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Original Research Article

Laparoscopic sleeve gastrectomy for morbidly obese children and adolescents in Saudi Arabia

Ahmad M. Kashha[1]*, Abdurrahman F. Mirza[2], Hassan H. Alzebedi[1], Salim M. Kashha[3], Ali M. Assiri[1], Hashim A. Alghamdi[1]

[1]Department of Pediatric Surgery, Maternity and Children Hospital, Abha, Saudi Arabia
[2]Department of Pediatric Surgery, King Abdulaziz Medical City, Jeddah, Saudi Arabia
[3]King Abdulaziz University, Jeddah, Saudi Arabia

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***Correspondence:**
Dr. Ahmad M. Kashha,
E-mail: a-1k1@hotmail.com

ABSTRACT

Background: In this study, laparoscopic sleeve gastrectomy results for pediatric and adolescent patients with morbid obesity over a 4-year period at Maternal and Children Hospital in Abha, kingdom of Saudi Arabia were reported.
Methods: A study reviewed data on 15-year-old or younger Patients who underwent laparoscopic sleeve gastrectomy to manage morbid obesity. Demographics, clinical characteristics, complications, BMI, and symptom resolution were collected from medical records from 2017-2020. Data was obtained from patients' medical records.
Results: Our study showed Postoperative complications occurred in one patient (2.6%), and gallbladder stones were observed in three patients (7.9%), while gastritis was reported in two patients (5.3%). The BMI changes at 6, 12, and 24 months were -7.49, -14.00, and -20.20 kg/m^2, respectively, and the percentage changes in BMI were -16%, -30.69%, and -44.28%. The resolution of symptoms and comorbid diseases was 100% for respiratory symptoms and obstructive sleep apnea, 71.4% for musculoskeletal symptoms, 50% for bronchial asthma and diabetes mellitus, and 25% for hypothyroidism.
Conclusions: Laparoscopic sleeve gastrectomy is a safe and effective method for treating morbidly obese children and adolescents. It achieves considerable weight loss and comorbidity resolution with a low risk of consequences.

Keywords: Children and adolescents, Complications, Laparoscopic sleeve gastrectomy, Morbid obesity, Weight loss

INTRODUCTION

Global obesity epidemic is a major health problem worldwide.[1] Children aged 2-19 years are classified as obese if their BMI is 95th percentile for age and gender, whereas severe obesity is defined as BMI ≥35 kg/m^2 or BMI 99th percentile.[2] Obesity rates have surged, with 18.5% of adolescents aged 2-19 being obese, peaking at 21% for those aged 12-19.[3] 1 in 5 children are overweight and 41 million kids were obese according to World Health Organization.[4] The causes of obesity involve a combination of individual, familial, societal, and environmental factors. Obese children and adolescents are more susceptible to develop cardiovascular and metabolic disorders such as diabetes mellitus type 2 (T2DM), high blood pressure (HTN), obstructive sleep apnea (OSA), non-alcoholic steatohepatitis (NASH), and gastroesophageal reflux disease (GERD). In addition, obesity raises the risk of death, depression, low life quality, and social stigma.[4] Childhood overweight increases the risk of adult obesity by 42-64%.[5] Therefore, early detection and management of pediatric obesity are essential. Obesity treatment involves lifestyle changes, exercise, and behavior therapy as initial steps. Once diagnosed, alternatives such as behavioral therapies, medication, metabolic approaches, and bariatric surgery are available. However, medication and lifestyle changes often fail for weight loss.[6] For adolescents whom are

extremely obese, metabolic and bariatric surgery is a safe and effective option because of its low risk of complications, successful weight loss, and decreased risk of morbidity.[7,8] The American Society for Metabolic and Bariatric Surgery Pediatric committee modified guidelines, widening eligibility criteria and expanding the potential beneficiaries of bariatric surgery.[9] A multidisciplinary pediatric team is necessary for screening, surgery, and postoperative (postop) care in order to provide this group with effective care. Children underwent weight-loss surgery such as vertical laparoscopic sleeve gastrectomy (LSG), adjustable gastric bands, and Roux-en-Y gastric bypass (RYBG). A gastrectomy involves the surgical removal of 80% of the stomach, leaving a tubular-shaped section behind. The most popular operation is a vertical (LSG).[8] Because it reduces nutritional inadequacy and surgical mortality.[8] As far as we are aware, studies on bariatric surgery for extremely obese Saudi kids and teens are limited. The purpose of the study was to assess the safety and efficacy of LSG in managing pediatric patients with morbid obesity and its consequences in Abha, Saudi Arabia over a 4-year period. It also assessed the remission of obesity related symptoms and comorbidities after a 24-month follow-up.

METHODS

Retrospective analysis was done on prospectively collected data pertaining to all patients aged 5 to 15 years who received LSG at Maternity and children hospital, Abha, Saudi Arabia, between 2017 to 2020 for the treatment of morbid obesity. In addition to related symptoms and comorbidities, demographic and anthropometric information was gathered. Surgical information, surgical results, follow-up body mass index, and symptom and comorbidity remission for 24 months were also documented. All children and adolescents with morbid obesity who had LSG treatment at Maternity and children hospital, Abha during the study period made up the sample size of this study.

Preoperative evaluation

Because there are no national regulation that direct bariatric surgery on children or adolescents, patients for LSG evaluated for matched criteria: BMI 40 kg/m^2 with additional co-morbidities (such as HTN, insulin resistance (IR), glucose intolerance, impaired quality of life or daily activities, and dyslipidemia) or BMI 35 kg/m^2 with major co-morbidities, moderate-to-severe OSA, pseudotumor cerebri, or severe (NASH).[10] Prior unsuccessful attempts to achieve weight loss for at least a year through diet and behavioral therapy made patients candidates for surgery were also included. Exclusions from the study were patients with a BMI of 35 kg/m^2 and those who underwent additional bariatric surgeries such as RYBG, biliopancreatic diversion with duodenal switch, and adjustable gastric banding. Excluded patients were those with remediable causes of obesity, substance misuse, and issues hindering post-operative compliance. Patients who lost at least 10% of their initial body weight over a 6-month follow-up period with the multidisciplinary team were also excluded. The following comorbidities have been investigated: hypertension, defined as systolic and/or diastolic blood pressure ≥95th percentile for gender, age, and height; and type 2 diabetes, defined as HA1c ≥6.5 % or fasting plasma glucose (FPG) ≥126 mg/dl; and PSQ is a clinical tool used to assess OSA, and polysomnography is used to investigate the condition. Patients who had an apnea/hypopnea index >2 and a PSQ score >33 are considered diagnosed with OSA.[11] The brief pain inventory was used to evaluate musculoskeletal (MSK) pain.[12] As needed, treatment for these medical conditions was initiated.

Surgical intervention

All patients received standard procedures of five-port LSG, done by same pediatric surgeon. First port inserted under direct vision utilizing 10 mm optical port at infra umbilical site insufflation with CO2 to make pneumoperitoneum at pressure 12-15 mmHg. A 10-mm 30° scope introduced by an infraumbilical port. In addition, two ports inserted at left and right side of abdomen to be used in retraction and manipulation of large stomach one of which is a 12 mm port introduced for instrumentation and laparoscopic stapler and one more 5 mm epigastric port used for retraction of liver. A harmonic scalpel device used for greater omentum division care for gastroepiploic vessels to be preserved and as well short gastric vessels divided then sleeve created with multiple loads of a 60 mm linear automatic endostapler over a 36-F gastric bougie. No reinforcement of suture line is needed. The integrity of the stapled line checked and tested resected part of the stomach retrieved and deflation of abdomen done closure of fascia made using absorbable sutures.

Follow-up

BMI gathered (postop) at 6, 12, and 24 months. BMI loss calculated as final BMI minus initial BMI. Percentage changes of BMI calculated as final BMI minus initial BMI divided by initial BMI and multiplied by 100. Complications and resolution of associated symptoms and comorbidities like T2DM, OSA, GERD, and HTN assessed in follow-up. Attaining a persistent FPG level <7.0 mmol/L and an HbA1c level <6.5% while off anti-diabetes medication is the definition of diabetes mellitus remission.[13] Improvement and remission in OSA are clinically assessed based on changes in symptoms as collected by PSQ.[11] An assessment of changes from baseline is used to evaluate the change in (MSK) pain using Brief Pain Inventory survey.[12] All patients took multivitamin supplement in (postop) period.

Statistical analysis

Data obtained analyzed utilizing IBM SPSS Statistics for Windows, version 23 (IBM SPSS, IBM Corp., Armonk, N.Y., USA). Shapiro–Wilk test utilized to evaluate

normal value distribution. Collected parametric data presented as mean±standard deviation (minimum–maximum); while categorized data presented as frequency (%). BMI at different periods compared with a repeated ANOVA test followed by the Bonferroni test to find difference between different studied periods. A p value less than 0.05 considered statistically significant.

RESULTS

Demographic characteristics of patients

Thirty-eight morbidly obese children and adolescents underwent LSG at our hospital between January 2017 and December 2021, 20 patients (52.6%) female and 18 (47.4%) males. Not a single syndromic case and all patients were Saudi. The age ranged from 5-15 years; with mean age 11.79 years. Mean preoperative (Preop) weight, height and BMI were 103.37 kg (range, 60–176), 150.19 cm (range, 119-164), and 45.62 kg/m^2 (range, 40–70) respectively. 18 patients (47.4%) had associated symptoms, 15 patients (39.5%) had respiratory, 14 (36.8%) had (MSK) and 8 patients (21.1%) had OSA. Number of symptoms presented in the same patient were either 1 (n=6, 15.8%), or 2 symptoms (n=6, 15.8%) or 3 symptoms (n=6, 15.8%). Nine patients (23.7%) had associated disease comorbidities, 5 (13.2%) had (BA), 4 patients (10.5%) had hypothyroidism and 2 patients (5.3%) had DM. Seven patients (18.4%) had only on associated disease, while 2 (5.3%) patients had 2 comorbidity diseases at the same time (Table 1).

Surgery and follow-up

Most operations made at 2019 (n=21, 55.3%) followed by 2020 (n=11, 28.9%), 2018 (n=4, 10.5%) and least at 2017 (n=2, 5.3%). The average length of the surgery was 83.61 minutes range from 45 to 120 min, and the intraoperative estimated blood loss ranged from 3 to 30 ml (mean 11.21 ml). No open approach conversions or intraoperative complications occurred. Nothing per oral (NPO) duration (Postop) had a mean of 3.87 days and a range of 2 to 6 days. The average length of hospital stay was 7.82 days, with a range of 5 to 16 days. 6 patients (15.8%) were admitted to ICU (postop) of them 5 cases (13.2%) admitted due to high BMI for (postop) observation and one case (2.6%) admitted due to (BA) for (Postop) mentoring and 2 patients were readmitted to the surgical ward because of repetitive vomiting and dehydration. (postop) complications reported in one case (2.6%) manifested by epigastric pain and recurrent vomiting for two weeks (postop) investigation revealed renal vein thrombosis, acute kidney injury, and idiopathic intracranial hypertension. Postop follow up revealed gallbladder stones in 3 cases (7.9%) and gastritis in 2 cases (5.3%) (Table 2).

Table 1: Demographic characteristics of patients (n=38).

Characteristics	Value
Gender, N (%)	
Male	18 (47.4)
Female	20 (52.6)
Age at surgery time (years)	11.79±2.24 (5.00-15.00)
Height (cm)	150.19±9.13 (119.00-164.00)
Weight (kg)	103.37±21.77 (60.00-176.00)
Associated symptoms, N (%)	
No	20 (52.6)
Yes	18 (47.4)
Respiratory	15 (39.5)
Musculoskeletal	14 (36.8)
Obstructive sleep apnea	8 (21.1)
Number of symptoms, N (%)	
1	6 (15.8)
2	6 (15.8)
3	6 (15.8)
Comorbid diseases	
No	29 (76.3)
Yes	9 (23.7)
Bronchial asthma	5 (13.2)
Hypothyroidism	4 (10.5)
Diabetes mellitus	2 (5.3)
Number of comorbid diseases	
1	7 (18.4)
2	2 (5.3)

Table 2: Clinical characteristics of patients, operative and postoperative status (n=38).

Characteristics	Value
Years of surgery, N (%)	
2017	2 (5.3)
2018	4 (10.5)
2019	21 (55.3)
2020	11 (28.9)
Surgery durations (min)	83.61±18.26 (45.00-120.00)
Estimated intraoperative blood loss (ml)	11.21±5.28 (3.00-30.00)
NPO duration post-operative (days)	3.87±1.04 (2.00-6.00)
Length of stay (days)	7.82±2.12 (5.00-16.00)
ICU admission, N (%)	
No	32 (84.2)
Yes	6 (15.8)
Bronchial asthma	1 (2.6)
High BMI	5 (13.2)
Readmission, N (%)	
No	36 (94.7)
Yes (vomiting)	2 (5.3)
Postoperative complications	1 (2.6)
Postoperative follow up findings, N (%)	
Gallbladder stones	3 (7.9)
Gastritis	2 (5.3)

Table 3: Comparison of preoperative and postoperative body mass index at different months (n=38).

Items	Baseline	Postoperative follow up months		
		6 months	12 months	24 months
BMI (kg/m^2)	45.62±6.54 (40.00-70.00)	38.13±7.38[a] (30.00-62.00)	31.62±6.99[a,b] (21.00-55.00)	25.42±6.67[a,b,c] (18.00-51.30)
Change in BMI (kg/m^2)	-	-7.49±3.51 (-16- 0)	-14.00±3.71[b] (-21- -7.00)	-20.20±3.96[b,c] (-27- -12)
Percentage change BMI (%)	-	-16%	-30.69%	-44.28%

Changes in BMI calculated as (Postop) BMI – (Preop) BMI. Percentage changes BMI calculated as (Postop) BMI – (Preop) BMI/ (Preop) BMI X 100. a: significance versus baseline BMI; b: significance versus 6 months BMI (Postop); c: significance versus 6 months BMI (Postop).

Table 4: Resolution of symptoms and comorbidities after laparoscopic sleeve gastrectomy.

Items	Preoperative (%)	Last follow-up (%)	Resolution (%)
Associated symptoms			
Respiratory	15 (39.5)	-	15/15 (100)
Musculoskeletal	14 (36.8)	4 (10.5)	10/14 (71.4)
Obstructive sleep apnea	8 (21.1)	-	8/8 (100.0)
Comorbid diseases			
Bronchial asthma	4 (10.5)	2 (5.3)	2/4 (50.0)
Hypothyroidism	4 (10.5)	3 (7.9)	1/4 (25.0)
Diabetes mellitus	2 (2.3)	1 (2.6)	1/2 (50.0)

Weight loss

A repeated measure ANOVA with a Greenhouse-Geisser correction revealed that the mean BMI is statistically different in different times (F=471.917, p<0.0001). Post hoc tests using the Bonferroni correction revealed that LSG elicited a significant reduction in BMI from basal BMI to 6 months after surgery (45.62±6.54 kg/m^2 vs 38.13±7.38 kg/m^2, p<0.0001). After 12 months, BMI reduced to 31.62±6.99 kg/m^2, which was statistically significantly from basal BMI (p<0.0001) and 6 months Postop BMI (p<0.0001). After 24 months, BMI reduced to 25.42±6.67 kg/m^2, which was statistically significantly different from basal BMI (P <0.0001), 6 months Postop

BMI (p<0.0001), and 12 months postop BMI (p<0.0001). Therefore, conclude that a statistically significant decrease in BMI observed by a long-term follow-up of 24 months. The changes in BMI after 6, 12, and 24 months postop were -7.49, -14.00, and -20.20 kg/m^2 respectively that showed a statistically significant reduction over time. The percent changes in BMI after 6, 12, and 24 months. Postop were -16%, -30.69%, and -44.28% respectively (Table 3 and Figure 1).

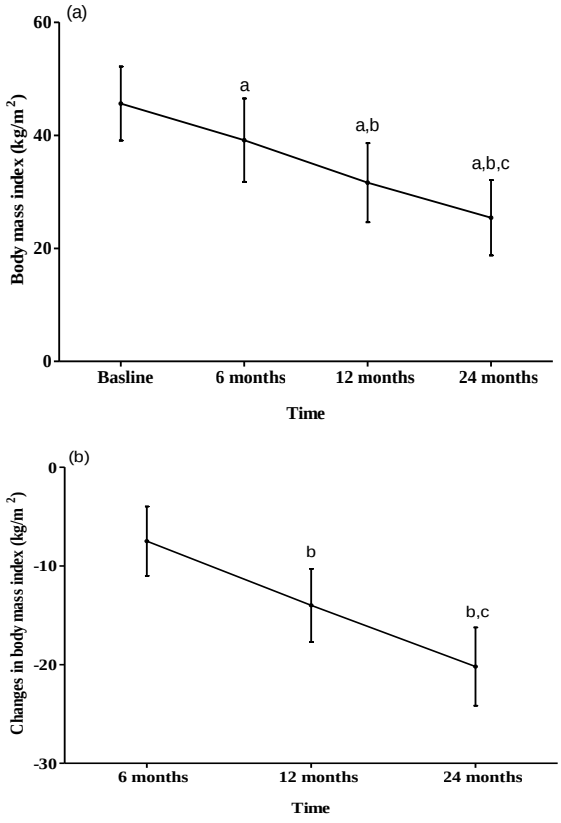

Figure 1: Comparison of (preop) and (postop) body mass index (a) and changes in body mass index (BMI) (b) at different months.

a: significance versus baseline BMI; b: significance versus 6 months BMI (postop).

Impact on laparoscopic sleeve gastrectomy on comorbidities

In all affected patients, LSG led to the remission of respiratory symptoms and OSA. While remission was noted in 10 of 14 patients (71.4%) with (MSK) symptoms, 2 out of 4 patients (50.0%) with (BA), 1 out of 4 patients (25.0%) with hypothyroidism, and 1 out of 2 patients (50.0%) with (DM), remission was not noted in any of the other conditions (Table 4).

DISCUSSION

Bariatric surgery effective treatment, produce long-lasting weight loss and controlling related comorbidities. The total number of bariatric procedures increasing significantly in spite of the unknown long-term consequences, unexplained effects on overall growth, and ethical dilemmas. Likewise, a growing amount of research advocates the use of bariatric surgery as a safe and effective substitute for treating adolescents with morbid obesity.[7,8,14] LSG has become the most popular and commonly performed weight loss surgery in the past decade. It is a simpler, restrictive procedure without adverse effects on absorption, and can be converted into other procedure if necessary.[15] 38 morbidly obese child and adolescent patients had LSG at our unit between January 2017 and December 2021; 20 patients (52.6%) were female and 18 patients (47.4%) were male. No single syndromic case and all patients were Saudi. Their age ranged from 5-15 years; with mean age 11.79 years. The mean Preop BMI was 45.62 kg/m^2 (range 40–70). Blüher et al reviewed LSG in teenagers with severe obesity.[16] The original papers that were part of their study were: a case report of a 16-year-old girl.[17] a case report of a 10-year-old boy.[18] a case report of 16 year old boy.[19] a case series of 4 girls.[20] a case series of 7 female patients (13–18 years).[21] a retrospective case series of 12 patients with morbid obesity aged 12–20 years at the time of bariatric surgery (2 out of 12 had sleeve gastrectomy).[22] a prospective study on 23 adolescents with a mean age of 17.3 years [21] and a retrospective study with 51 patients <19 years.[23] Most LSG surgeries in this study were carried out in 2019 (n=21, 55.3%), followed by 2020 (n=11, 28.9%), 2018 (n=4, 10.5%), and 2017 (n=2, 5.3%). This shows that LSG performance has improved over time. In this study, the average operation time was 83.61 minutes, and the estimated intraoperative blood loss ranged from 3 to 30 milliliters with a mean of 11.21 milliliters. No intraoperative complications or conversions to the open approach. NPO last 2 to 6 days postop. The length of the hospital stay 5 to 16 days. 6 patients (15.8%) were admitted to the ICU postop, of which 5 cases (13.2%) were admitted due to high BMI for Postop observation, 1 case (2.6%) was admitted due to (BA) for postop mentoring, and 2 patients were readmitted to the surgical ward due to persistent vomiting and dehydration. In this study, epigastric discomfort and recurrent vomiting were described as perioperative complications in one instance (2.6%); further testing indicated renal vein thrombosis, acute kidney damage, and idiopathic intracranial hypertension. <4% patients had perioperative complications, mostly minor According to Alqahtani et al.[13] 30-day complications rate: 2.7-4.5% in other study.[24] Readmission and reoperation rates were 1.5%.[25] According to Tuna et al, there was no surgical morbidity or mortality following LSG, indicating that the procedure is safe.[26] Postop follow up in this research revealed gallbladder stones in 3 cases (7.9%) and gastritis in 2 cases (5.3%). A study revealed an increasing GERD symptoms prevalence from 9% to 26% over first 5 years in adolescents after LSG.[27] According to Tuna et al, two of the three patients (19%) who had gallstone disease underwent cholecystectomy.[26] Globally, 13% of reoperations in Teen-LABS research were cholecystectomy (8%). Additional reasons included wound drainage, RYGB conversion, and hernia repair.[14]

Despite all the data, many medical professionals still oppose sending kids and teenagers for bariatric surgery.[14] In 2010, half of U.S.A doctors opposed bariatric surgery for obese adolescent, preferring a yearlong weight-management program, and 65% suggested minimum age of 18 years for surgery.[28] Statistically significant reduction in BMI observed after 24 months of LSG operation in this study. The changes in BMI after 6, 12, and 24 months Postop were -7.49, -14.00, and -20.20 kg/m^2 respectively that showed a statistically significant reduction over time. The percent changes in BMI after 6, 12, and 24 months postop were -16%, -30.69%, and -44.28% respectively. According to Alqahtani et al patients' percent excess weight loss (%EWL) at 3, 6, 12, and 24 months following LSG was 28.9%, 48.1%, 61.3%, and 62.3%, in that order.[29] Teen-LABS carried out a multicenter prospective analysis of outcomes, involving 242 patients with a mean BMI of 53 kg/m^2 and an age of 17 years. 67 patients got LSG procedures. In addition, after three years, the mean decrease in body weight was 38 kg (26%) and the mean decrease in BMI was 13 kg/m^2.[14] In this study, there were 18 patients (47.4%) with related symptoms, 15 (39.5%) with respiratory symptoms, 14 (36.8%) with (MSK) symptoms, and 8 (21.1%) with OSA. There were either 1 (n=6, 15.8%), 2 (n=6, 15.8%), or 3 (n=6, 15.8%) symptoms present in the same patient. 9 patients (23.7%) had concomitant diseases, including 5 (13.2%) with (BA), 4 (10.5%) with hypothyroidism and 2 (5.3%) with type 2 diabetes. Two patients (5.3%) had two comorbid conditions concurrently, while seven (18.4%) patients had only one related disease. More than 90% of the patients had at least one co-morbidity, and over half had three or more, according to Alqahtani et al.[13] Pre-existing co-morbidities fully recovered within a year after LSG.[13] In 192 patients (85.0%) had NAFLD, of which 26 patients (13.5%) had bridging fibrosis and 65 patients (33.9%) developed NASH.[13] In this study, LSG eliminated all affected individuals' OSA and respiratory symptoms. Remission was recorded in 10 of 14 (71.4%) patients with (MSK) complaints, in 2 of 4 (50.0%) patients with (BA), in 1 of 4 (25.0%) patients with hypothyroidism, and in 1 of 2 (50.0%) patients with T2DM. LSG is a safe and effective procedure in the short term, with a 12- to 24-month follow-up. Minimum morbidity and the resolution of up to 70% of patients' pre-existing comorbidities are associated with it.[21,23] Comorbidity resolution rates between 50% and 100% reported, diabetes remission and IR the best.[14] Diabetes, dyslipidemia, and (HTN) improve by 94% (15/16), 70% (21/30), 75% (27/36) in Alqahtani et al , and by 50% (1/2) 58% (7/12) 100% (4/4) in Boza et al at three years following surgery, 95% of adolescents in US research had remission of T2DM, and 76% had remission of prediabetes (161 RYBG and 67 LSG).[13,14,23] With a more prolonged follow-up duration of up to 46 ± 9 months, no adolescents relapsed and 75% of the (DM) had full resolution in El-Matbouly et al study.[30] According to Tuna et al LSG is 100% effective in remission of OSA, IR, and hyperuricemia. Effects on (HTN), dyslipidemia, and NAFLD were more diffident but Considerable.[26] Of the 226 children and adolescents in Saudi Arabia, 40% had an OSA diagnosis, and more than 90% of them improved postop**.**[13] El-Matbouly et al found that although 7 (63.6%) of the 11 adolescents with OSA had stop BI-PAP at 6–12 months postop, which is in line with other research findings.[13,30] These findings highlight treating pediatrics obesity to avoid obesity-related co-morbidities in adulthood. Several obstacles arise when bariatric surgery is used to help severely obese children and teenagers lose weight. Surgery-related weight loss and problems are comparable to those experienced by adults, but its use in children is concerned due to worries about potential growth effects in patients who have not achieved puberty or skeletal maturity. Long-term commitment and lack of information on success and effects in adolescents require careful patient selection. Treating comorbid conditions earlier reduces the risk of surgery and irreversible complications.

Limitations

This study's limitations include its retrospective study methodology, which introduces all the biases that go along with it, and the inability to obtain part of the data. Additionally, although our findings are similar with those in the literature, the small sample size hinders generalization. Last but not least, there are fewer patients at each follow-up point because they missed their follow-up visit.

CONCLUSION

In the short-term (follow-up 24 months), the laparoscopic sleeve gastrectomy was performed on children and adolescents was demonstrated to be a safe and effective bariatric treatment with the exception of 5 patients, three of whom had gall bladder stones and two of whom had gastritis. Long-term results with larger samples of children and adolescents and involving additional factors, like nutritional and psychological status, are required to better understand the efficacy and safety of this treatment as well as to look into its possible long-term benefits for children and adolescents. Additionally, it is critically necessary to conduct randomised, controlled trials to examine conventional treatment options for childhood and adolescent morbid obesity, as well as bariatric methods. More than 90% of co-morbidities that are treated with laparoscopic sleeve gastrectomy in children and adolescents are resolved or improved. Additionally, it produces successful weight loss and regular growth and is linked to safe outcomes. Future research may develop recommendations depending on the severity of co-morbidities and the predictors of their resolutions as opposed to absolute age and BMI.

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