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Laparoscopic Gastric Plication in the Morbidly Obese Adolescent Patient

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Abstract

Childhood obesity is a significant problem. Due in part to suboptimal weight loss with lifestyle intervention alone, bariatric surgery, combined with ongoing lifestyle changes, has become a favorable approach in adolescents with severe obesity and weight-related comorbidities and is associated with effective weight loss and reducing weight-related comorbidities. Laparoscopic greater curvature plication is a promising new bariatric surgical procedure that has been shown to be effective in adults with severe obesity but has not been evaluated in the adolescent population. Gastric plication may be a particularly attractive approach for the adolescent patient as it is potentially reversible, does not involve the surgical removal of tissue and is without a significant malabsorptive component. Our team has obtained approval from our Institutional Review Board to perform a laparoscopic greater curvature plication on 30 adolescent patients with severe obesity and study its effect on weight loss, metabolic effects, and psychological functioning in the setting of a multidisciplinary program. Results of this study, including comprehensive clinical and psychological data collected over a three and a half year span, will inform larger prospective investigations comparing the laparoscopic greater curvature plication and other bariatric operations in the adolescent population.

Keywords

gastric; plication; greater curvature; adolescent; bariatric

BACKGROUND

Adolescent Bariatric Surgery

The rates of pediatric obesity have increased rapidly over the past several decades according to reports from 1999–2008. Though the prevalence of pediatric obesity has stabilized over the last few years, it remains very high, with 16.9% of children in the United States meeting

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obesity criteria (body mass index [BMI] > 95th percentile).(1) Alarming, obesity has emerged as the second leading cause of preventable premature death in the United States. (2) It is associated with numerous medical and psychological comorbidities, which may already be present in childhood and adolescence, including hypertension, type 2 diabetes, hyperlipidemia, obstructive sleep apnea, depression, eating disorders and poor quality of life. (3) Furthermore, overweight youth are over twenty times more likely to remain obese as adults, increasing their risk of early mortality. (4,5) Thus, the treatment and prevention of obesity are paramount to reduce morbidity and mortality among affected youth. Alarming, some experts estimate that the life expectancy of today's youth is shorter than that of their parents, highlighting the significant impact of obesity on overall mortality. (4,5)

In 2007, an Expert Committee established a four-step approach to weight management in 2–19 year olds with a BMI >85th percentile.(6) Stage 4 intervention would be for children >11 years old with a BMI >95th percentile and significant comorbidities who are not successful with the less intensive treatment support in Stages 1–3. Stage 4 care should be conducted in a tertiary care setting and may include meal replacements, low calorie diets, medications and surgery in addition to ongoing intensive lifestyle modification. (6) In concordance with the central role of behavior change in this staged approach, many family-based pediatric obesity programs have been developed. However, most comprehensive adolescent obesity treatments generate only modest metabolic improvement on average and rarely effect sustained, long-term weight loss.(7,8) Unfortunately, despite multiple monitored attempts at medical management of obesity, many adolescents do not experience significant improvements in BMI or coincident reduction in obesity related comorbidities; results are particularly suboptimal among adolescents with extreme obesity. (9,10)

Given these findings, bariatric surgery is becoming more widely accepted as a treatment option (in conjunction with ongoing intensive lifestyle modification) for adolescents with severe obesity and associated comorbidities, with demonstrated improvements in weight and resolution of comorbidities.(11) Importantly, it is recommended that surgical patients are carefully selected to improve the likelihood of positive surgical outcome. These criteria are evolving, particularly in regards to adolescents. According to the “Best Practice Updates for Pediatric/Adolescent Weight Loss Surgery from 2009,” the American Society for Metabolic and Bariatric Surgery (ASMBS) recommends the following selection criteria for the pediatric population: BMI of greater than or equal to 35 kg/m² with major co-morbidities (type 2 diabetes mellitus, moderate to severe sleep apnea [apnea-hypopnea index>15], pseudotumor cerebri, or severe non-alcoholic fatty liver disease [NAFLD]) or a BMI of greater than or equal to 40 kg/m² with other weight-related comorbidities (hypertension, insulin resistance, glucose intolerance, substantially impaired quality of life or activities of daily living, dyslipidemia, or sleep apnea with apnea-hypopnea index>5). (12,13) In addition, candidates for surgery must have undergone comprehensive pre-surgical assessments by a multidisciplinary team including a surgeon, medical pediatric specialist, psychologist, registered dietitian, and physical therapist/exercise physiologist as well as participation in at least 6 months of medically observed and attempted non-surgical weight loss.(13,14) Our comprehensive, multidisciplinary program adheres to these well-established guidelines. Patients with severe obesity and weight-related comorbidities who have not experienced adequate reductions in weight despite adherence with lifestyle modifications may be considered by the team for bariatric surgery. Currently, laparoscopic gastric sleeve resection is the only bariatric operation that we offer outside of a clinical trial and, in our preliminary experience, have had very good results.

Multiple weight loss surgery techniques are available and several factors must be considered when selecting how to maximize outcomes and minimize risk. There are two main categories of bariatric surgery: restrictive and combined restrictive / malabsorptive

procedures. Both types of surgical procedures are most often performed laparoscopically and are described in greater detail below. As described, these procedures vary in terms of reversibility, malabsorptive aspects, and presence of foreign body (e.g., a band). These operations have been performed in the adolescent population and studied in terms of excess weight loss, resolution of comorbidities, and complications, in addition to relative effectiveness compared to other surgical options.

Roux-en-Y gastric bypass is an example of a combined restrictive / malabsorptive procedure that has been demonstrated to be an effective procedure for adolescents with significant and sustained decreases in BMI.(15) In a meta-analysis of six studies, obese adolescents undergoing Roux-en-Y demonstrated a reported BMI reduction ranging from 17.8 to 22.3 kg/m² (95% confidence interval) following surgery.(11) Despite metabolic improvements, this procedure is irreversible with potential for significant complications of micronutrient deficiencies and malabsorption. , The reported rates of post-operative morbidity among adolescents have been comparable to those observed in adults.(13) According to the ASMBS, there have been rare but reported cases of anastomotic leak, sepsis, bleeding and thromboembolic events among adolescents following this surgical approach.(13) Although no adolescent deaths have been reported during or immediately following surgery, at least 3 deaths have been reported in adolescents longer term after the procedure. (13,16) As the procedure is malabsorptive, patients are also at risk of nutritional deficiencies (specifically vitamin B12, vitamin D, calcium and iron), which may be detrimental in adolescence, a period of growth and continued development. (17)

In contrast, procedures such as laparoscopic adjustable banding and laparoscopic gastric sleeve resection restrict food intake by limiting the capacity of the stomach to accommodate food. Laparoscopic adjustable gastric banding (LAGB) also has promising results in the pediatric population. In the large meta-analysis mentioned above, LAGB was associated with significant weight loss in adolescents, with excess body weight loss ranging from 37% to 63% over a 6 month to 7 year follow up period.(11) However, with LAGB, most complications were related to the device such as need for readjustment and slippage, which often required reoperation. (11) Most importantly, at this time, the adjustable gastric band is not FDA-approved for adolescents. As a result, the majority of its documented use in the pediatric population has been investigational. In addition, with a reported BMI loss ranging from 10.6 to 13.7 kg/m² , the results are less robust than those seen with gastric bypass. (11)

Among adults, studies examining the sleeve gastrectomy have demonstrated results that are similar to those examining the gastric bypass. (18,19) Adolescent studies are also very encouraging. In a recent study, 108 obese children underwent laparoscopic sleeve gastrectomy and were followed for up to 24 months. Findings suggested favorable results of “successful short-term weight loss in more than 90% of pediatric patients and 70% or more comorbidity resolution.”¹⁹ Similarly positive results were found in a related study of 23 patients with an average age of 17.3 years. Specifically, Nadler et al. demonstrated almost one year follow up with “mean % excess weight loss (EWL)...of 32 ± 13 at 3 months, 38 ± 14 at 6 months, and 40 ± 19 at 1 year of follow-up...and resolution of 12 of 22 comorbid conditions.” (19) While these results are favorable in this population, some concern remains over use of the sleeve gastrectomy among adolescents given its irreversibility.

Laparoscopic Gastric Plication

Laparoscopic gastric plication (LGP) is a recently introduced bariatric procedure. In this operation, the stomach is folded into itself and sutured to reduce the volume without removing any gastric tissue, Figure 1. This procedure is restrictive in nature (comparable to the sleeve gastrectomy), but it does not have malabsorptive components, involve the removal of tissue, or insertion of a foreign body (such as in the laparoscopic adjustable

banding). Further, LGP may be reversible if the sutures are removed. These features make the LGP potentially appealing for the adolescent population. Furthermore, the LGP can be progressive if a patient needs a 2-stage operation (i.e., advancement to gastric bypass or sleeve) due to insufficient weight loss. Preliminary studies, almost entirely in adult patients, have compared the LGP to other gastric bypass procedures and showed promising results, as demonstrated in Figure 2.

One of the first descriptions of this procedure came from Iran with a total vertical gastric plication (TGVP), first studied in a sheep animal model. TGVP was then performed in 100 adult patients.(21) The mean weight loss was 21.4% 1 month after the operation, 54% after 6 months (n=72), 61% after 12 months (n=56), 60% after 24 months (n=50), and 57% after 36 months (n=11).(21) Furthermore, diabetes resolved in 8 patients; significant improvements in hypertension and sleep apnea were also found. With TGVP, average operative time and hospital stay was 98 minutes and 1.3 days, respectively. Importantly, there were only four surgical procedural complications in the 100 TGVP performed. These included: permanent vomiting from an adhesion between the fundus and the liver (relieved with reoperation); liver hematoma secondary to retractor manipulation; leakage at the suture line (resolved with reoperation); and lastly, acute gastric perforation away from the suture line (repaired with reoperation). There were two non-procedural complications: hypocalcemia in a patient with asymptomatic preoperative hypercalciuria; and two cases of nonobstructive jaundice in patients with history of fatty liver disease (attributed to drug-related hepatitis), both of which resolved spontaneously. Overall, results of this series suggested that TGVP was comparable to other laparoscopic weight loss procedures.(21)

Greater curvature LGP was performed in 52 adult patients in Brazil.(22) By imbricating only the greater curvature, the greater curvature LGP was considered “less aggressive” than total vertical gastric plication. Mean operative time was 50 minutes with a mean hospital stay of 36 hours. Greater curvature LGP resulted in EWL of at least 20% at 1 month in 42 patients and 62% after 18 months in 9 patients. No intra-operative complications were reported for the greater curvature LGP, nor were any of the procedures converted to an open procedure. Postoperatively, 20% of patients reported nausea, 16% of patients had vomiting and 35% of patients had sialorrhea; however, all of these symptoms resolved within 2 weeks. Three patients experienced mild esophagitis on routine endoscopic evaluation and were placed on a proton pump inhibitor, with no residual lesions or symptoms seen on 6 month follow up. There was no report of weight regain at any follow up assessment (up to 18 months). (22)

A related series of laparoscopic greater curvature plications (LGCP) was reported in Greece by Skrekas, et al. (23) This prospective study was performed with 135 patients who had BMI >40 kg/m² or BMI >35 kg/m² with a co-morbidity. Patients with BMI >50 kg/m² were excluded. These patients underwent a 5-trocar port technique with a single plication. In the second phase of the study, the procedure was modified to have double or triple lines of plication. Mean operative time was 58 minutes with mean hospital stay of 1.9 days. LGCP induced rapid and sustained excess weight loss with a mean follow-up of 22.6 months and mean %EWL of 65.3 at 24 months. In a subgroup analysis comparing patients with an initial BMI <45 kg/m² and >45 kg/m², the %EWL was significantly greater in the first group compared to the second group (69.9 to 55.5, p=0.006). There was no significant difference between the original and modified procedure. The overall complication rate was 8.8%. Four patients required readmission for prolonged nausea and vomiting. There were two cases of GI bleeding and two patients were readmitted with abdominal pain that was considered to be a micro-leak; however, all patients were managed conservatively. In terms of severe complications, four patients required reoperation. The first experienced partial jejunal necrosis from postmesenteric thrombosis on the 24th day postoperatively. There was a case

of acute gastric obstruction that developed 14 months post operatively due to prolapse of the gastric fundus. There were two other cases of delayed gastric obstruction due to serous fluid accumulation. Ultimately, both of these patients required reversal of the plication because the obstructive symptoms did not resolve. There were fewer complications in the group with the modified technique. (23)

The LGP procedure has not been widely studied in the United States with only one published study in adults and none in adolescent patients. Brethauer et al. at the Cleveland Clinic performed 15 LGP procedures on adults in a nonrandomized prospective study comparing anterior plication (which includes folding the anterior wall of the stomach from the fundus to the antrum) to greater curvature plication.(24) There were no significant differences in the baseline BMI of the groups. Nine patients underwent anterior plication (mean operative time 89 minutes) and seven underwent the greater curvature plication (mean operative time 72 minutes). At 1 year follow up, the %EWL at for the anterior plication group was 23.3% compared with 53.4% in the greater curvature group. Further, almost all patients had nausea, which resolved within 2 weeks. One patient in the greater curvature plication group required reoperation due to gastric obstruction. Overall, results of this study suggested that the plication procedure is a viable option for weight loss surgery, with relatively greater weight loss when performed using the greater curvature plication technique. (24)

In a meta-analysis performed by Abdelbaki et al. (25), the results of 307 patients who had undergone LGP were assessed and compared. (Note that this study population includes many of the patients discussed in the above studies). Twenty-five patients experienced complications. Nausea and vomiting were the most common complication. Gastric leaks and perforations were found in five patients, three of whom required reoperation. This analysis also highlighted the lack of standardization of the LGP surgical techniques. For example, many of these studies showed variety in trocar placement as well as use of a bougie versus gastroscope for approximating the size of the lumen of the stomach. They concluded that LGP is still novel and requires larger studies comparing it to other more established types of bariatric surgery. Furthermore, there is a paucity of studies among adolescents.

In a large 12 year series that included 800 patients, Talebpour reported overall %EWL of 42% over 10 years.(26) Only nine of the patients were under 18 years of age; however, authors stated that “for adolescents, EWL was generally the same as adults. Nine adolescent patients had 54% EWL after 6 months and 62% after 12 months.” This is the first report of any patients receiving plication under the age of 18 years old. They conclude that the advantages of the procedure are that there are no foreign bodies, few post-operative technical complications (1%), low reoperation (1%), reversible if needed, and can later be complemented with malabsorptive procedures. As many studies were feasibility or pilot studies, this 12 year series that includes 800 patients provides a population that can demonstrate statistically significant weight loss with the LGP. Further, effectiveness and complication rates are comparable to other bariatric surgery but at a lesser cost.(25) In this study, the price of hospitalization for plication was half of the price for gastric bypass or sleeve because there was no use of stapler or band, demonstrating that a more affordable procedure may be appealing to patients as they decide which procedure to pursue. (26)

A study that compared laparoscopic sleeve gastrectomy to LGCP among 39 patients noted that EWL was 80% vs. 58.8% respectively, which continues to demonstrate favorable results in patients with both surgeries. Average age was 33.9 years in the LGCP group and 34.2 years in the sleeve group. These EWL data are appealing as it suggests that LGCP can show effective (although relatively lower) weight loss in patients who do not want to undergo a resection. There was one major complication in the gastric sleeve resection group- a gastric

stenosis that required readmission. Among LGCP patients, five had nausea (a known complication of this procedure), compared with two in the gastric sleeve resection group. These symptoms all resolved within 2 weeks without intervention. (27) Larger trials comparing sleeve resection to LGCP are needed to better compare weight losses and complications.

LGP Complications and Their Management

Given that the LGP is a newer bariatric procedure, it is worth discussing specific possible complications and their management. Several studies recognize nausea as a possible and common complication. Its management is therefore aggressive and most studies report resolution within a few weeks. (23,24) Some cases of severe vomiting have also been reported, for which patients were managed with intravenous hydration, a prolonged hospital stay and, if needed, management of obstruction. However, authors report that once the technique was modified to multiple plications, post-operative vomiting was minimal and only lasted for a few hours. (23) Importantly, in another recent study by Atlas et al. (28), 11 out of 44 patients returned to the hospital with intractable nausea and vomiting and were subsequently hospitalized. Four of these patients had their plication reversed. Reports of leakage or perforation, were very rare and were mostly managed with reoperation when identified. (29) One case of gastric perforation due to necrosis of the fundus was treated with conversion to a sleeve gastrectomy. (30) Other cases were attributed to patient non-adherence to the post-operative protocol (e.g., attempting to eat solid food too early at post-operative day 5) and were managed non-operatively with hydration, intravenous antibiotics and food restriction, after which the symptoms resolved. (23) One author suggests that leak could be due to, “acute distension of the stomach or severe vomiting with a resultant full-thickness tear at the suture line, as well as delayed thermal injury of the stomach that occurs during division of the short gastric vessels, particularly if the attachments to the upper pole of the spleen were very short.” (24) Many studies therefore show that leak or perforation is possible in this procedure and if any symptoms arise, the possibility of leak should be investigated.

One of the many listed advantages of the laparoscopic gastric plication procedure is the potential reversibility. While this feature may be attractive as a last-resort to address medical complications, we feel strongly that patients (particularly adolescents) who are considering surgery do not base their surgical decision on potential reversibility, and rather view the decision to undergo weight loss surgery as committing to lifelong change. Nonetheless, some cases have been reversed such as in the case of gastric obstruction that developed three months after surgery despite initial attempts to manage it conservatively. (23) There is a reported case of reversal for another case of gastric obstruction, where due to persistent symptoms, the patient’s sutures were all taken down and no signs of leaks or necrosis were noted when the stomach was unfolded. The patient was able to tolerate liquids soon after the reoperation. (31) Talebpour et al. report that, if needed, this method is reversible during first 6 weeks just by cutting the suture lines and easily releasing the mild adhesions. (26) Reversal of LGP later is difficult and it needs tense fibrotic tissue dissection. (29) Atlas et al. reported 4 cases of reversal of plication: 3 for gastric obstruction and once for hernia. Compared with the difficulty of later reversal, they reported that plication could be easily reversed in an early postoperative period, before formation of dense adhesions between the layers of the plication. (28)

Another potential advantage of the procedure is the potential for conversion of a plication to another bariatric procedure in the case of inadequate weight loss. Atlas et al. reported transforming a plication to a sleeve gastrectomy in two different cases as far as 6 months after the procedure without difficulty. The authors noted that, after undoing the outer running suture, the stomach recovered a shape that allowed them to apply the staples along a

32 French bougie, without having to undo the inner row. (28) As mentioned above, conversion to sleeve gastrectomy could also be a treatment for a perforation if needed. (30) Using experience from canine experiments, Brethauer et al. state that, revision options for these patients would include repeat plication to achieve improved restriction, revision to sleeve gastrectomy, or conversion to gastric bypass and they believe that conversion to Roux-en-Y gastric bypass would be the optimal choice and would be technically feasible. (24) There is a case report demonstrating conversion of the procedure from a failed gastric plication to a laparoscopic gastric sleeve resection after adhesiolysis of the attachments to the plicated side of the stomach. This patient had no complications post-operatively and did have meaningful weight loss to BMI of 24 kg/m².(32)

It should be noted that there have been some reports of combining the laparoscopic adjustable band with a plication procedure and some authors believe that this could be a feasible and effective procedure as it combines restrictive and reductive treatment.(33) They report mean EWL at 1, 3, 6, 9, and 12 months after surgery was 21.9%, 31.9%, 41.3%, 55.2%, and 59.5%, respectively, but with a mean follow up of only 8 months, they recognize that long term follow up is necessary to establish long term conclusions about effectiveness. (33) These authors later went on to compare 2 years of follow up with patients who underwent laparoscopic sleeve gastrectomy and laparoscopic adjustable gastric banded plication. Results of this investigation demonstrated comparable results in %EWL, complications and resolution of comorbidities, concluding that patients who had undergone a plication could potentially manifest continued weight loss with the addition of an adjustable gastric band. (34)

LAPAROSCOPIC GREATER CURVATURE PLICATION PILOT STUDY

Background

At the Healthy Lifestyles Center at Children's Hospital of Richmond at Virginia Commonwealth University (VCU), we have proposed a multidisciplinary study to evaluate the efficacy of LGCP in the adolescent population. Specifically, we aim to evaluate the effect of LGCP on excess body weight, BMI, and obesity-related co-morbidities in 30 adolescents with obesity. We will also evaluate surgical outcomes and complication rates and investigate changes in secondary outcomes, including cardiometabolic risk factors, dietary intake, physical activity and fitness, psychopathology, and quality of life following LGCP. Lastly, we also plan to identify putative mediators and moderators of weight loss following LGCP including demographic characteristics, the presence of physical or psychological comorbidities, and biological markers among obese adolescents. This 3-year investigation has been approved by VCU's Institutional Review Board.

With the background of an already established Healthy Lifestyles Center that includes faculty specializing in endocrinology, psychology, exercise physiology and nutrition, patients that have been identified as obese undergo extensive evaluation to determine if they are candidates for surgical intervention. The presurgical evaluation and management by our multidisciplinary team incorporates at least 6 months of medically supervised lifestyle modification. After deciding to go forward with laparoscopic gastric plication, patients undergo a consent and assent process with their parent or legal guardian to determine understanding of the procedure and the commitment of visits for safety and study purposes. Consent / assent procedures specifically include a discussion of the potential role of weight loss surgery in a comprehensive treatment plan, the difference between various weight loss surgical approaches the importance of ongoing lifestyle modification both before and after surgery, and the need for ongoing clinical follow-up after the surgery. Discussion that parental authority does not override the right of a minor child to choose not to participate or withdraw from the study is also included.

Description of laparoscopic gastric plication procedure

The procedure is performed through a 4-port technique with a Nathanson liver retractor. The technical goal is to create a uniform narrowing of the gastric body and fundus without twisting or significant bulging or out-pouching. The procedure begins with division of the greater curve vessels from 4–5 cm proximal to the pylorus to the angle of His. Either ultrasonic energy or bipolar cautery is appropriate for this step. The surgeon must be careful not to injure the stomach during this process since unlike gastric sleeve, the greater curve of the stomach will be retained. All of the posterior attachments / adhesions of the stomach to the retroperitoneum must be divided. General consensus among American surgeons is to retain the highest short gastric that runs along the left crus. There have been several reports of leaks in this area and division of his vessel may be implicated. This area of the cardia is easily imbricated with this vessel intact.

Once completely mobilized, 4–5 stay sutures are placed to set up the plication. The first is 2 cm below the gastroesophageal junction. These sutures are placed one half the distance between the greater and lesser curve both on the anterior and posterior surfaces of the stomach. The last suture is 2–3 cm distal to the incisura. We use a braided permanent suture. The tails are left long for handling of the stomach. The first running imbrication stitch, 2-0 polypropylene, is started at the highest stay suture and run to the distal stay suture. This suture essentially closes the space between the stay sutures.

It is important to note the stomach is much broader in the mid body than at the incisura. Very little additional plication can safely be achieved at the incisura. Thus with the second suture the amount of stomach imbricated will be much greater in the mid- section than at the angle of His or the incisura. While some have used a bougie here, we prefer to use endoscopic guidance. The goal is to imbricate the stomach so the mucosa of the imbricated fold just touches the mucosa of the lesser curve. The second suture is also 2-0 polypropylene. The suture line begins just below the GE junction and runs to just beyond the previous suture.

The bites should be seromuscular with careful attention to avoid full thickness bites. The stomach will swell significantly and a full thickness bite could lead to a leak. The bites also must be close enough together to avoid herniation of stomach between them. This has been reported as a cause of late perforation. (35)

Nausea is the primary complaint of the majority of patients and aggressive management is indicated. A protocol of intraoperative dexamethasone (Decadron 10 mg intravenous every day for up to 3 days, Merck & Co., Inc., Whitehouse Station, NJ), ondansetron (Zofran 4mg IV or PO every 4 hours as needed for nausea/vomiting, GlaxoSmithKline, Research Triangle Park, NC) and scopolamine transdermal (Transderm Scop 1.5mg patch behind the ear every 3days as needed, ALZA Corporation, Vacaville, CA) followed by intermittent anticholinergics and short-acting benzodiazepines are usually effective. In Dr. Brengman's experience with only adult patients to date, the majority require an overnight stay (23hr) for symptom management and hydration. Because of the profound restriction, most patients develop symptomatic reflux in the early post-operative period. All patients are treated with proton pump inhibitors for the first three post-operative months. Some will develop significant epigastric "cramping" following the surgery. Hyoscamine (Levsin 0.125mg PO/SL every 4 hours as needed for cramping, Alaven Pharmaceuticals, Marietta, GA) and lorazepam (Ativan 1mg IV/PO every 6 hours as needed for anxiety or cramping, West-Ward Pharmaceuticals, Eatontown, NJ) are effective for these complaints that can last up to 2 weeks post-operatively. Finally, part of the initial enthusiasm for LGCP was the perception that gastric leak was not a significant risk. As has been described in this chapter, leaks can and do occur. As with all gastric surgery, and especially bariatric surgery, a high level of

suspicion is required. Early detection, reoperation and conversion to gastric bypass is most often the preferred treatment of choice in this situation.

Post-surgical care

Immediately post-operatively, the patient will be admitted to the hospital with pain medication and frequent vitals to assess for any changes in heart rate, respiratory status, pain or nausea. Nausea will be aggressively treated and monitored as it is a known frequent complication of this procedure. It is anticipated that a patient will likely stay in the hospital for 1–2 nights. During the hospitalization, subjects and their parent(s) will meet with the registered dietitian for instruction on the immediate post-operative diet. Additionally, prior to hospital discharge, subjects will be provided with information related to appropriate progression, types, and intensities of physical activity to engage in (and not to engage in) during their acute recovery period.

The post-surgical diet is comparable to a post-laparoscopic sleeve resection diet and is initiated on post-operative day 1 after having a normal upper gastrointestinal study, Figure 3, and been clinically cleared by the team. It will progress from easy-to-digest clear liquids (non-carbonated and sugar-free) for 24–48 hours followed by full liquids. After two weeks, and as tolerated the patient, the diet will be advanced to semi-solid foods including pureed meats and soft fruits and vegetables for another two weeks. The patient can then advance to the last stage, which is a maintenance phase where the patient will be allowed to slowly start eating soft textured, low-fat, low-sugar foods. At this point, they will no longer require liquid meal replacements. Patients will meet with a registered dietitian throughout the follow-up period, to develop and monitor an individualized nutrition education plan and assess for adequate nutritional status.

After undergoing surgery, patients will have follow up in short and long term capacity and in addition to anthropometric measurements such as height and weight (to measure BMI and %EWL), patients will undergo several other tests such as oral glucose tolerance tests, transthoracic echocardiogram, DXA scanning and flow-mediated vasodilation of the brachial artery to determine the metabolic effects and consequences on this procedure. Post-operative pain and nausea will be addressed clinically as well as using symptom scale assessments and these symptoms will be tracked and treated accordingly. An upper gastrointestinal series will be performed at 5 different times over the 3 years to assess motility and shape and size of the plicated stomach. It can also be a test to look for leak. In addition, they will be seen by the psychology team to determine the emotional, behavioral and mental consequences of this procedure.

CONCLUSIONS

Laparoscopic greater curvature plication is a promising procedure that has recently become more widely studied in the adult population. As it is not a malabsorptive operation, does not involve the removal of gastric tissue, and may be reversed if needed, LGCP may become another surgical option for adolescents with severe obesity. Our pilot study will provide complete clinical data to evaluate the efficacy of this procedure in this population as it is a multidisciplinary approach in carefully selected patients. Close and frequent follow up will help to track these patients in terms of outcomes and compliance and provide relatively long term data on weight loss in this adolescent group. These data will hopefully be used to determine if a larger prospective trial between LGCP and other bariatric surgical treatment options, such as sleeve gastrectomy, would be advisable.

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Figure 1.
Surgical steps for a greater curvature plication.

Figure 2. Percent of excess weight loss in comparative studies (AP - anterior plication, LGCP - laparoscopic greater curvature plication, LAGB - laparoscopic adjustable gastric banding, RYGB - Roux-en-Y gastric bypass, and VSG - vertical sleeve gastrectomy).

Figure 3.
Upper gastrointestinal series post-operative day 1 after a laparoscopic greater curvature plication.