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CLINICAL RESEARCH

Comparison Between the Results of Laparoscopic Sleeve Gastrectomy and Laparoscopic Roux-en-Y Gastric Bypass in the Indian Population: A Retrospective 1 Year Study

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Abstract
Background Laparoscopic sleeve gastrectomy (LSG) is gaining popularity as a procedure for the treatment of morbid obesity. Its indications and long-term results are currently under evaluation. Initially started as a first-stage procedure for superobese patients, it is now emerging as a standalone procedure in Asia and other parts of the world. Early results suggest that, at the end of 1 year, weight loss and resolution of comorbidities with LSG is comparable to laparoscopic Roux-en-Y gastric bypass (LRYGB). Whether LSG alone can replace LRYGB as a standard bariatric procedure is questionable. The aim of this study is to compare the results, resolution of comorbidities, and complications between LSG and LRYGB.
Methods A retrospective comparative analysis was done of 50 patients in each arm who underwent LSG and LRYGB from October 2007 to March 2008. Both groups were matched for age, sex, and body mass index. The resolution of comorbidities, percentage of excess weight loss (EWL), and complications were studied at 6 months and 1 year in our study.
Results It was seen that resolution of most comorbidities such as type 2 diabetes, hypertension, dyslipidemia, sleep apnea, joint pains, and percentage of EWL in both groups was comparable at the end of 6 months and 1 year. Though early resolution of type 2 diabetes was seen to be better in the LRYGB group, the results matched up at 1 year. There was increased incidence of gastroesophageal reflux disease in LSG patients. On comparison, it was also observed that the Asian studies have shown better results with LSG when compared to studies done in a largely Caucasian population.
Conclusions Long-term studies are needed to evaluate the efficacy of LSG alone as a procedure for the treatment of morbid obesity and its comorbidities.

Keywords Laparoscopic sleeve gastrectomy · Laparoscopic Roux-en-Y gastric bypass · Duodenal switch · Comorbidities · Excess weight loss · Body mass index · Gastroesophageal reflux disease · Ghrelin

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Introduction

The 1991 National Institutes of Health consensus states that bariatric surgery is the most effective treatment for morbid obesity and its associated diseases. It leads to excellent long-term sustained weight loss and hence reduction of comorbidities. Laparoscopic Roux-en-Y gastric bypass (LRYGB) and laparoscopic adjustable gastric banding (LAGB) are the most common procedures performed in the Asian region. Laparoscopic sleeve gastrectomy (LSG) is a newer addition to the spectrum of bariatric surgery. Sleeve gastrectomy was first described by Marceau and Hess in the 1990s. It was later popularized by Gagner et al. as a first-stage procedure before a duodenal switch (DS) in super superobese patients [1]. Recent reports recommend LSG as a definitive treatment for morbid obesity with a reported excess weight loss (EWL) between 50% and 83.3% [2–6]. These reports have shown a favorable impact on comorbidities.

LSG is fast gaining popularity in the Asian region. It is a technically simpler and faster procedure when compared to LRYGB. The contention is whether we can consider LSG

as a standalone bariatric procedure in terms of safety, efficacy, and maintenance of weight loss in the long term. Is the reduction in comorbidities comparable to other bariatric procedures?

The purpose of this study was to retrospectively compare the early results of LRYGB and LSG for a period of 1 year and follow them up over a period of 5 years to see if LSG can replace LRYGB as the gold standard bariatric procedure in Asia.

Aim

The aim of this study is to study the weight loss, resolution of comorbidities, and complications in patients who underwent LSG versus LRYGB over 1 year and follow them up over a period of 5 years.

Material and Methods

The study was done at the Center for Obesity and Diabetes Support at Saifee Hospital in Mumbai. It is a retrospective observational study. The study group included patients who were operated on between October 2007 and March 2008. There were 50 patients in each arm. The patients were matched for age, gender, and body mass index (BMI). The demographic characteristics of the two groups were as follows: There were 23 males and 27 females in the LRYGB group versus 24 males and 26 females in the LSG group. Median age was 42 years (20 to 66 years) in the LRYGB group versus 38 years (19 to 72 years) in the LSG group. Median BMI was 45.2 kg/m^2 (32 to 66 kg/m^2) in the LRYGB group versus 46 kg/m^2 (30 to 85 kg/m^2) in the LSG group. Type 2 diabetics were 14% in the LSG group and 33% in the LRYGB group. Eight percent of patients in the LSG group had hypertension and 27% of those in the LRYGB group were suffering from hypertension. In the preoperative assessment, 13% of the patients in the LRYGB group were recorded to have symptoms suggestive of gastroesophageal reflux disease (GERD) compared to 5% in the LSG group.

Both groups were evaluated in terms of weight loss, resolution of comorbidities, and complications at 6 months and 1 year. Median percent EWL and median decrease in BMI was calculated. We have preferred using median versus mean in our study as there were a few outliers in the LSG group. The BMI range was larger in the LSG group due to the inclusion of superobese patients. We studied the effect of surgery on medications for type 2 diabetes, hypertension, dyslipidemia, sleep apnea, and joint pains in both groups. Complications were recorded as major and minor.

Exclusion criteria of LSG were large hiatus hernia, gastric outlet obstruction, and esophageal dysmotility. Chronic smokers with an inability to give up smoking and those with an inability to take lifelong multivitamin supplements were excluded from the LRYGB group.

Surgical Technique

Laparoscopic Sleeve Gastrectomy

The five-port technique was used. The gastrosplenic omentum was divided from the greater curvature close to the stomach wall using Harmonic Scalpel™ or a Ligasure™ device. The left crus was dissected and the angle of His delineated. Posterior adhesions to the pancreas were lysed. After leaving 4 cm of antrum from the pylorus, the sleeve of the stomach was created over a 36-Fr gastric tube. First firing of the linear stapler was done using a green load and subsequently blue loads. The staple line was reinforced with a 2-0 absorbable suture. The methylene blue test was performed to check for a leak. A specimen of the stomach was removed.

Laparoscopic Roux-en-Y Gastric Bypass

An antecolic and antigastric Roux-en-Y gastric bypass was performed with an alimentary limb ranging from 150 to 250 cm. Biliopancreatic limb was 50 cm in all cases. A side-to-side jejunojejunostomy was done using linear stapler with white loads. Mesenteric defect was sutured in all cases. An omental split was done. A 30- to 50-cc vertical gastric pouch was created. End-to-side gastrojejunostomy was done using a 25-mm circular stapler. At the end of the procedure, an intraoperative gastroscopy was done and underwater air leak test was performed.

Results

Median percent EWL at the end of 6 months was 50.8% (27% to 70%) with LSG and 41.7% (18.4% to 67%) after LRYGB. At the end of 1 year, the median percent EWL was 76.1% (48% to 112%) in the LSG group and 62.2% (35.8% to 108%) in the LRYGB group (Fig. 1).

Median BMI was evaluated in both the groups at 6 months and 1 year. At 6 months, the median BMI was 31.8 kg/m^2 (24 to 64.8 kg/m^2) in the LSG group and 35.4 kg/m^2 in the LRYGB group. At 1 year, median BMI was 26.3 kg/m^2 (23 to 56.4 kg/m^2) in the LSG group and 31 kg/m^2 (24 to 42.3 kg/m^2) in the LRYGB group (Fig. 2).

Type 2 diabetics were 14% in the LSG group and 33% in the LRYGB group. At 6 months, type 2 diabetes resolved in 79% of patients in the LSG group. In the remaining 21%, the dosage of medication was decreased. In the LRYGB

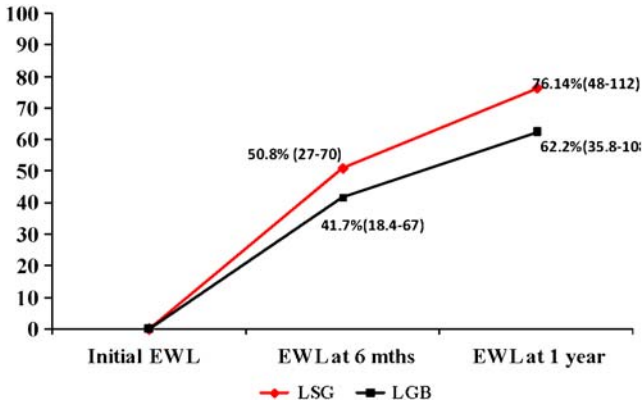

Fig. 1 Median percent EWL at 6 months and 1 year

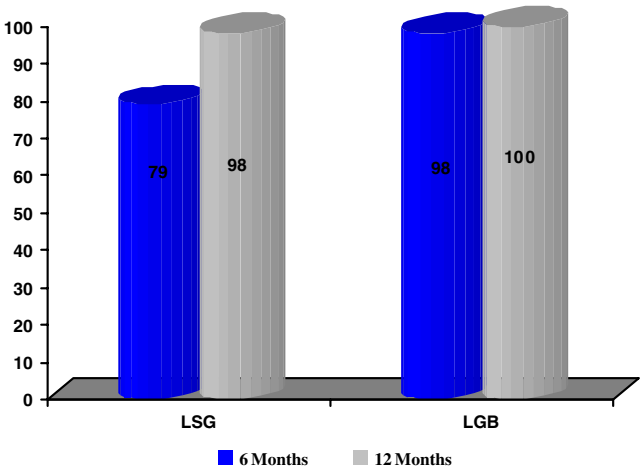

Fig. 3 Resolution of type 2 diabetes at 6 months and 1 year

group, type 2 diabetes was reported as resolved in 98% of the patients at 6 months. At 1 year, 98% resolution was reported in the LSG group and 100% in the LRYGB group (Fig. 3). Resolution was taken as HbA1c levels below 7, normal premeal and postmeal blood sugar levels without any medications for type 2 diabetes.

Eight percent of the patients were hypertensive in the LSG group and 27% in the LRYGB group. At 6 months, hypertension resolved in 83% of patients who underwent LSG and in 92% of those who underwent LRYGB. At 1 year, hypertension resolved in 91% of patients who underwent LSG and 95% of those who underwent LRYGB (Fig. 4).

At 1 year, dyslipidemia resolved in 75% of patients who underwent LSG and in 78% of those who underwent LRYGB. Joint pains resolved in 97% of patients undergoing LSG and 96% undergoing LRYGB. Sleep apnoea resolved in 100% of the patients in both the groups (Table 1).

In the preoperative period, 13% of the patients had GERD in the LRYGB group and 5% in the LSG group. After surgery, symptoms of gastroesophageal reflux subsided in all patients and none of them needed to be on any kind of antireflux treatment. Incidence of GERD was seen to rise to 9% in the LSG group at 1 year.

Complications were reported as major and minor. In the LSG group, minor complications included a left subcostal wound infection in one patient. Major complication requiring a reoperation was a delayed leak from the gastroesophageal junction which was detected 21 days postsurgery.

In the LRYGB group, minor complication included a wound infection in one patient. Major complications included a pulmonary embolism in one case. It was reported on the 15th postoperative day and was managed conservatively. Major complication requiring reoperation in one patient was a leak from the gastrojejunostomy site on the third day after surgery. There was no mortality in either group.

Discussion

LRYGB is a safe and effective bariatric procedure with excellent results reported over long-term follow-up. There is

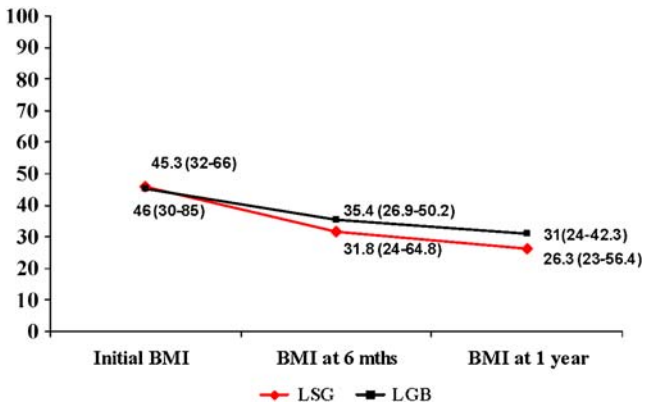

Fig. 2 Median decrease in BMI at 6 months and 1 year

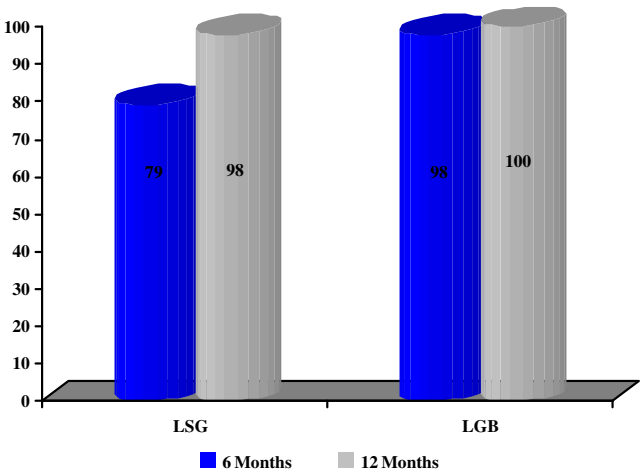

Fig. 4 Resolution of hypertension at 6 months and 1 year

Table 1 Resolution of comorbidities in both groups at 1 year

Comorbidity	LSG (%)	LGB (%)
Dyslipidemia	75	78
Joint pains	97	96
Sleep apnea	100	100

a significant weight loss and favorable effect on comorbidities. It is considered to be the procedure of choice the world over except Australia. The weight loss benefits of LRYGB far outweigh the nutritional deficiencies that may occur. Risk versus benefit ratio of a procedure like LRYGB is much lower than that of other purely malabsoptive procedures like biliopancreatic diversion and DS.

LSG was initially conceptualized as the first stage of a DS operation in superobese patients. It is the modern version of vertical banded gastroplasty (VBG). VBG was introduced by Mason in 1982. It was a purely restrictive procedure with a stapled but undivided stomach and a controlled outlet. VBG has been reported to have high revision rates ranging from 29% to 56% [7–9]. Common indications for revision after VBG are: (a) weight regain due to staple line disruption, pouch and stoma dilatation, and increased sweet intake after surgery and (b) vomiting and reflux due to stenosis at stoma outlet.

Over a period of years, VBG has fallen out of favor due to poor results of weight loss, weight regain in the long term, and high rate of revision surgery. The advent of laparoscopy, decreased mortality rates of procedures like LRYGB, and better long-term results have further added to decreasing the popularity of VBG. Among the gastroplasties, the Magentrasse and Mill operation is reported to have the best results to the extent of 60% EWL at the end of 5 years [10].

Both VBG and LSG are purely restrictive procedures. However, the biggest difference between the two surgeries is that, in VBG, the stomach remains intact. In LSG, two thirds of the stomach is removed which includes the ghrelin-producing fundus. Ghrelin is an orexigenic peptide which has been implicated in mealtime hunger and long-term regulation of body weight. Ghrelin also seems to play a key role in the complex energy balance loop and may be a predictor of the long-term success of a bariatric procedure.

Markedly reduced ghrelin levels after LSG could be responsible for the weight-reducing effect of this surgery. The fact that this is the only bariatric procedure in which the ghrelin-producing fundus is permanently "removed" from the body could explain the good results being achieved by LSG.

The other difference between LSG and VBG is that, in LSG, the pylorus is the only outlet hence there is no chance of an outlet stenosis or obstruction as in a VBG.

LSG was initially started by Marceau and Hess as the first stage of a DS surgery. The rationale of a first-stage surgery in superobese patients was to achieve a substantial weight loss and amelioration of comorbidities, thus making the second-stage surgery a much safer surgery with a good chance to achieve the optimum weight loss. LRYGB and DS are the two surgeries which are commonly performed after a first-stage LSG. DS as a procedure is not very popular in India and Asia because of a predominantly vegetarian diet. The local diet does not support the requirement of 120 g of elemental protein intake which is a must after a DS. Another disadvantage is the long-term requirement of water-soluble and fat-soluble multivitamins and minerals which most patients in Asia find difficult to adhere to. There are about three centers, including ours, that are presently doing DS in India. At present, it is being done mainly to cater to foreign patients who come as medical tourists to India. LRYGB is the preferred procedure of choice for the second stage in the Indian setting.

Interestingly, in three studies with a total of 198 patients that were intended to have a second-stage surgery, only 51 patients finally had the second surgery. The second stage was not required in a good number of patients [2, 8, 9]. The second stage is usually done when the weight loss after the first stage is inadequate and has reached a plateau.

These reports suggested that the use of LSG as a definitive procedure for the surgical treatment of morbid obesity is a good option. It is fast gaining popularity as a standalone procedure in the Asian region.

LSG has many advantages. EWL varying from 33% to 83% has been reported in various series after LSG. The resolution of comorbidities is also favorable. It is technically a simpler and faster procedure with a lower learning curve compared to LRYGB. It is pylorus-preserving, hence there is no occurrence of dumping syndrome. There is a lower chance of developing nutritional deficiencies when compared to LRYGB. There is no risk of developing anastomotic ulcers, intestinal obstruction, or internal herniae. The remnant stomach is always easily accessible to upper gastrointestinal endoscopy which holds a great significance for Asian countries like Japan and South Korea that have a high incidence of gastric cancers.

LSG also has its disadvantages. A higher rate of reflux symptoms and a higher leak rate have been reported.

In our series, we have retrospectivey studied the effects of LSG and LRYGB on morbidly obese patients at 6 months and 1 year. The LSG group showed 72.1% EWL at the end of 1 year compared to 62.2% in the LRYGB group.The bougie size used in our study was 36 Fr. In 2005, in a series of 60 Asian patients, Han et al. reported a EWL of 83.3% at the end of 1 year with a 48-Fr bougie [4]. In 2006, Cottam et al. reported 46% EWL in 126 patients using a bougie size ranging between 46 and 50 Fr [11]. Silecchia et al. reported

a 40.8% EWL at the end of 1 year in a series of 41 patients in 2006 [12]. They used a 48-Fr bougie in their study. In 2005, Mognol et al. reported their experience of LSG in ten high-risk superobese patients. They reported an average percent EWL of 51% at the end of 1 year. Bougie size used by them was 32 Fr [3].

Factors that may affect weight loss and resolution of comorbidites after LSG are: (1) removal of the entire fundus of the stomach, (2) bougie size, (3) antral resection, and (4) ethnicity.

In LSG, the ghrelin-producing fundus of the stomach is completely removed. Incomplete resection of the fundus can also lead to weight regain over a period of time. Role of ghrelin has been implicated in weight loss as well as amelioration of type 2 diabetes after LSG. Seventy percent of the circulating ghrelin is produced in the stomach, the rest being produced in the intestines and pancreatic islets. Systemic action of exogenous ghrelin to increase blood glucose levels in humans and rats has been reported before [13]. Endogenous ghrelin is said to play a role in physiological regulation of systemic insulin and glycemia. Low plasma ghrelin levels are associated with inceased fasting insulin levels and insulin resistance [14]. Antagonizing ghrelin levels can lead to increase in insulin levels and thus control glucose intolerance. Another study done by Toshihiko et al. on gastrectomized rats suggests that it is the ghrelin produced by the pancreas that serves as the local regulator of insulin release [15]. They suggested that, though the pancreatic ghrelin does not contribute to the circulating ghrelin levels, it is the one responsible for the suppression of glucose-induced insulin release. The precise role of stomach-derived or pancreas-derived ghrelin is yet to be established. Further studies are needed to elucidate the exact mechanism of the role of ghrelin in glucose metabolism.

Bougies ranging from 32 to 60 Fr have been used by various investigators. Smaller bougie size is said to lead to a greater weight loss. Johnston et al. used a 40-Fr bougie in the initial cases of Magentrasse and Mill operation. Weight regain was a significant problem with large-sized bougies and has been reported in the 2-year results of earlier studies of LSG. Larger bougie sizes have been implicated as the cause of weight regain in these studies. Depending upon the size of the bougie, the volume of the sleeve can range from 60 to 200 ml. Dilatation of the gastric pouch is a possibility in a few years time if a large sleeve is left behind.

The bougie size was progressively decreased to 32 Fr and is considered the standard for further procedures. Mognol et al. and Baltasar et al. used 32 Fr bougies in their studies and reported an EWL of up to 51% and 62.3% at the end of 1 year, respectively. With smaller bougie sizes and tighter sleeves, weight regain is unlikely to happen although long-term data is awaited.

In our series, we have reported an EWL of 72.1% at 1 year in the Indian population with a 36-Fr bougie. Our findings correlate with the other Asian study done by Han et al. who have reported an EWL of 83.3% with a 48-Fr bougie. Both these studies indicate a higher weight loss. These results are conflicting with those done in the largely Caucasian population. This observation has lead us to speculate that the Asian phenotype has a role to play in the better weight loss after LSG in Asians. Although in view of the vast diversity in ethnicity and race in the Asian region, we need more long-term studies with a larger sample size to establish this observation.

In our series, we have studied the effect of LSG and LRYGB on type 2 diabetes at 6 months and 1 year. At 6 months, type 2 diabetes resolved in 79% of the patients who underwent LSG compared to 98% of those who underwent LRYGB. However, at 1 year, diabetes resolution in the LSG group matched that in the LRYGB group. Resolution of diabetes was faster in the LRYGB group but at the end of 1 year both groups had similar results. Our results are comparable to the results of Han et al. who have reported 100% diabetes resolution at 1 year after LSG. Cottam et al. and Silecchia et al. have reported 81% and 79.6% resolution at 1 year and 18 months, respectively. The resolution of type 2 diabetes after LSG in our study and in the other Asian study done by Han et al. was better compared to the western studies. The reason behind this is unclear as of now. Our hypothesis is that Asians have a higher body fat percentage and a lot more central obesity than the Western population. A series of comparative data have pointed out that under fixed BMI or fatness, metabolic risk is much greater in South Asians compared to Caucasians in terms of diabetes mellitus, insulin resistance, and hypertriglyceridemia [16]. Hence, abdominal weight loss with ensuing loss of insulin resistance may be the reason for better results with type 2 diabetes mellitus in the Asian population.

Baltasar et al. have reported that antral resection may play a role in weight loss. They recommend the division of the antrum 2 cm proximal to the pylorus leading to a gastric pouch of 50 cc [2], although this theory has not been supported by other investigators.

Like all restrictive procedures, high-calorie diet and increased sweet intake can lead to weight gain after LSG. Hence, all the patients undergoing this procedure must follow nutritional guidelines postsurgery for optimum results. In case of inadequate weight loss or weight regain, LSG can be converted to a DS or LRYGB.

Whether the Asian body type has a role to play in better metabolic outcome after LSG is yet open to discussion. There may be yet other unknown mechanisms which may have a role to play. We need many more prospective studies with larger sample size before these observations can be applied to the vastly diverse population in the Asian continent.

Other metabolic outcomes like resolution of hypertension, dyslipidemia, sleep apnea, and joint pains at 1 year were comparable in both LSG nad LRYGB group. Thirteen percent of the patients in the LRYGB group had GERD in the preoperative period. We observed that the symptoms of GERD resolved after surgery in all the affected patients in this group. In the LSG group, 5% of the patients were suffering from GERD to start with. The number of patients who complained of GERD at the end of 1 year increased to 9% in the LSG group. All of them were relieved with regular intake of proton pump inhibitors. Himpens et al. have reported that LSG patients were more affected by GERD at the end of 1 year. These results were shown to reverse at 3 years. Lack of gastric compliance and clearance was said to be the causative factor for GERD at 1 year. Increased compliance and better gastric emptying was reported at the end of 3 years [17]. Another factor that could play a role in causing GERD post-LSG could be blunting of the angle of His during surgery.

Overall, the complication rate in both groups was comparable and there was no mortality in either groups. Han et al. have reported a complication rate of 2.9%, Himpens et al. reported a complication rate of 5%, and Baltasar et al. have reported a complication rate of 6.9%. Our complication rate is 2.9%, which is comparable to these studies.

To summarize the results, we observed that, at the end of 1 year, weight loss with LSG was better compared to LRYGB. Resolution of type 2 diabetes and hypertension was earlier with LRYGB compared to LSG. At 1 year, results were similar in both groups. Resolution of all other comorbidities was comparable in both groups. The complication rate of LSG was comparable to LGB. The incidence of gastric reflux was higher in LSG compared to LRYGB at the end of 1 year.

The limitations of our study are that it is a retrospective observational study. There is a selection bias as randomization was not possible. These are short-term results in a small patient pool. To study the future trends of both these surgeries, we are following up these patients for a 5-year period and will be reporting the results in due course. We have also decided to have a prospective randomized study in patients with a BMI range between 30 and 40 kg/m^2. The study is currently in its first year.

Conclusions

Results of LSG are comparable to LRYGB at 1 year interval. LSG has shown better weight loss and better metabolic outcome in the Asian population compared to similar studies in the Caucasian population. However, we need more long-term randomized studies with a larger patient pool before we can recommend it as a standalone procedure.

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