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Laparoscopic sleeve gastrectomy for treatment of type 2 diabetes mellitus in adolescents

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Abstract

Background: Metabolic diseases have been associated with childhood obesity no longer restricted to adults as previously known. Hypertension and diabetes mellitus (DM) have been reported in children with morbid obesity. Laparoscopic sleeve gastrectomy (LSG) has been used as a primary procedure for weight control among children and adolescents with acceptable records of effective weight loss together with evidence of improvement of associated co-morbidities.

Results: Thirty-two patients were diagnosed with morbid obesity and DM presented to obesity and nutrition clinic and were included in this study. Laparoscopic sleeve gastrectomy (LSG) was the chosen operation to treat their obesity and associated co-morbidities. Fasting blood sugar and HbA1c were measured before the operation and 1 year after surgery. Twenty-seven patients had significant improvement of their glycemic profile and managed to stop the hypoglycemic medication.

Conclusion: LSG may play an important role as a metabolic control procedure rather than a bariatric restrictive procedure only.

Background

Obesity in children and adolescents became a global problem with three times increase in percentage among communities through the past three decades [1]. Metabolic diseases have been a serious association with childhood obesity, and the previously called adult diseases like hyperlipidemia, hypertension, and type 2 diabetes mellitus have been reported in much younger ages and with greater prevalence among patients with morbid obesity [2].

Demographic representation of obesity with associated metabolic disturbance has shown a higher prevalence in specific regions than others; the Middle East and North Africa scored 7% morbid obesity among the pediatric age group [3].

Laparoscopic sleeve gastrectomy (LSG) has been used as a primary procedure for weight control among children and adolescents with acceptable records of effective weight loss together with evidence of improvement of associated co-morbidities [4].

We are introducing our series of pediatric patients with morbid obesity who underwent weight control surgery; we are aiming through this study to clarify the changes in glycemic pattern after performing LSG operations in morbid obese children with associated type II diabetes mellitus.

Methods

It is a prospective study on the patients who were operated during the period between January 2019 and January 2020. During the 1-year study period, we received three hundred fifty-two morbidly obese (above the 99th

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percentile) less than 19 years old in our bariatric surgery clinic of whom 57 were diabetic. Exclusion criteria were contraindication to laparoscopy, patients in need of insulin for glycemic control, use of drugs causing obesity, and endocrine or genetic syndromes associated with obesity. Twenty-five patients were excluded as per the exclusion criteria: 12 uncontrolled diabetics, 9 had endocrine and genetic syndromes associated with obesity, and 4 were unfit for laparoscopy (2 respiratory function tests and 2 previous laparotomies).

Thirty-two patients were enrolled in the study; all had morbid obesity and type 2 diabetes mellitus (DM) and were scheduled for lap sleeve gastrectomy (LSG) as a primary procedure for weight reduction. All patients had a body mass index (BMI) $\geq 35\,kg/m^2$ with their weight above the 99th percentile, and they were diagnosed as type 2 DM as fasting blood glucose was > 126 mg/dl and HbA1C > 6.5% [5]. All included patients had to start oral hypoglycemic medications for at least 1 year and were successfully controlled [6].

Our primary outcome target was studying the effect of the surgery on type 2 DM by measuring fasting blood glucose and HbA1C before surgery and 1 year after surgery, while the secondary outcome was to measure the excess weight loss (EWL) during the first year after surgery.

Remission of type 2 DM was considered when postoperative levels of HbA1C score less than 6.5% and fasting blood glucose less than 126 mg/dl while on no oral medications or insulin.

Results

During the period of the study, 32 patients with obesity and co-morbidity were enrolled, their mean age was 17 ± 0.97 years (11.5–18.5), mean weight was 141.19 ± 14.96 kg (117–167), and mean BMI was $49.2 \pm 3.4\,kg/m^2$ (range $46–52\,kg/m^2$) (Table 1).

Preoperative preparation included wrist X-ray to determine bone age, pelviabdominal ultrasound, thyroid profile, and lipid profile. Patients received a prophylactic dose of amoxicillin-clavulanic acid with induction of anesthesia. All the patients had LSG with a mean operative time of 45 ± 9.4 min, and no intra-operative complications were recorded in any of the patients. Postoperatively, patients received non-steroidal anti-inflammatory drugs, proton pump inhibitors, and low molecular weight heparin for DVT prophylaxis. Clear fluids were administered 24 h after surgery proceeding to a soft diet on the next day and sent home once off IV fluids. Follow-up included clinic visits at 1 week, 1 month, and every 3 months for 1 year. Fasting blood sugar and HbA1C were measured 1 month postoperatively then every 3 months. None of our patients had early complications (wound infection or anastomotic leakage). There was an overall improvement of the glycemic profile in our patients who showed decreased levels of FBS and HbA1c (Figs. 1 and 2). HbA1c ranged from 7.3 to 11.2, 606 to 11.3, 6.1 to 10.9, and 6.1 to 11.1 before surgery, 3 months after surgery, 6 months after surgery, and 1 year after surgery respectively.

In 27 patients (84.3%), the mean levels of fasting blood sugar showed levels below 126 mg/dl and monthly measurements of HbA1c showed levels below 6.5% by the end of the period of follow-up without the use of oral hypoglycemic drugs, while in 5 patients (15.6.6%), there was no significant decrease in their levels after 3 months after the surgery in the absence of hypoglycemic drugs (3 patients showed partial improvement and 2 patients showed no changes) and were considered to be resistant cases (Table 2) so oral hypoglycemic drugs had to be restarted to avoid hyperglycemia.

Regarding weight loss, 29 patients (90.6%) lost more than 65% of the excess weight after 1 year from the surgery with no recorded late complications (reflux, nutritional deficiency, or undesired weight loss) (Table 3).

Four patients had repeated attacks of easy fatigability despite their normal postoperative blood picture and resolved within an approximate period of 6 weeks with an empirical course of multivitamins.

Table 1 Description of the sample demographic data

		N* (%)** **Mean ± *SD
Sex	Male	19 (59.38%)
	Female	13 (40.63%)
Weight		141.19 ± 14.96 (117–167)
Age		17.03 ± 0.97 (11.5–18.5)

Discussion

Sedentary lifestyle and changes of feeding habits are the main avoidable predisposing factors for children obesity. Other factors include familial, psychological, socioeconomic, use of some drugs, and endocrine and genetic syndromes associated with obesity. Screening and treating children with obesity has been the goal of pediatricians and nutritionists during the past few years. The concept of fighting obesity in children is purely directed towards treating the associated co-morbidity especially when knowing that the risk of associated diseases with obesity is much higher in children than that in cases of adult obese patients [7].

Studies found that the risk of co-morbidities associated with obesity in adolescents reach 97% mainly

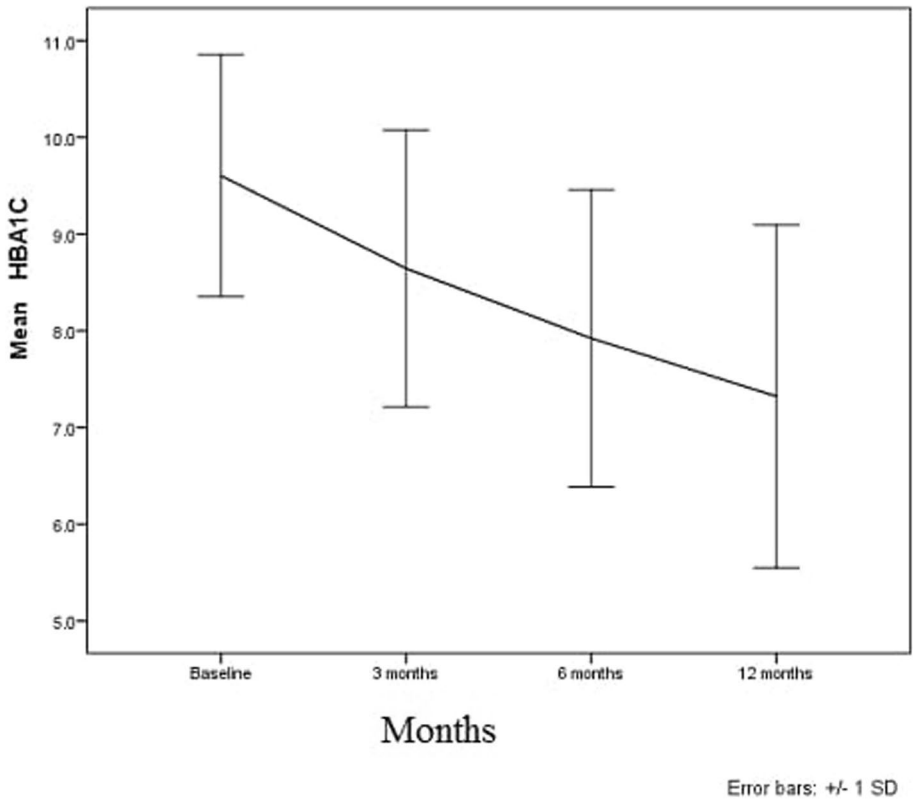

Fig. 1 Changes in HbA1C after the surgery

cardiovascular diseases and hyperlipidemia and diabetes mellitus and showed also decreased quality of life when compared to other nonobese children and more risk of being obese adults [7–9].

LSG has become a well-trusted procedure in treating obese children especially after understanding the extended risk of obesity in this age group [10–12].

The surgical treatment of type II DM through bariatric procedures became a well-known option in adults through the past few years. Studies show documented results of improvement of insulin resistance after sleeve gastrectomy and even DM remission in youth without using oral hypoglycemic drugs for 1 year [13–15].

We are presenting our series of diabetic adolescents who were chosen to undergo LSG as a primary procedure for treating both obesity and diabetes; the mean weight loss during the first 12 months was 42 ± 4 kg representing more than 65% of excess weight loss (EWL) which is comparable to that reported by Nadler and Cols [16] and more than that reported by Franco and his coauthors [11].

The follow-up period after surgery was 12 months which is considered a shorter period compared to other authors like AlQahtani et al. who reported a 24-month follow-up period [13]. We can attribute that our focus was mainly on the glycemic response rather than weight reduction only.

Regarding the blood glucose levels, there was a significant improvement of glycemic metabolism and DM remission in our patients with a mean decrease of 3.1 mg/dl in the HbA1c after 12 months with no oral metformin or insulin in 27 patients (84.3%) which is less than that reported by several authors like Inge et al. who reported 100% remission in 6 patients only with type 2 DM and obesity in his study which was done to figure out the effect of bariatric procedures in general—including gastric bypass and sleeve gastrectomy—on the health status of the patients [14].

Similar studies with a small patient number also reported comparable results of remission, but these studies showed the metabolic effect of LSG on adolescents in general with no research specification to its effect on DM [11, 17, 18].

On the other hand, our results of DM remission are comparable to that mentioned by other studies which included a larger number of patients with type 2 DM and showed remission after LSG like that reported by Elhag et al., who reported 80% type 2 diabetes

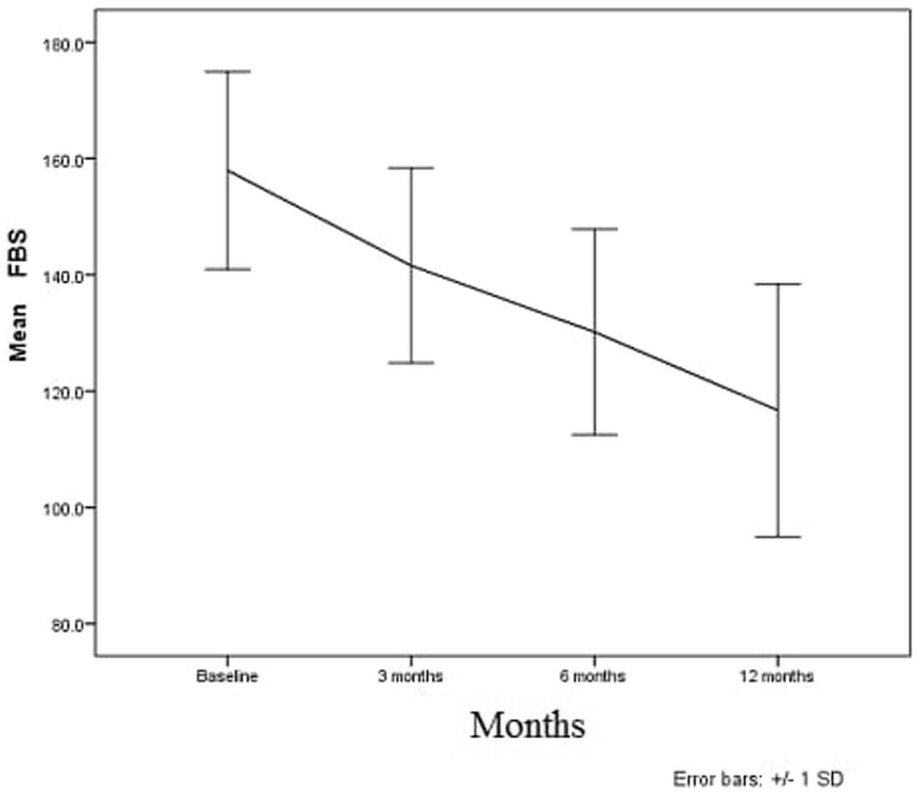

Fig. 2 Changes in fasting blood sugar (FBS) after the surgery

Table 2 Differences in glycemic index postoperative

	Baseline	3 months	6 months	12 months	Repeated measure ANOVA*	
	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	Mean ± *SD*	*p* value	sig.
FBS	157.94 ± 17	141.59 ± 16.78	130.16 ± 17.67	116.69 ± 21.71	< 0.001	S
PPS	248.19 ± 20.3	217.53 ± 30.96	192.72 ± 35.93	166.63 ± 40.55	< 0.001	S
HBA1C	9.6 ± 1.25	7.12 ± 1.53	6.9 ± 1.65	6.5 ± 1.77	< 0.001	S

Table 3 Weight loss along the follow-up period

	1 month	3 months	6 months	12 months
EWL*	14 ± 1.3 kg	23 ± 1.9 kg	30 ± 2 kg	42 ± 4 kg
WL%*	21.5%	35%	46%	65%

**EWL* excess weight loss, **WL %* percentage of weight loss

remission in adolescents after a 2-year follow-up period [17].

Most of the data mentioned in the literature regarding the effect of LSG on DM was a part of a wider spectrum study which included other morbidities together with DM like hyperlipidemia and hypertension [11, 13, 17] or reported the effect of different types of bariatric procedures on glycemic control like gastric bypass and gastric banding [19, 20].

Weight regain along with relapse of diabetes is well reported in the literature as well as relapse of diabetes. Therefore, close follow-up and diet control are essential. It is worth noting that patients with relapse of diabetes are easier to control with lower drug doses. Long-term studies are highly recommended to define the effect of bariatric surgery on the progression of end-organ damage including nephropathy, retinopathy, and atherosclerosis. Relapse most commonly occurs in patients with advanced diabetes preoperatively (longer duration and receiving higher drug doses to obtain control) [21].

The limitations in our study included the short period of follow-up which was 12 months, but as we mentioned, we focused on our primary goal which was the glycemic control which showed marked improvement followed by remission within few months.

We presented a smaller number of patients compared to other studies, because of several factors including the fact that bariatric procedures in children and adolescents are relatively nonpopular procedures in Egypt compared to the adult rates and the centers performing such procedures in children are not widely spread in our community.

Conclusion

LSG may play a role in weight reduction and type 2 diabetes control in adolescents as in adults.

LSG in adolescents may play an important role as a metabolic control procedure rather than a bariatric restrictive procedure only.

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Authors' contributions
MM and AY shared in writing, collecting, and analyzing the data. MS was the clinical supervisor and helped in editing this manuscript. I confirm that all authors have read and approved the manuscript.

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Availability of data and materials
The data and material are available for review.

Declarations

Ethics approval and consent to participate
This study was approved by the IRB of Surgery Department, Faculty of Medicine, Ain Shams University, with reference number 00006379.
A written consent was obtained from all participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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