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Single-stage versus 2-stage sleeve gastrectomy as a conversion after failed adjustable gastric banding: 30-day outcomes

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Abstract
Background Sleeve gastrectomy (SG) is being performed as a conversion after adjustable gastric banding (AGB), often in a single stage. However, some argue that it should be performed in 2 stages to improve safety. Few studies compare complications between 1-stage and 2-stage procedures. Our aim is to compare the 30-day complication rates among these two groups.
Methods We retrospectively reviewed patients converted from AGB to SG between 8/2008 and 10/2013 and compared patients undergoing 1-stage and 2-stage techniques. Primary outcome was overall 30-day adverse event rate (postoperative complication, readmission, or reoperation). Secondary outcomes included operating room (OR) time, length of stay (LOS), leak, infection, and bleeding rates, as well as mortality.
Results A total of 83 patients underwent SG after band removal; three were excluded due to short follow-up, leaving 60 1-stage and 20 2-stage. Mean time from band removal to SG for 2-stage was 438 days. Demographics, intraoperative technique (bougie size, staple reinforcement, oversewing staple line, and leak test), and mean follow-up were not statistically different. Mean OR time (132.1 min 1-stage vs. 127.8 min 2-stage, $p = 0.702$) and LOS (3.1 vs. 2.4 days, $p = 0.676$) were similar. Overall 30-day adverse event rate was 12 % for 1-stage versus 15 % for 2-stage procedures ($p = 0.705$). Differences in 30-day readmission (8 vs. 5 %) and reoperation (5 vs. 0 %) were not statistically significant ($p = 0.999$ and 0.569, respectively). Leak (3 vs. 0 %, $p = 0.999$), abscess (2 vs. 5 %, $p = 0.440$), and bleeding rates (2 vs. 0 %, $p = 0.999$) were not different. There were no deaths.
Conclusions SG performed as a conversion after AGB is safe and feasible. Our findings indicate no statistical difference in 30-day outcomes when performed in 1 or 2 stages. Future studies with larger sample sizes are necessary to further investigate these differences.

Keywords Sleeve gastrectomy · Gastric banding · Bariatric · Conversion · Obesity · Surgical/technical

While bariatric surgery is highly effective as a treatment for morbid obesity, some patients respond better than others. Patients can experience inadequate weight loss, weight regain, or suffer complications. As such, reoperative surgery (either corrective or as a conversion to another procedure) is sometimes required in order to adequately treat the disease. This is often times challenging due to adhesions and alteration of anatomy, and has been found to be associated with higher short-term complication rates [1]. When performed in the right setting, the effectiveness and low morbidity rate of reoperative surgery have been well documented [2–4].

For adjustable gastric banding (AGB), the type of reoperative surgery chosen should be based on the indication for reoperation. Band intolerance, gastroesophageal reflux disease (GERD), and port problems, for instance, can be managed with corrective surgery [5, 6]. On the other hand, inadequate weight loss, weight regain, or complications such as erosion and gastric perforation can be managed with conversion [7, 8]. Options for conversion after gastric band removal include Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy (SG). Specifically, SG has been

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shown to be a viable option after failed AGB [9–13]. A recent meta-analysis reported a rate of 15.7 % short-term and 2.5 % long-term complications after conversion from AGB to SG, with percent excess weight loss (%EWL) ranging from approximately 30–60 % [14]. One group detailed their operative technique for conversion from AGB to SG and reported a low morbidity rate with 0 % leak rate [15].

Conversion from AGB is often performed as a single-stage operation, with band removal and concurrent conversion. However, some argue that conversion to a second bariatric procedure should be performed several months after band removal ("2-stage procedure"), in order to allow for resolution of perigastric inflammation. For conversion to RYGB, a 2-stage procedure is associated with less morbidity and fewer anastomotic strictures [16]. For SG, there is a paucity of the literature that directly compares the safety of a 1-stage versus 2-stage conversion from AGB [17]. The primary aim of this study was to compare the 30-day postoperative complication rates among patients undergoing 1-stage versus 2-stage conversion from AGB to SG.

Materials and methods

We conducted a retrospective cohort study from a prospectively collected database at a single, academic institution. The focus was on our early experience with conversion from AGB to SG between 8/2008 and 10/2013. This cohort was divided into two groups: 1-stage (band removal with concurrent SG) and 2-stage (band removal with subsequent SG at a later date). Exclusion criteria were follow-up time <27 days and any bariatric procedure prior to AGB. Of note, patients with revisional surgeries after SG were included, as long as the revision occurred after 30 days postoperatively.

The primary outcome was overall 30-day adverse event rate, which included any postoperative complication, readmission, and/or reoperation. Postoperative complications were included regardless of the setting in which they occurred (i.e., during initial hospitalization, on readmission, or as an outpatient). Secondary outcomes included operating room (OR) time (for 2-stage procedures, this refers to SG time), length of stay (LOS), leak, abscess, and bleeding rates, as well as mortality.

We gathered information regarding the length of time that patients had the band in place, the time from band removal to SG for 2-stage patients, the reasons for conversion to SG, and the reasons for electing to perform the conversion in 2 stages. Several sub-analyses were also performed. Among patients with initial band erosion, we investigated the number of patients who subsequently developed any complication. Similarly, among those who later had infectious complications, we looked back to see how many of them originally had a band erosion. In the 2-stage group, we looked at the timing from band removal to SG for those who developed complications. Specific intraoperative metrics were compared, including the rate of conversion to open, bougie size, use of staple line reinforcement, frequency of oversewing the staple line, and performance of an intraoperative leak test. Statistical analyses included two-sample t test, Wilcoxon rank sum test, or Fisher's exact test.

Operative technique

The operations were performed by any one of 4 surgeons (BS, MK, CR, or GF). Entry into the peritoneal cavity was accomplished with the use of an optical trocar in the left upper quadrant. Lysis of adhesions and release of the gastrogastric plication was performed as necessary in order to visualize the gastric band surrounding the upper stomach. With the gastric band free, sheers were used to divide and unlock the buckle anteriorly, allowing removal of the band. The underlying "pseudocapsule" was excised in order to minimize the disparity in tissue thickness during stapling, as well as to relieve any constriction on the gastric tissue. Complete dissection at the left crus was also performed in order to facilitate full exposure and mobilization of the gastric fundus at a later step. In the 2-stage group, these steps were typically performed at the time of SG (2nd stage).

The greater curvature of the stomach was mobilized, taking care to preserve the gastroepiploic arcade. Using a tissue-sealing device, this dissection was extended proximally to the angle of His, including the careful division of the short gastric vessels. Distally, the greater curvature was mobilized to a point 2–3 cm proximal to the pylorus. A linear stapler was then used to fire the first staple line from a point 5–7 cm proximal to the pylorus, using a bougie as a guide. Bougie size was not standardized and was based on surgeon preference, ranging from 32 to 40 Fr. The remainder of the stapling was then performed along the bougie toward the gastroesophageal junction. Staple size was also not uniform, but generally around 4 mm in height.

Our surgical technique adapted over the duration of this study time period. Specifically, the use of bioabsorbable staple line reinforcement became more consistent and routine over time. We also made an effort to oversew or imbricate the proximal staple line at the angle of His, as well as to fixate the gastric sleeve to the greater omentum to help avoid twisting of the sleeve. Intraoperative leak test with methylene blue was performed routinely except for one surgeon who had a more selective approach. No nasogastric or drainage tube was routinely placed.

Postoperative management

Patients undergoing a single-stage operation were managed in the same way postoperatively as with primary SG. This included an esophagram on postoperative day 1, initiation of thin liquid diet thereafter, and discharge by postoperative day 2 or 3 if tolerating the diet and ambulating. Patients undergoing a 2-stage procedure were discharged the same day after band removal and returned for SG at a later time (generally no sooner than 8 weeks), again following standard postoperative management protocols. All patients converted from gastric band to SG due to band erosion underwent a 2-stage procedure.

Results

A total of 83 patients underwent SG after band removal during this time period; three were excluded due to short follow-up, leaving 60 (75 %) patients in the 1-stage group and 20 (25 %) in the 2-stage group. Demographic data was similar between the groups [Table 1]. Patients had the gastric band in place for an average of 5.8 years in the 1-stage group and 4.8 years in the 2-stage group. The mean time from band removal to SG for patients undergoing a 2-stage procedure was 438 days. The vast majority of cases were performed laparoscopically in both groups without the need for conversion to open. Over half of the patients had the gastric band removed due to band intolerance (discomfort with adjustments, GERD, and/or vomiting) (Fig. 1). Among patients undergoing a 2-stage procedure, the reasons for the delayed conversion are illustrated in Fig. 2. A majority of these patients experienced significant weight regain after band removal and subsequently decided to undergo SG. Band erosion was another significant reason for delayed conversion.

Factors involving intraoperative technique were also assessed. Figure 3 shows the distribution of bougie size used among the two groups, which was not statistically significant. Staple line reinforcement, oversewing/imbricating the staple line, and intraoperative leak test were performed with similar frequency among the two groups (Fig. 4).

The main 30-day outcomes are summarized in Table 2. Mean OR time, approximately 2 h in duration, was similar between the groups, as was hospital LOS. The rate of overall 30-day adverse events was 12 % for 1-stage versus 15 % for 2-stage procedures ($p = 0.705$). Differences in 30-day readmission (8 vs. 5 %) and reoperation (5 vs. 0 %) were not statistically significant ($p = 0.999$ and 0.569, respectively). Postoperative complications that required readmission or reoperation included severe pain, nausea, PO intolerance, gastric outlet obstruction, catheter-related sepsis, acute pancreatitis, leak, intraperitoneal abscess, hematoma, and deep vein thrombosis (DVT). Complications that were managed in the outpatient setting included superficial surgical site infection and seroma formation. Rates of specific postoperative complications, including leak, abscess, and bleeding, were similar when comparing 1-stage and 2-stage procedures. There were two patients who each had a single leak event, and these occurred on postoperative days 5 and 17. There were no deaths in either group.

Of the 2-stage procedure group, five patients had a band erosion and were subsequently converted to SG. None of these patients experienced a postoperative adverse event. Of the two patients with infectious complications after SG, none of them originally had an eroded band. Finally, the three patients who underwent a 2-stage conversion and suffered postoperative adverse events had a wait time from band removal to SG of 238, 549, and 554 days.

Table 1 Comparison of patient characteristics between patients undergoing 1-stage versus 2-stage conversion from AGB to SG

	1-Stage ($N = 60$)	2-Stage ($N = 20$)	p value
Age at conversion (years)			
Mean (SD)	43.2 (10.5)	41.5 (13.1)	0.551[a]
Range	[17 69]	[22, 66]	
Gender			
Male [% (n)]	28 ($n = 17$)	10 ($n = 2$)	0.132[b]
Female [% (n)]	72 ($n = 43$)	90 ($n = 18$)	
Race			
Caucasian [% (n)]	65 ($n = 39$)	75 ($n = 15$)	0.182[b]
African American [% (n)]	22 ($n = 13$)	10 ($n = 2$)	
Hispanic [% (n)]	5 ($n = 3$)	15 ($n = 3$)	
Other/unknown [% (n)]	8 ($n = 5$)	0 ($n = 0$)	
BMI at conversion (kg/m^2)			
Mean (SD)	43.1 (8.7)	41.1 (4.6)	0.191[a]
Range	[26.0, 67.2]	[30.7, 49.6]	
Approach			
Laparoscopic [% (n)]	95 ($n = 57$)	95 ($n = 19$)	0.367[b]
Converted to open [% (n)]	5 ($n = 3$)	0 ($n = 0$)	
Open [% (n)]	0 ($n = 0$)	5 ($n = 1$)	
Duration with band in place (days)			
Mean (SD)	2,104 (792)	1,756 (834)	0.097[a]
Range	[538, 4,082]	[181, 3,475]	
Time from band removal to SG (days)			
Mean (SD)	0	438 (327)	N/A
Range		[91, 1,279]	

[a] Two-sample t test

[b] Fisher's exact test

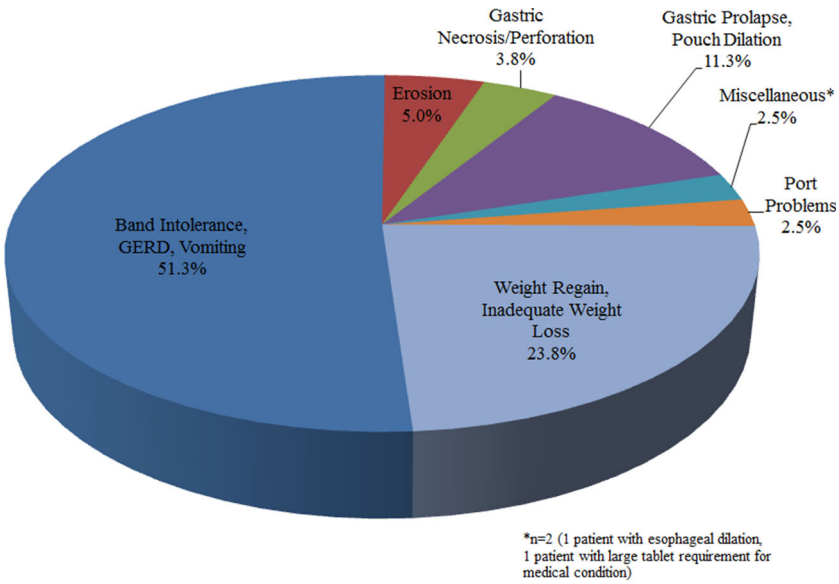

Fig. 1 Reason for gastric band removal among all patients ($n = 80$)

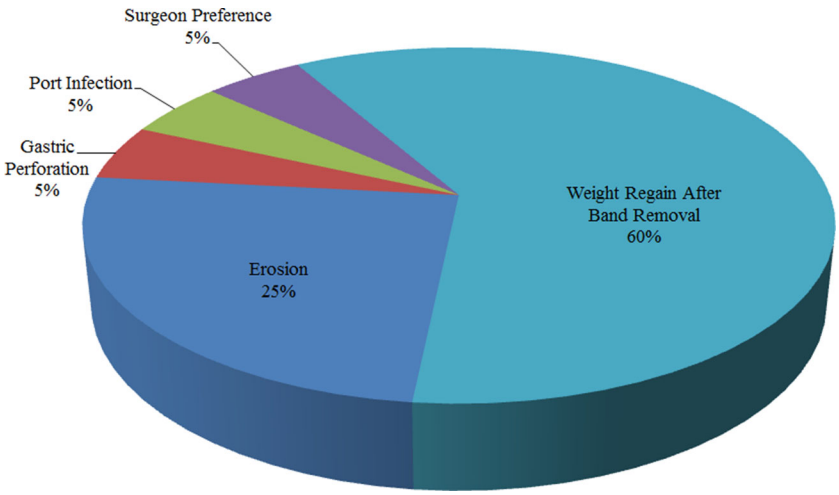

Fig. 2 Reason for delayed (2-stage) conversion from gastric band to SG ($n = 20$)

Discussion

AGB, in the proper practice setting with appropriate resources, has been shown to achieve satisfactory, sustainable weight loss [18, 19]. As a bariatric procedure, it is unique in that it requires long-term, frequent patient follow-up for adjustments. The success of this procedure relies, in large part, on several key factors. Preoperatively, a greater number of missed appointments is linked to less %EWL achieved and likely represents a suboptimal level of patient motivation [20]. Along the same lines, the number and frequency of postoperative office visit evaluations for adjustments has been shown to be proportional to weight loss [21, 22]. As a result, patients may experience inadequate weight loss or weight regain with AGB. In our study, almost one in 4 patients sought conversion for this reason.

While AGB has been shown to have the lowest risk profile, SG typically attains a higher mean %EWL as a primary bariatric procedure [23]. Based on these proven results, conversion to SG is an increasingly popular option after failed AGB. As referenced above, the safety and effectiveness of this conversion has been reported, including a percent excess BMI loss (%EBMIL) of 65 % at 18 months and 48 % excess weight loss at 3 years [10–12, 24]. The main question pertains to how and when to convert these patients. For SG, the percentage of patients undergoing a step-wise approach to conversion from AGB varies with each surgeon's practice. One retrospective review documented 13 % of their patients having a 2-stage operation, while a more recent study reports a rate of 43 % [11, 24]. In our study, we performed a 2-stage procedure on 25 % of patients, which falls in the middle range of that reported in the literature.

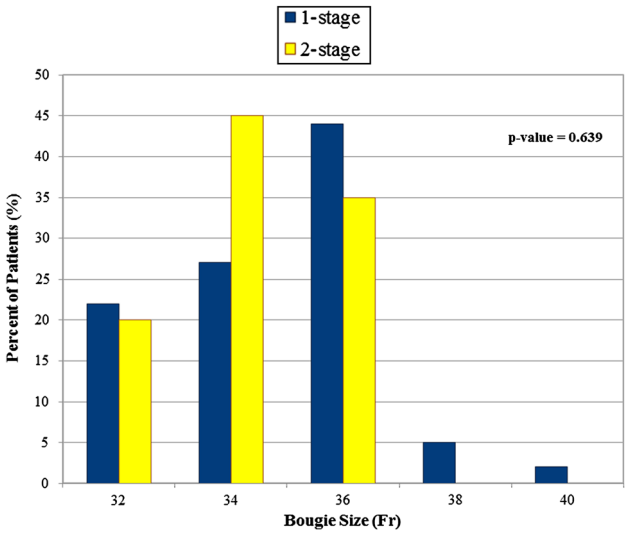

Fig. 3 Comparison of bougie size used for SG

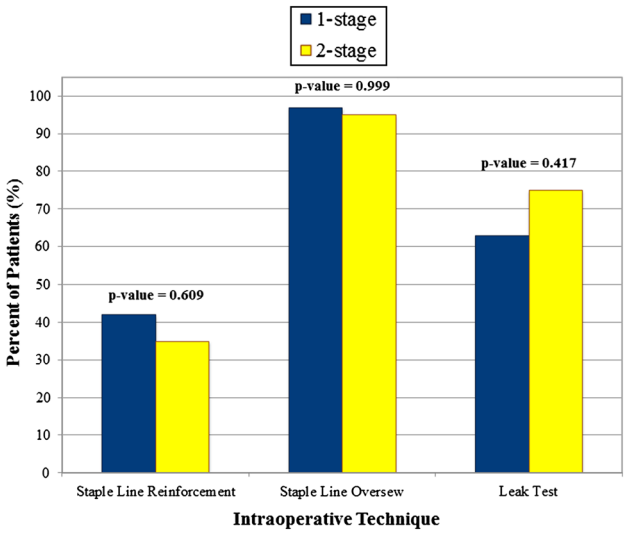

Fig. 4 Comparison of intraoperative techniques used during SG

The argument against single-stage conversion is that the perigastric inflammation from the band presents a higher risk of postSG complications. Alqahtani et al. [25] reviewed the results of their 1-stage conversions from AGB to SG. They reported a complication rate of 5.5 % with no mortalities at 24 months. A group from India also published their operative technique and outcomes of band removal with concomitant SG [15]. Their technique for single-stage conversion was also reviewed and is very similar to ours, including complete excision of the pseudocapsule. However, they did not use staple line reinforcement; instead, the entire staple line was inverted

Table 2 Comparison of 30-day outcomes between patients with 1-stage versus 2-stage conversion from gastric band to SG

	1-Stage ($N = 60$)	2-Stage ($N = 20$)	p value
OR time (minutes)			
Mean (SD)	132.1 (44.5)	127.8 (35.4)	0.702[a]
Range	[62, 258]	[76, 205]	
LOS (days)			
Mean (SD)	3.1 (4.1)	2.4 (0.9)	0.676[b]
Range	[1, 31]	[1, 4]	
Overall adverse event	12 % ($n = 7$)	15 % ($n = 3$)	0.705[c]
Readmission	8 % ($n = 5$)	5 % ($n = 1$)	0.999[c]
Reoperation	5 % ($n = 3$)	0 % ($n = 0$)	0.569[c]
Leak	3 % ($n = 2$)	0 % ($n = 0$)	0.999[c]
Abscess	2 % ($n = 1$)	5 % ($n = 1$)	0.440[c]
Bleed	2 % ($n = 1$)	0 % ($n = 0$)	0.999[c]
Death	0 % ($n = 0$)	0 % ($n = 0$)	NA

[a] Two-sample t test

[b] Wilcoxon Rank sum test

[c] Fisher's exact test

and oversewn. The group from India also left an intra-abdominal drain in place for a minimum of 7 days, even with lack of clinical evidence for leak. Among the 25 patients in their study with a 1-stage conversion, there were no minor or major complications, including leak or death.

A direct comparison of 1-stage versus 2-stage conversions was reported from Germany [17]. This study included 174 patients, of which 21 % were converted in a step-wise approach. Both groups had similar OR times to our study, about 2 h in length, with similar conversion to open rates. Bougie size was also similar to the sizes used in our practice. Interestingly, staple line reinforcement material was selectively used, 16 % among 1-stage and 42 % among 2-stage procedures. Our own practice for staple line reinforcement changed over the duration of this study, with more routine use of buttress material over time. This is why our study reports staple line reinforcement use in only 35–42 % of the cases. In the German study, surgery-specific morbidity was low: leak rate of 4.4 % for 1-stage versus 0 % in the 2-stage group, abscess 2.2 versus 0 %, and bleeding 0.8 versus 5.4 %. These were all found not to be statistically significant differences, consistent with our study.

There are several limitations to our study. While this was a cohort study, it was retrospective in nature and therefore relies on the accuracy and thoroughness of the database. The relatively small sample size of the groups can lead to an underpowered analysis. Intraoperative factors were not controlled for, although there were no

significant differences between the groups. These included bougie size, staple size, and use of intraoperative leak test. There were also differences in practice of oversewing the staple line, with some oversewing the entire length and others just at the angle of His or staple crossing. Fixation to the omentum was also not uniform. There was no standard wait time between band removal and conversion to SG, although our minimum wait time was 3 months. All of these factors, however, reflect the lack of standardization for the way SG is performed throughout the world [26, 27].

In summary, SG performed as a conversion after failed AGB is safe and feasible. Our findings indicate no difference in 30-day complications when performed in 1 or 2 stages. Future studies with larger sample sizes are necessary to further investigate these differences.

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