Laparoscopic Sleeve Gastrectomy as a Surgical Modality in Management of Pediatric Obesity

Tamer M. Nabil[1] M.D, Ahmed H. Khalil[2] M.D, MRCS, Mohamed M. Elbarbary[3] M.D
[1]Department of general surgery, faculty of medicine, Beni Sueif University
[2]Department of general surgery, faculty of medicine, Cairo University
[3]Department of pediatric surgery, faculty of medicine, Cairo University

ABSTRACT

Background: *Obesity affects any age, gender and nationality. Pediatric obesity is considered worldwide problem leading to many serious associated health hazards. Untreated obese children will lead to morbid obesity in adulthood. Nonsurgical weight loss programs including exercise, life style modification, diet regimens and weight loss medications rarely have successful results making bariatric surgery an excellent, effective and safe solution for treating obesity and its associated health hazards without affecting the child growth.* ***Patients & methods:*** *This prospective study included 15 morbidly obese patients for whom laparoscopic sleeve gastrectomy (LSG) was done in Cairo and Beni Sueif university hospitals during the period between December 2015 and December 2018. Inclusion criteria were age ≤ 18 years with body mass index (BMI) ≥40 kg/m^2 (> 95th percentile for age) or BMI ≥35 kg/m^2 and associated with obesity comorbidities. Exclusion criteria included patients with mental retardation, impaired movement, psychological instability, endocrinal disorders causing obesity as hypothyroidism, any contraindication to surgery and those who didn't previously participate in weight loss program. All patients were followed up for one year.* ***Results:*** *The study included 8 male patients (53.3%) and 7 female patients (46.7%) with a mean age of 13±1.41 years. The mean BMI of our patients is 51.33±10.77 Kg/m^2 , the mean operative time is 48.67±5.5 minutes, the mean hospital stay duration of 2.93±1.53 days. In this study 7 patients (46.7%) had co-morbidities. There was significant reduction in the BMI of the patients one year after surgery, it ranged between 22.8 – 55.4 kg/m^2 with a mean of 29.5±8.29 kg/m^2 . The percentage of the excess body weight loss (% EBWL) ranged between 31.8 and 95% with a mean of 77.37±18.56 one year after surgery with satisfactory results achieved in 13 patients (EBWL 63.5% - 95% after 1 year) .The % EBWL in the remaining 2 cases was 31.8 and 45% one year after surgery. The mean preoperative height was 154.73±19.16cm and the patients gained height by a mean of 160.47±19cm one year after surgery (p<0.001) making LSG safe on children growth. One complication was encountered in one patient (6.66%) in the form of bleeding that was managed successfully by conservative measures. Mortality was not encountered.* ***Conclusion****: LSG is a safe reliable solution providing effective sustained body weight loss for morbid obese pediatric patients together with improvement of obesity associated health hazards without adverse effect on children growth.*

Key Words: *Morbid obesity, sleeve gastrectomy, pediatric obesity, bariatric surgery.*

INTRODUCTION

From 1980 to 2013, the prevalence of overweight and obesity in children increased by nearly 50% [1]. Currently 10% of children worldwide are either overweight or obese [2]. The body mass index (BMI) growth curves define children in the 85th to 95th percentile range as overweight, while those >95th percentile is defined as obese [3]. Similar to adult population, lifestyle modification as diet regimen, exercise, and behavior changes rarely results in significant and durable weight loss [4] making bariatric surgery the effective and successful solution [5].Untreated obesity results in various health hazards as type 2 diabetes mellitus, hyperlipidemia, hypertension and obstructive sleep apnea (OSA) [6]. Laparoscopic sleeve gastrectomy is a popular, safe and effective tool for treatment of obesity and resolution or improvement of its associated comorbidities [7]. The aim of this work is to study the feasibility and safety of laparoscopic sleeve gastrectomy (LSG) in obese pediatric patients as well as its effect on their growth.

PATIENTS AND METHODS

This is a prospective study conducted on 15 morbidly obese pediatric patients in Cairo and Beni Sueif university hospitals during the period between December 2015 and December 2018. Inclusion criteria were age ≤ 18 years with BMI ≥40 kg/m^2 (> 95th percentile for age) or BMI ≥35 kg/m^2 and associated with obesity comorbidities as type 2 diabetes mellitus, hyperlipidemia, hypertension and obstructive sleep apnea. All included patients should have failed to achieve significant weight loss (10 % of baseline body weight) despite participation in a formal weight management program. Exclusion criteria included patients with mental retardation, impaired movement, psychological instability, endocrinal disorders causing obesity as hypothyroidism, any contraindication to surgery and those who didn't previously participate in weight loss program. All patients were subjected to proper history taking, full clinical examination to assess obesity and its associated health hazards and routine laboratory investigations in the form of complete blood count (CBC), liver functions tests, kidney functions tests, fasting blood sugar (FBS), coagulation profile and lipid profile. Cardiological assessment was done by echocardiography and electrocardiomyography (ECG). Pulmonary functions tests and chest X-ray were done to all patients to assess the chest condition. An informed written consent was signed by the patients' parents explaining the surgical procedure as well as any expected complications.

Surgical technique:

Under general anaesthesia, the patient was placed in supine position; prophylactic dose of intravenous antibiotic was administered. Five trocars were applied through which mobilization of the gastric greater curvature was done starting 3 cm proximal to the pylorus till the gastro-oesophageal junction using sealing devices. A 36 Fr orogastric tube was introduced till the 1st part of the deudenum along the lesser curvature. An stapler was used to divide the stomach alongside of the orogastric tube. The staple line was inspected properly and hemostasis is performed. The orogastric tube was pulled proximally till the cardia then methylene blue was injected through the tube while the pylorus was closed by non-traumatic grasper to exclude leakage. The resected part of the stomach was extracted and a nelaton tube drain was introduced alongside of the staple line.

Follow up:

Vital signs and drain output were monitored. Intravenous antibiotics, antiemetics and proton pump inhibitors (PPI) as well as subcutaneous anticoagulants (low molecular weight heparin 40mg/ 24hrs for 2 weeks) were administered. Oral gastrographin meal was done to all patients on the next postoperative day to exclude leakage after which the drain was removed, oral intake was started and the patients were discharged. All Patients were instructed to continue on PPI for 6 months, subcutaneous anticoagulants for 2 weeks to guard against development of portal vein thrombosis, daily oral doses of multivitamins for at least 6 months. The diet regimen was prescribed in the form of sugar free fluids for the first 2 weeks, carbohydrate and fat free soft diet was added starting the 4th week. Regular healthy fat and carbohydrate free diet was introduced starting the 6th week. All patients were encouraged to perform regular physical exercise one week after surgery 3 times weekly. Patients were informed about the schedule of their visits to the outpatient clinic to monitor weight loss and manage any postoperative complaints. Follow up was performed by multidisciplinary team including surgeons, dieticians and pediatric consultants. Postoperative laboratory investigations in the form of CBC, lipid profile, liver and renal function tests and serum calcium, iron and vitamins were requested at 6 and 12 months after surgery. Statistical analysis was done using IBM© SPSS© Statistics version 19 (IBM© Corp., Armonk, NY, USA). Numerical data were expressed as a mean and standard deviation and median and range. Qualitative data were expressed as frequency and percentage. Chi-square test (Fisher's exact test) was used to examine the relationship between qualitative variables. For quantitative data, the comparison between the two groups was made using independent sample t-test. A p-value < 0.05 was considered significant.

RESULTS

This prospective study was conducted over 15 morbidly obese pediatric patients for whom LSG was done. It included 8 males (53.3%) and 7

females (46.7%). The age ranged between 9 - 15 years with a mean age of 13±1.4 years. The patients' BMI ranged between 40.4 - 79 kg/m^2 with a mean of 51.33±10.77 kg/m^2. Seven patients (46.7%) had co-morbidities, one was diabetic on oral hypoglycemic medications, one had hypertension and one had hyperlipidemia. The remaining 4 cases suffered joint pain three of them due to Blount's disease. After surgery, gradual improvement of these comorbidities occurred with cessation of the medication after complete resolution. Joint pain improved gradually and patients with Blount's disease underwent surgical correction after stabilization of their body weight. Table (1) shows the demographic data of the included patients.

Table (1): demographic data of the patients

Total number of cases	Male (%)	Female (%)	Range of age (years)	Mean age (years)	BMI range (kg/m^2)	Mean BMI (kg/m^2)	Associated comorbidities (%)
15	8(53.3)	7(46.7)	9-15	13±1.4	40.4 - 79	51.33±10.77	7(46.7)

The operative time ranged between 40 – 60 minutes with a mean time of 48.6 ± 5.5 minutes (table2). The hospital stay ranged between 2 – 7 days with a mean of 2.93± 1.53 days (table 2).

Table (2): operative time and hospital stay in our study

	Operative time (min.)	Hospital stay (days)
Mean	48.67	2.93
Median	50	2
Std. deviation	5.5	1.53
Minimum	40	2
Maximum	60	7
Range	20	5

There was significant weight reduction from 121.07±27.4 kg before surgery to 102.2± 20.58 kg 1 month after surgery till it reached 75.46±14.03kg after 1 year (p= 0.001) as shown in table(3).

Table (3): body weight (Kg) before surgery and during follow up period.

Body weight (Kg)	Preoperative Weight (Kg)	After 1month	After 3 months	After 6 months	After 1 year	P value
Mean	121.07	102.2	91.93	82.47	75.46	**<0.001**
Median	118	108	96	84	73	
Sd.deviation	27.4	20.5	17.85	15.48	14.03	
Min	64	58	55	52	50	
Max	170	131	121	112	102.5	
Range	106	73	66	60	52.5	

The percentage of the excess body weight loss (EBWL) ranged between 31.8 and 95% with a mean of 77.37±18.56 one year after surgery with satisfactory results achieved in 13 patients (EBWL 63.5% - 95% after 1 year) .The percentage of EBWL in the remaining 2 cases was 31.8 and 45% 1 year after surgery due to bad compliance of the patients. There was significant reduction in the BMI of the patients one year after surgery, it ranged between 22.8 – 55.4 kg/m^2 with a mean of 29.5±8.29 kg/m^2 (between 85th & 99th percentile on growth curves with a mean of 92.8th percentile) as illustrated in table (4).

Table (4): Follow up BMI 1 year after surgery.

BMI (Kg/m^2)	BMI after 1 year (kg/m^2)	BMI after 1 year on growth curves
Mean	29.5	92.8
Median	26	93
Mode	22.8	95
Std. Deviation	8.299	4.29
Range	32.6	14
Minimum	22.8	85
Maximum	55.4	99

Surgery didn't affect the growth of our patients. The mean preoperative height was 154.73±19.16cm and the patients gained height by a mean of 160.47±19cm one year after surgery ($p<0.001$) as shown in table (5).

Table (5): One year follow up of the patients' height.

Height (cm)	Preoperative (cm)	After 1 year (cm)	P value
Mean	154.7	160.47	**<0.001**
Median	159	165	
Std. deviation	19.16	19.03	
Minimum	90	95	
Maximum	179	180	
Range	89	85	

One complication was encountered in one patient (6.66%) in the form of bleeding that was managed successfully by conservative measures without surgical intervention. There was no mortality in our study.

DISCUSSION

Obesity can affect any age, gender and nationality. In United States, 4-7% of children between the ages of 6-19 years are affected by severe obesity which is an important predictor of severe obesity in adulthood[8]. Obesity may be associated with several comorbidities as type 2 diabetes mellitus, hyperlipidemia, hypertension and obstructive sleep apnea, early intervention by specific diet regimen, exercise or weight loss surgery (WLS) can prevent or treat these comorbidities [9]. However, surgical risk, nutritional challenges, long term results and impact on growth contribute to the refusal of some physicians to the surgery as a solution for obesity. No empiric data firmly support their opinion [10]. Significant sustained excess body weight reduction is rarely achieved by life style modification (diet and exercise programs) while it can be easily obtained by bariatric surgery which is now considered the most effective solution for morbid obesity. It is performed by multidisciplinary team including surgeons, dieticians, pediatricians and psychiatric consultants [11-13]. Despite increasing evidence adopting bariatric surgery as an effective reliable solution for morbid obese children, yet some physicians still believe in postponing this solution till late adolescence and instead follow non-surgical weight loss management program (NSWM), the latter showed high failure disappointing results [14]. In addition current weight loss medication didn't show successful weight loss results, have side effects and some are not licensed for use. Patient noncompliance as missing doses, improper dose interval and early drug discontinuation led to disappointing results [15&16].

In a systematic review and meta-analysis of bariatric surgery in pediatric patients, five studies presented the results of LSG with a follow-up between 6 and 24 months. BMI before surgery ranged between 41.8–54.5 kg/m^2 with a mean of 48.1 kg/m^2, and BMI loss in these studies ranged between 10.8–17.5 kg/m^2 with a mean of 14.1 kg/m^2 [17]. In 2016, Alqahtani and colleagues published their study conducted on 116 morbidly obese children younger than 14 years with a

mean weight of 103.7±26.3 kg, a mean height of١٤٧.٨ ±١٤.5 cm., and a mean BMI of 45.3±7.6 Kg/m^2 reported loss average of 64% of their excess weight. The BMI continued to decrease, with these young children losing 17.3±2.5 points by the fifth postoperative year [18]. McGuire and colleague performed LSG on 59 adolescents with morbid obesity. The average age was 17.2 years, 81% were women, average pre-operative weight was 144kg and average BMI was approximately 51 Kg/m^2 .The average hospital stay was 1.7 days. There was an average of 32.4% EBWL and 17.8% decrease in BMI at 3 months. At 6months, an average of 38.6% EBWL and 21.6% decrease in BMI was achieved, which increased to 24.9% at 12 months [19]. However a series including 51 patients with a range of age between 15 -19 years done by Boza & colleagues reported that EBWL was 94.6%, 96.2% and 92.9% at 6months, 1 year and 2 years postoperatively respectively [20]. In our study, the patients' weight ranged between 64 and 170 kg. The height ranged between 90 and 179 cm. Their BMI ranged between 40.4 and 79 Kg/m٢with a mean of 51.33±10.77 Kg/m٢. There was significant reduction in the BMI of the patients one year after surgery, it ranged between 22.8 – 55.4 kg/m^2 with a mean of 29.5±8.29 kg/m^2. The percentage of EBWL ranged between 31.8 and 95% with a mean of 77.37±18.56 one year after surgery with satisfactory results achieved in 13 patients (EBWL 63.5% - 95% after 1 year). The operative time ranged between 40 and 60 minutes with a mean time of 48.67±5.5 minutes. The hospital stay ranged between 2 and 7 days with a mean duration of 2.93±1.53 days.

A meta-analysis studying the effect of LSG on obesity associated comorbidities showed resolution of hypertension in 75-100% of cases while hyperlipidemia improved in all cases with resolution rates of 58-70% of cases. The resolution rate of diabetes was 50-93.8% of obese patients [17]. Alqahtani and colleagues in their study had 11 (9.5%) diabetic patients, 20 patients (17.2%) had dyslipidemia, 32 (27.6%) had hypertension, and 52 (44.8%) had OSA. Remission was observed in all cases of diabetes, and in all but 2 cases of OSA. Overall, 87% of co-morbidities were in complete remission, and all co-morbidities showed varying resolution ranging from improvement to complete remission [18]. In our study we had 7 patients (46.7%) with comorbidities. One patient (6.67%) was diabetic, another one had hypertension. Hyperlipidemia was encountered in one patient and 4 patients (26.67%) complained of joint pain 3 of them had Blount's disease. All comorbidities of our patients improved gradually postoperative and medications of diabetes & hypertension were stopped with regaining normal levels of lipid profile and serum blood glucose. Those with Blount's disease are planned for surgical correction after stabilization of the body weight.

One of the most debatable points in pediatric bariatric surgery is affection of growth after surgery. There is lack of sufficient data concerned with the longtime follow up of the growth of pediatric obese patients after LSG except the study of Alqahtani et al. in which they compare between the pediatric patients who underwent LSG and control group on NSWM program. Children who underwent surgery before age 14 had a mean preoperative height of 147.8±14.5 cm and the mean one year post-operative was 154.3±14.3 cm. These patients gained a mean of 4.9±4.0 cm in one year while Children who were on NSWM program had a mean height of 146.6±13.8 cm and the mean height after one year was 148.1±13.2 cm. These patients gained a mean of 1.5±2.1 cm in one year. The patients who underwent surgery gained a mean of 14.5±3.2 cm in the 5 years after surgery, compared with 12.3±6.4 cm for the same duration in the control group. Children who underwent LSG experienced significant growth with an average rate of 0.9 mm more per month than their matched controls who were on NSWM. By the fourth year, The LSG group had experienced a statistically significant increase in height, gaining 5.3cm more compared with the NSWM group [18]. In our study, the mean preoperative height was 154.73±19.16cm and that one year after surgery was 160.47±19.03 cm. These patients gained a mean of 5.6±0.13 cm in one year ($p<0.001$). Studies reported that height changes gained by obese children improved after LSG compared with those who do not undergo surgery who showed a decline in the growth rate compared with the normal population **[21]**.

The complications reported in five studies including 272 patients were two peri-operative complications (0.7%) with no mortality. The incidence of wound infection was 2.0%. Late complications occurred in 1.2% with gastrointestinal complaints in 4.9% of the patients

[17]. Alqahtani reported that four (3.4%) children experienced complications: Postoperative wound infection was reported in 2 patients, 1 patient had gastroesophageal reflux symptoms (controlled with proton-pump inhibitors), and 1 patient developed nausea and vomiting. No major complications, including leaks, readmission, bleeding or reoperations were observed [18]. In our study, we had one complication (6.67%) in the form of post-operative bleeding that was successfully managed conservatively. Mortality was not encountered in the study.

CONCLUSION

Pediatric obesity is a worldwide problem with alarming rates in children and adolescents. Without intervention this will lead to even more obese adults. LSG is an excellent safe solution providing significant and sustained excess weight loss with improvement or resolution of obesity associated co-morbidities without any affection of growth.

REFERENCES

1. Ng, Marie; Fleming, Tom; Robinson, Margaret; Thomson, Blake; Graetz, Nicholas; Margono, Christopher; Mullany, Erin C; Biryukov, Stan; Abbafati, Cristiana; Abera, Semaw Ferede; Abraham, Jerry P; Abu-Rmeileh, Niveen M E; Achoki, Tom; Albuhairan, Fadia S; Alemu, Zewdie A; Alfonso, Rafael; Ali, Mohammed K; Ali, Raghib; Guzman, Nelson Alvis; Ammar, Walid; Anwari, Palwasha; Banerjee, Amitava; Barquera, Simon; Basu, Sanjay; Bennett, Derrick A; Bhutta, Zulfiqar; Blore, Jed; Cabral, Norberto; Nonato, Ismael Campos; et al. (May 29, 2014). "Global, regional, and national prevalence of overweight and obesity in children and adults during 1980—2013: a systematic analysis for the Global Burden of Disease Study 2013". The Lancet. 384 (9945): 766–781.
2. Bessesen DH (June 2008). "Update on obesity". J. Clin. Endocrinol. Metab. **93** (6): 2027–34.
3. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, et al. CDC growth charts: United States. Adv Data. 2000; (314):1–27.
4. McGovern L, Johnson JN, Paulo R, et al. Clinical review: Treatment of pediatric obesity: A systematic review and meta-analysis of randomized trials .J Clin Endocrinol Metab 2008; 93:4600–4605.
5. Michalsky M, Reichard K, Inge T, et al. ASMBS pediatric committee best practice guidelines. Surg Obes Relat Dis 2012; 8:1–7.
6. Inge TH, Krebs NF, Garcia VF, et al. Bariatric surgery for severely overweight adolescents: concerns and recommendations. Pediatrics 2004 ; 114:217–223.
7. Till H, Blüher S, Hirsch W and Kiess W: Efficacy of laparoscopic sleeve gastrectomy (LSG) as a stand-alone technique for children with morbid obesity. Obes Surg 2008; 18(8):1047–1049.
8. Childhood Obesity Facts. Available at http://www.cdc.gov/healthyyouth/obesity/ facts.htm.
9. Inge TH, Krebs NF, Garcia VF, et al. Bariatric surgery for severely overweight adolescents: concerns and recommendations. Pediatrics 2004 ;114:217–223.
10. Woolford SJ, Clark SJ, Gebremariam A, et al. To cut or not to cut :physicians' perspectives on referring adolescents for bariatric surgery. Obes Surg 2010; 20: 937–942.
11. McGovern L, Johnson JN, Paulo R, et al. Clinical review: Treatment of pediatric obesity: A systematic review and meta-analysis of randomized trials . J Clin Endocrinol Metab 2008; 93:4600–4605.
12. Michalsky M, Reichard K, Inge T, et al. ASMBS pediatric committee best practice guidelines. Surg Obes Relat Dis 2012; 8:1–7.
13. Buchwald H, Oien DM. Metabolic/bariatric surgery worldwide 2011 . Obes Surg. 2013;23:427–436.
14. Savoye M, Nowicka P, ShawM, et al. Long-term results of an obesity program in an ethnically diverse pediatric population. Pediatrics .2011;127:402–410.

15. Chanoine JP, Hampl S, Jensen C, Boldrin M, Hauptman J. Effect of orlistat on weight and body composition in obese adolescents: a randomized controlled trial [published correction appears in JAMA. 2005;294:1491 .[JAMA. 2005; 293:2873–2883.
16. Kendrick JG, Carr RR, Ensom MHH. Pharmacokinetics and drug dosing in obese children. J Pediatr Pharmacol Ther. 2010;15:94–109.
17. Givan F. Paulus & Loes E. G. de Vaan. Et al.; Bariatric Surgery inMorbidly Obese Adolescents: a Systematic Review and Meta-analysis. OBES SURG (2015) 25:860–878.
18. Alqahtani AR, Elahmedi M, Alqahtani YA.; Laparoscopic sleeve gastrectomy in children younger than 14 Years. Ann Surg (2016); 263: 312–319.
19. M.M. McGuire et al.; Laparoscopic vertical sleeve gastrectomy for adolescents with morbid obesity. Seminars in Pediatric Surgery (2014); 23: 21–23.
20. Boza C, Viscido G, Salinas J, et al. Laparoscopic sleeve gastrectomy in obese adolescents: results in 51patients. Surg Obes. 2012; 8: 133–139.
21. Lidar Z, Behrbalk E, Regev GJ, et al. Intervertebral disc height changes after weight reduction in morbidly obese patients and its effect on quality of life and radicular and low back pain. Spine (Phila Pa 1976). 2012; 37:1947–1952.