Early results after laparoscopic sleeve gastrectomy in adolescents with morbid obesity

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Background. Obesity has been identified as one of the most important public health concerns in both children and adolescents. Unfortunately, even the most comprehensive and aggressive multidisciplinary weight management programs have shown only modest weight loss results. There has been increasing enthusiasm for bariatric surgery for adolescent patients with morbid obesity. Because of the relatively high morbidity and mortality associated with gastric bypass surgery, we have begun to explore laparoscopic sleeve gastrectomy as an alternative. We hypothesized that it would be a safe and effective short-term strategy.

Methods. We have prospectively collected data from all patients undergoing bariatric surgery at our institution since the inception of our adolescent weight loss surgery program in January 2010. Baseline data collected included age, gender, race/ethnicity, height, weight, body mass index, and comorbid conditions. Postoperative data collected included the type of operation, length of stay, operative morbidity, the need for reoperation, and percent excess weight loss and body mass index at 3-month intervals.

Results. Twenty-three patients have undergone laparoscopic sleeve gastrectomy at our institution since January 2010. Of these, 18 were female and 5 were male. The mean age was 17.3 ± 1.5 years of age. The mean preoperative weight was 149 ± 30 kg with a body mass index of 52 ± 9 kg/m². There were no intraoperative complications, and the only postoperative complication has been pancreatitis in 1 patient. The mean length of stay was 2.2 ± 1.1 days. The mean follow-up was 10.9 ± 7.4 months. The percent excess weight loss at 3 months, 6 months, and 1 year postoperatively was 32%, 38%, and 40%, respectively, in those who had reached these time points.

Conclusion. Laparoscopic sleeve gastrectomy is a safe operation for adolescent patients with morbid obesity and represents an effective early treatment strategy with approximately 40% excess weight loss at 6 months and 1 year of follow-up. Because of the minimal morbidity associated with laparoscopic sleeve gastrectomy, it may be the optimal non-device surgical option for this select group of adolescent patients. (Surgery 2012;152:212-7.)

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Obesity has been clearly identified as one of the most important public health concerns in children and adolescents, and the costs of care continue to mount in parallel with the prevalence of the disease. Obesity prevention remains the essential long-term strategy to combat the epidemic, but the promising interventions are either too expensive or require more robust data to support their use and therefore have not been universally implemented. Compounding the problem is the fact that the most comprehensive and aggressive multidisciplinary weight management programs have shown only modest weight loss results in the populations that are most severely afflicted. There has therefore been increasing interest in bariatric surgery for adolescent patients with morbid obesity, although some clinicians have argued that perhaps too much enthusiasm has been devoted to this treatment option without sufficient long-term follow-up. Because of the relatively high morbidity and mortality associated with gastric bypass surgery, and the lack of approval by the US Food and Drug Administration for laparoscopic adjustable gastric banding (LAGB) in patients <18 years of age, we have begun to explore laparoscopic sleeve gastrectomy (LSG) as a procedural option for adolescents who are morbidly obese. LSG has become an accepted surgical alternative for adults with
morbid obesity, and its popularity among adult centers is increasing. We hypothesized that it would also be a safe and effective short-term strategy in adolescent patients.

MATERIALS AND METHODS

All patients who have undergone LSG at our children’s hospital since the inception of our weight loss surgery program in January 2010 were entered into our prospective database and were retrospectively reviewed. The patients met the National Institutes of Health consensus development conference criteria for bariatric surgery in adults, and we have always used these criteria for adolescents rather than those initially recommended by others in the pediatric community. Informed consent was obtained from parents with assent from the patient if he or she was <18 years of age, or directly from the patient for those ≥18 years of age. Institutional review board approval was obtained before the initiation of the registry. Patients ≥18 years of age were offered either LSG or LAGB; patients <18 years of age all received LSG but were offered the choice to wait until 18 years of age when LAGB could be performed. The data were prospectively entered into our database and the following information was abstracted for review: age, gender, ethnicity, preoperative body mass index (BMI), comorbid conditions, length of hospital stay (LOS), percentage of excess weight loss (%EWL), mean BMI, and complications. Excess weight was calculated as the patient’s current weight minus his or her ideal body weight, and the %EWL is the ratio of weight lost at each timepoint over the total excess weight. All continuous data were assessed for normal distribution, and once normalcy was confirmed the data were presented as mean and standard deviation.

All of the procedures were performed either by 2 attending pediatric surgeons in concert (Drs Nadler or Qureshi) or via a single attending (Dr Nadler) and a resident or fellow. The procedures were performed at a single children’s hospital with a comprehensive medical and surgical weight loss surgery program. The LSG was performed using 5 incisions using a 40 F Bougie dilator and otherwise standard technique that has been described previously. Staple line buttressing using an absorbable polymer membrane (W.L. Gore, Newark, DE) was used, and intraoperative assessment of the staple line was performed via methylene blue-stained saline injection into the post-resection remnant. A contrast esophagram was obtained on postoperative day 1 to confirm the absence of a staple line leak before initiating oral intake. Patients were discharged once they had achieved adequate oral intake, their pain was under control, and they were ambulating without difficulty. A strict postoperative nutritional regimen was used that consisted of a liquid diet for the first 2 weeks, with gradual increases in food texture over the ensuing 3 months. After 3 months, drinking beverages at the time of food consumption was permitted. Patients returned to the office for evaluation 2 weeks after surgery, and then every 3 months for the first postoperative year to monitor weight loss, appetite, dysphagia or food intolerance, eating behavior, comorbidity status, and the presence of any complications. Follow-up was then decreased to every 6 months after the first year.

RESULTS

Between January 2010 and December 2011, 23 patients between 14 and 19 years of age underwent LSG at our institution for the treatment of morbid obesity. Detailed demographic characteristics of the patients are listed in Table I. The cohort consisted of 5 males and 18 females. There were 13 African American patients (56%), 5 Hispanic patients (22%), and 5 white patients (22%). The mean age was 17.3 ± 1.5 years, with a mean initial weight of 149 ± 30 kg and a mean initial BMI of 52 ± 9 kg/m². All operations were performed via a laparoscopic approach, and the mean LOS was 2.2 ± 1.1 days. There were no conversions to the open approach and no intraoperative complications. One patient suffered from pancreatitis 14 months after LSG from a presumed biliary origin, although no gallstones were noted on an ultrasound examination of the gall bladder at the time of the symptoms. Subsequent repeat ultrasound did reveal choledolithiasis. Two other patients were admitted approximately 3 months after surgery with postviral gastroparesis that resolved with expectant management. Otherwise there were no postoperative complications at a mean follow-up of 10.9 ± 7.4 months. The mean %EWL was 32 ± 13 at 3 months, 38 ± 14 at 6 months, and 40 ± 19 at 1 year of follow-up. Detailed weight loss data are presented in Table II. More important than the absolute weight loss is the impact of the weight loss on the patient’s comorbid conditions. At baseline, our 23 patients suffered from a total of 64 obesity-related comorbid conditions. Impaired glucose tolerance, whether it be insulin resistance or frank type 2 diabetes (n = 14), was the most commonly reported comorbid condition at baseline, followed by obstructive sleep apnea (n = 12) and hypertension (n = 8). Nine patients who reached 1 year of follow-up had a total of 22
The obesity epidemic continues to be a challenging problem across the age spectrum. The consequences of morbid obesity in adults are well described, and the prevalence of those which incur the risk of future cardiovascular events is increasing in both pediatric and adolescent populations. A full list of the reported comorbidities in these 9 patients and their status at 1 year is presented in Table III. At 1 year of follow-up, 12 of the 22 (55%) comorbid conditions were completely resolved and 5 (22.5%) were improved. Unfortunately, 5 (22.5%) comorbidities were unable to be evaluated because 2 patients who lived a fair distance from our institution had their 1-year follow-up elsewhere and did not undergo repeat laboratory evaluation or polysomnogram to assess the status of their conditions.

**DISCUSSION**

The obesity epidemic continues to be a challenging problem across the age spectrum. The consequences of morbid obesity in adults are well described, and the prevalence of those which incur the risk of future cardiovascular events is increasing in both pediatric and adolescent populations. Recent data show that while children with obesity who maintain their obese state as adults have a significantly increased risk of type 2 diabetes, hypertension, dyslipidemia, and carotid artery atherosclerosis, the risks of these outcomes are mitigated if the child is non-obese by adulthood. It is imperative that we not only find ways to prevent children from becoming obese but that we find suitable treatment options for those children already stricken with the disease. Complicating the problem is that there is no consensus regarding the most effective way to effect weight loss in the child or adolescent with obesity, and even the most comprehensive and intense weight loss programs do not achieve weight loss that would permit an adolescent with obesity to return to the non-obese state. The long-term success of these programs and the ability of the child to maintain significant weight loss into adulthood is also varied. Therefore, attention has turned to surgical intervention to achieve significant and sustained weight loss for the adolescent with morbid obesity. Initially, much of the focus for adolescent weight loss surgery centered on the laparoscopic Roux-en-Y gastric bypass (RYGB) because it had been the primary surgical procedure for adults with morbid obesity. However, it has been documented that the morbidity and mortality associated with the RYGB is greater than that related with other surgical options currently used for weight loss, particularly the LAGB. The lower complication severity associated with LAGB led us to initially use the LAGB in adolescents with excellent short-term results. However, despite the fact that there continue to be reports of safety and efficacy with LAGB in the adolescent population in the United States and despite the long-term data from overseas documenting the procedure’s durability, the FDA still has not approved the use of the device in patients <18 years of age. We began to explore the LSG as our primary non-device option for adolescents with morbid obesity because it has recently been supported as an effective standalone surgical procedure for weight loss and has a much lower complication rate than RYGB. In addition, 1 small case series from Germany also supported LAGB for morbidly obese children.

In our cohort of 23 adolescent patients who underwent LSG, we had a similar gender distribution (78% female), like most adult bariatric surgery series, but our ethnic makeup (78% African American or Hispanic) and payer mix (70% public insurance) and initial BMI (52 ± 9 kg/m²) are quite different than most adult reports. These differences are important because our %EWL of approximately 40% at 1 year of follow-up is much less than the approximately 60% EWL reported in a large questionnaire based report of adult outcomes. The simplest explanation for our lower %EWL may just be the learning curve as we began performing the procedure. We use a 40-Fr bougie dilator, which has been shown to decrease the risk of staple line leak, but some suggest that a smaller size of the gastric sleeve is important in achieving maximum weight loss, and 36 Fr was the mean bougie size used in those polled at the Third International Consensus Summit for Sleeve Gastrectomy. It is possible that as our experience grows and our willingness to create a smaller sleeve increases, our %EWL will be closer to that seen in adult reports. An alternative explanation is the unique demographic composition of our adolescent cohort. Data from the National Inpatient Sample database...
reveal that 74% of adult patients who underwent bariatric surgery between 2006 and 2008 were white and 73.5% had private insurance, while our cohort has entirely inverse proportions (78% ethnic minority and 70% public insurance). It has been well documented that African Americans lose less weight after bariatric surgery than whites regardless of procedure type. The same ethnic differences in weight loss after bariatric surgery are seen in patients of Hispanic origin, although there is much less published information on the disparities between Hispanics and whites after bariatric surgery. Potentially augmenting the impact of ethnicity on %EWL in our cohort is our high proportion of publicly insured patients. Insurance status has definitively been linked to longer inpatient hospitalization and greater risk of complications in patients undergoing bariatric surgery, but its impact on weight loss is less clear. One additional independent predictor of poor weight loss after bariatric surgery that could also be a contributing factor to our poorer than expected %EWL outcomes is super obesity (BMI >50 kg/m²), given that our cohort had a mean BMI of 52 kg/m². Lastly, 3 of our patients were admitted to inpatient weight loss programs before their surgical procedure to improve their health status before undergoing general anesthesia. It has been suggested that initial BMI predicts the nadir BMI after surgery, and whether this nadir is achieved with medical weight loss.

Table II. Percent excess weight loss in adolescents with morbid obesity after laparoscopic sleeve gastrectomy

<table>
<thead>
<tr>
<th>Time</th>
<th>No.</th>
<th>Mean weight (kg)</th>
<th>Mean BMI (kg/m²)</th>
<th>%EWL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperatively</td>
<td>23</td>
<td>149 ± 30</td>
<td>52 ± 9</td>
<td>NA</td>
</tr>
<tr>
<td>3 months</td>
<td>22</td>
<td>122 ± 29</td>
<td>42 ± 9</td>
<td>32 ± 13</td>
</tr>
<tr>
<td>6 months</td>
<td>13</td>
<td>119 ± 32</td>
<td>40 ± 8</td>
<td>38 ± 14</td>
</tr>
<tr>
<td>9 months</td>
<td>10</td>
<td>117 ± 33</td>
<td>40 ± 11</td>
<td>40 ± 23</td>
</tr>
<tr>
<td>1 year</td>
<td>9</td>
<td>119 ± 36</td>
<td>39 ± 8</td>
<td>40 ± 19</td>
</tr>
</tbody>
</table>

All patients at our institution who underwent laparoscopic sleeve gastrectomy for the treatment of morbid obesity were entered into our prospectively collected database. These data do not include 3 patients who missed their 6 month postoperative visits, and a different patient who missed the 9-month visit. Data represent the mean ± the standard deviation. BMI, Body mass index; %EWL, percent excess weight loss.

Table III. Comorbid conditions associated with morbid obesity in adolescent patients 1 year after laparoscopic sleeve gastrectomy

<table>
<thead>
<tr>
<th>Patient ID no.</th>
<th>Preoperative comorbidities</th>
<th>Status 1 year postoperatively</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IR, hidradenitis suppurativa, OSA, and depression</td>
<td>Hidradenitis improved (multiple sites healed, other still active); depression improved (still with some symptoms but off medication); OSA resolved</td>
</tr>
<tr>
<td>2</td>
<td>Orthopedic pain and exercise-induced asthma</td>
<td>Both resolved</td>
</tr>
<tr>
<td>3</td>
<td>IR</td>
<td>Unknown</td>
</tr>
<tr>
<td>4</td>
<td>Dyslipidemia, type 2 diabetes mellitus, OSA, and HTN</td>
<td>All unknown</td>
</tr>
<tr>
<td>5</td>
<td>PCOSs and GER</td>
<td>PCOS improved (still on birth control pills); GER improved (still takes occasional calcium pills)</td>
</tr>
<tr>
<td>6</td>
<td>Headaches, IR, OSA, and depression</td>
<td>Headaches, IR, and OSA resolved; depression improved (still in therapy)</td>
</tr>
<tr>
<td>7</td>
<td>HTN, OSA, depression, and IR</td>
<td>All resolved</td>
</tr>
<tr>
<td>8</td>
<td>OSA</td>
<td>Resolved</td>
</tr>
<tr>
<td>9</td>
<td>Pseudotumor cerebrii</td>
<td>Resolved</td>
</tr>
</tbody>
</table>

Since the inception of our weight loss surgery program, 23 patients have undergone laparoscopic sleeve gastrectomy. The protocol includes evaluation of comorbid conditions preoperatively and 1 year post surgery. Nine patients returned for their 1-year follow-up. Two patients (3 and 4) did not return at 1 year, accounting for the “unknown” status of their comorbidities. GER, Gastroesophageal reflux; HS, hidradenitis suppurativa; HTN, hypertension; IR, insulin resistance; OSA, obstructive sleep apnea; PCOS, polycystic ovarian syndrome.
followed by surgery or surgery alone, it may be that there is a natural set point that cannot be surpassed in some patients. Our 3 patients had 13%, 24%, and 31% EWL, respectively, before surgery. If you add the %EWL from the first 2 patients who are 1 year from surgery, their individual %EWLs would be 74% and 39%, respectively, and our adjusted mean %EWL at 1 year would be slightly increased to 43% (data not shown).

Despite the emphasis on weight loss in most publications addressing bariatric surgery, the resolution of the obesity-related comorbid conditions should be an important metric by which the success of surgery is evaluated. In the adolescent population, the risk of the procedure in comparison to the likelihood that the comorbidity will be adequately treated is the balance that must be weighed by the weight management team. In our preliminary experience, the safety of LSG seems to be adequate given that we experienced no intraoperative complications and none of the patients required conversion to laparotomy. Our cohort is quite heavy, with a mean BMI of 52 kg/m², and the patients suffered from significant comorbidities, including nearly two-thirds with either insulin resistance or frank type 2 diabetes, and more than half suffering from obstructive sleep apnea. In all patients where these conditions could be evaluated at 1 year post-surgery, the impaired glucose tolerance and obstructive sleep apnea were completed resolved. We also have 1 patient with severe pseudotumor cerebri who had complete resolution of her symptoms 6 months after surgery, and another with non-alcoholic steatohepatitis whose liver function tests normalized 3 months post-surgery. These data suggest that the 40% EWL in our patients is sufficient for resolution of even the most severe of the obesity-related comorbid conditions in our cohort of adolescents.

In conclusion, our preliminary data suggest that LSG is not only a safe operation for adolescents with morbid obesity, but it also represents an effective treatment strategy with a %EWL of approximately 40% at 1 year of follow-up. It should be noted, however, that our results may not be generalized to all populations because of the unique nature of our cohort. The weight loss in the early stage of our program is less than that seen in the adult population, but a larger cohort and longer-term follow-up would be necessary to determine whether these differences are maintained. In addition, LSG provides resolution or improvement in the obesity-related comorbidities with little to no short-term morbidity. We propose that LSG may be a better non-device surgical weight loss option than RYGB for adolescents with morbid obesity, and recommend that further study into its safety and efficacy be pursued.

REFERENCES

17. Reinehr T, Kleber M, Lass N, Toschke AM. Body mass index patterns over 5 y in obese children motivated to participate