For instance, previous studies had reported higher rates of reoperation and nutritional deficiencies postoperatively, as well as increased healthcare consumption for adolescents undergoing bariatric surgery compared with adults. Also, recently published studies revealed normal growth for adolescents who underwent metabolic and bariatric surgery.[8]

Ensuring LSG safety is of concern to the patient and family. Results from studies of pediatric and adolescent patients in Saudi Arabia have proven that LSG is an effective and safe procedure. Another study of 22 patients from Korea demonstrated a high rate of improvement in comorbidities.[10] In this study, there was only one case of leakage (5 % of all cases) that was detected intraoperatively and managed appropriately, with no other intraoperative or early postoperative complications and no mortality cases, allowing for early discharge from the hospital.

The percent of excess weight loss (%EWL) $\left(\frac{\text{Preoperative weight}-\text{current weight}}{\text{Preoperative weight}-\text{ideal weight}}\times 100\right)$ was used to assess the degree of weight loss. According to Brolin et al.'s criteria, EWL with more than 50 % participation was considered successful.[11] The EWL seen 1 year postoperatively in this study ranged from 56.86 % to 105.0 %, with a mean ± SD percentage of 82.41 % ± 13.25 %. (Table 7), and all patients showed more than 50 % EWL.

In the study of Olbers et al. on 81 obese adolescent patients who underwent LRYGB, the mean reduction in BMI was 13 kg/m^2, and nearly 72 % of the patients in their study had developed some degree of nutritional deficiency. Therefore, sleeve gastrectomy is thought to be a better option for weight loss in adolescent obese patients who require bariatric surgery.[11]

As regards psychological and social outcomes in adolescents, research from Chile and the USA has shown improved QOL after LSG for obese adolescents. A recently published study revealed improvements in overall QOL at 6–12 months and in depression at 4–6 months post-BS.[12] Our study supports that psychological complications (depression, low self-esteem, social embarrassment, and social isolation) were found in 90 % of cases and improved in all patients postoperatively. In our series, we had five cases of prediabetes (25 % of all cases) detected by elevated HbA1C preoperatively, which had been normalized 3 months postoperatively. Hence, our results agree with those found in the US study, where there was resolution of T2DM in 95 % of the adolescents and prediabetes remission in 76 % after surgery by 3 years. Also, in Kuwait, LSG revealed a remission of diabetes among 100 % of morbidly obese children/adolescents.[12] Weight loss has a great impact on the quality of sleep; in a published study from Saudi Arabia; 40 % of the 226 children and adolescents were diagnosed as suffering from OSA postoperatively, and more than 90 % of them have improved. In this study, we had 14 patients (70 % of cases) with OSA, and all of them showed significant improvement in their sleep quality with resolution of nighttime snoring even in the early postoperative period with still minimal weight loss, which is consistent with other research results. Also in this study, 20 % of patients had stress urinary incontinence, 10 % had arthralgia, and 5 % had irregular menses. Postoperatively, all of them showed marked improvement in all the comorbidities mentioned.

Loss of hair is common after MBS, but there is debate in the literature about its incidence and causes. It has been found that hair loss occurs in 57 % of patients after bariatric surgery and that its occurrence decreases with longer follow-up periods. Compared with controls, those patients have lower levels of serum folic acid, ferritin, and zinc. Although loss of hair often does not lead to severe

Table 7. Descriptive analysis of body weight in the studied cases. (n = 20).

Body weight (kg)	Min–Max.	Mean ± SD	Median (IQR)
Preoperative	100.0–138.0	123.60 ± 11.54	127.0 (116.0–132.50)
After 1 year	66.50–91.0	76.30 ± 6.68	75.50 (71.0–81.0)
Ideal weight after 1 year	49.0–74.82	65.82 ± 5.86	66.83 (62.81–69.31)
%EWL	56.86–105.0	82.41 ± 13.25	81.06 (72.88–93.78)

morbidity, it can result in low self-esteem and mental health problems and negatively impact patient quality of life. Guo et al. found that the onset of hair loss and its end time was 3.4 ± 1.4 months and 9.03 ± 3.6 months, respectively. However, during the 15-month follow-up period, all patients' hair loss stopped and new hair began to grow out.[13] Acute-onset alopecia after BS is often due to telogen effluvium, and like telogen effluvium that occurs due to other causes, the treatment of telogen effluvium due to bariatric surgery includes monitoring for subsequent hair growth. However, hair loss after bariatric surgery can be multifactorial and influenced by more than one factor.[14] This study matches the previous literature's finding that, among our cases, 80 % of patients developed hair loss (100 % of female patients and 20 % of male patients). It started 3 months postoperatively, and after the ninth month, it became less severe. After 1 year, most of the patients' hair returned to its preoperative condition. However, a longer-term follow-up and further investigation in the preoperative and postoperative periods are needed to figure it out.

Although LSG is considered a restrictive type of BS, it may carry some risk of nutritional deficiencies as a result of postoperatively limited caloric intake, food intolerance, and/or restricted food supplementation. Moreover, if there were any nutritional deficiencies preoperatively, they could be worsened after surgery if not identified and managed.[15] Routine screening for folate, vitamin D, vitamin B12, and iron is recommended for all patients.[16] In this study, serum levels of iron, calcium, vitamin B12, and folate, along with a full blood count, were done for all patients 9 months postoperatively. Of the patients, 15 % had low serum iron and iron-deficiency anemia (two girls and one boy). Another 5 % had low serum calcium. We have no cases with detected decreases in serum folate or vitamin B12; however, longer follow-up and screening for other vitamins and minerals are needed.

The risk of developing gastroesophageal reflux disease (GERD) after LSG remains controversial, with many reports subjectively evaluating it soon after surgery. There have been more than five systematic reviews or meta-analyses on this topic to date; the majority of them concluded that GERD is not resolved after LSG and that new-onset GERD could be seen in a large number of patients, but some recently published reviews revealed improvement of GERD symptoms following LSG.[17] Among general bariatric surgeons, GERD was considered a relative contraindication for sleeve gastrectomy; in the Fifth International Consensus Conference about the Current Status of SG, only 23.3 % of experts considered GERD a relative contraindication for LSG, and data suggest that sleeve gastrectomy improves symptoms of GERD.[18] In our study, only one patient (5 % of cases) developed symptoms suggesting GERD, such as heartburn, nausea, and vomiting, 9 months after the operation. Further investigations and longer follow-up are needed to clarify this issue.

In this study, skin redundancy was noticed in 40 % of patients (4 girls and one boy) in the ninth month of the postoperative period. It was marked on the abdomen and arms. It may be due to marked weight loss with suboptimal physical activity, but further investigation and a prolonged period of follow-up are needed to manage this problem appropriately.

Although we only had 20 patients with a 1-year follow-up (because this study was conducted during the COVID-19 pandemic), our study provided preliminary results for the 1-year outcomes of laparoscopic sleeve gastrectomy in pediatric patients that may be valuable for any future studies.

4.1. Conclusion

LSG is a safe and effective intervention for treating morbid obesity in children and adolescents. It has minimal complications and results in the resolution or improvement of most obesity-related comorbidities.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article.

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Conflicts of interest

The authors declared that there were no conflicts of interest.

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