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Safety and short-term outcomes of sleeve gastrectomy and Roux-en-Y gastric bypass following removal of adjustable gastric banding

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Abstract

Background: The practice of bariatric surgery was studied using the German Bariatric Surgery Registry (GBSR). The focus of the study was to evaluate whether revision sleeve gastrectomy (R-SG) or Roux-en-Y Gastric Bypass (R-RYGB) has a major benefit in terms of perioperative risk in patients after failed Adjustable Gastric Banding (AGB).

Methods: The data collection includes patients who underwent SG or RYGB as revision surgery after failed AGB between 2005 and 2019. Outcome criteria were perioperative complications, comorbidities, 30-day mortality, and operative time.

Results: The study analyzed data from 1395 patients after revision SG and RYGB. 907 patients after R-RYGB, and 488 after R-SG. Intraoperative and overall postoperative complication rates were not significantly different between the two groups ($p=0.321$ and 0.621). The specific postoperative complication rate was significantly lower in R-SG than in R-RYGB ($p=0.049$). The mean operative time differed significantly between the two groups in favor of R-SG (160.3 min vs. 128.3 min; $p<0.001$). There was no significant difference in 30-day mortality between the two groups ($p=0.952$).

Conclusion: The study shows that R-SG and R-RYGB are safe and feasible as revision procedures and have acceptable complication and mortality rates. However, in our study, we cannot make a recommendation in favor of any of the surgical methods. Proper patient selection is essential to avoid possible adverse effects. Concerning the long-term results, further studies with higher methodological quality are necessary.

Keywords: Bariatric surgery; Sleeve gastrectomy; Gastric bypass; Gastric banding; Complications; Comorbidities

1. Introduction

Obesity is an enormous global chronic health problem [1]. Its prevalence has tripled since the 1980s, and there are now over 1.9 billion obese people worldwide [2]. In children and adolescents, obesity has increased significantly in recent years [3]. Comorbidities and obesity-associated diseases lead to increasing morbidity and mortality, as well as increasing reduction in quality of life and impairment due to severe psychopathological disorders [4, 5]. In recent decades, bariatric surgery, regardless of the type of surgical procedure used, has shown great success in changing BMI compared with the results of non-surgical procedures [6]. Bariatric surgery is recommended for people who have not been able to achieve permanent %total weight loss (TWL %) with non-surgical methods [7]. A well-known bariatric

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surgical procedure for the treatment of severe obesity is adjustable gastric banding (AGB) [8]. Unfortunately, AGB requires revision surgery in 20-60% of cases due to band slippage, chronic esophagitis, erosion, pouch dilation, infection, discomfort, and complications (i.e., vomiting, infection or positioning problems, pain after eating, or difficulty swallowing) or failure with significant TWL% [9, 10, 11, 12]. Here, surgeons should use other surgical procedures to achieve tremendous TWL% and effective complication management. The most used surgical procedures are gastric bypass (RYGB) and sleeve gastrectomy (SG) [13]. Several clinical trials investigated the effect of both surgical procedures in terms of BMI change and complication management as revision surgery after failed gastric banding [13, 14, 15, 16]. Our study aims to show the safety and feasibility of revision surgery from AGB to RYGB and SG.

2. Material and methods

This retrospective study with prospectively collected data analyzed data from patients who underwent revisional RYGB surgery (R-RYGB) and revisional sleeve gastrectomy (R-SG) between 2005 and 2019 after AGB failure. Processed data from the export of the Quality Assurance Study for Surgical Therapy of obesity of the German Bariatric Surgery Registry (GBSR) of the Institute for Quality Assurance in Surgical Medicine of the Otto-von-Guericke University Magdeburg were used. Only interventions that were validated as plausible at the time of data export were included in our analysis. Plausibility checks were performed when preparing obesity data for annual reports. Data included demographic and medical aspects such as age, sex, comorbidities, change in BMI (kg/m^2), 30-day mortality, operative time, and intra- and postoperative complications.

All analyzes were performed by StatConsult GmbH using SAS 9.4 software (SAS Institute Inc., Cary, NC, USA). As this was an exploratory analysis, the overall significance level of 5% was deliberately used, i.e., no correction for multiple testing is applied, and any $p \leq 0.05$ corresponds to a significant result.

In our study, data from 1395 patients were analyzed. In this study, we focused only on the results of the revision procedures (R-SG and R-RYGB) according to AGB. For both procedures, we did not discuss and analyze the reasons for band removal and reoperation. The distributions of the (quasi-)continuous variables, the mean and standard deviation (STD), were reported in the results tables. For categorical variables, relative (%) frequencies were presented in contingency tables. For categorical variables, the chi-square test was used for unadjusted analyzes of the procedures (R-SG vs. R-RYGB). For continuous variables, analysis of variance (ANOVA) was used. Analyzes on non-normally distributed data (operative time) were performed with log-transformed values.

Our analysis included various medical aspects, such as intraoperative and postoperative complication rates, mortality, and operative time. In addition, the specific postoperative complications such as sepsis, abscess formation, bleeding requiring transfusion, bleeding requiring surgery, and anastomotic leakage after RYGB or staple line leakage after SG were investigated. Intraoperative complications such as splenic, biliary, hepatic, and vascular injuries, pneumothorax, gastric perforation and intraoperative bleeding were analyzed. Our study compared the short-term outcomes of revision surgery (R-SG vs. R-RYGB) after AGB. Long-term outcomes were not analyzed in this study.

We compared the outcome of patients after R-SG (n = 488) with those who underwent R-RYGB (n = 907). With one exception, the indication for R-SG and R-RYGB was not standardized and was not documented in our study. Because this is a registry data collection, we cannot describe the surgical steps for band removal and revision surgery. It depends on the surgeons and their expertise which method they use during the procedure. In our analysis, the type of surgery (laparoscopic vs. open approach) was not considered.

3. Results

We analyzed data from 1395 patients from 2005 to 2019; 907 patients underwent R-RYGB and 488 patients underwent R-SG (Table 1).

Table 1 Distribution of patients according to demographic variables and surgical method

		R-SG	R-RYGB	p-value
Age (y)	n/mean value ± STD	488 / 45.7 ± 9.5	907 / 46.1 ± 10.1	0.415
BMI Kg/m2	n/mean value ± STD	488 / 45.8 ± 10.7	907 / 44.0 ± 7.8	0.001
Gender (m/f)	%	27.3/72.7	19.7/80.3	0.001
	(n)	133/355	179/728	
Distribution of surgical method				
Method		**R-SG**	**R-RYGB**	
N		488	907	
Total		1395		

3.1. Descriptive statistics and unadjusted analyses

The continuous parameters of the perioperative course are shown in Table 1 for all patients who underwent R-RYGB and R-SG surgery. Here, there was a significant difference in the mean BMI between the two groups. Thus, the R-SG patients had a significantly higher BMI (45.8 ± 10.7 kg/m^2 R-SG vs. 44 ± 7.8 kg/m^2 R-RYGB; p=0.001). However, there was no significant difference between the two groups in terms of mean age (R-SG 45.7 ± 9.5 years vs. 46.1 ± 10.1 in the R-RYGB; p=0.415). In addition, we analyzed the percentage distribution of male patients who underwent bariatric surgery compared to female patients. We found that the number of female patients accounted for a significantly higher proportion than the number of male patients in both groups ([f/m] 72.7%/24.3% in R-SG and 80.3%/19.7% in R-RYGB; p=0.001).

The percentage distribution of total comorbidities was not significant between the two groups (78.7% in R-SG group vs. 80.2% in R-RYGB group; p=0.517). 26% of patients in the R-SG group had type 2 diabetes mellitus (T2DM) vs. 24.8% in the R-RYGB group (p=0.651). The rate of arterial hypertension was 52.7% in the R-SG group and 48.6% in the R-RYGB group (p=0.150). Sleep apnea was diagnosed significantly more frequently in the R-SG group (18.4%) than in the R-RYGB group (12.8%; p=0.005). The ASA classification showed a significant difference between the two groups. ASA II and III were significantly higher in R-RYGB than in R-SG (ASA II 45.7% in R-SG vs. 47.2% in R-RYGB, ASA III 42.6% in R-SG vs. 49.4% in R-RYGB; p<0.001). Regarding pulmonary comorbidities and the incidence of pulmonary embolism, no significant difference was found between the two groups (p=0.151 and 0.881). Other comorbidities such as degenerative spine disease (DSD), other cardiac and vascular diseases, varicoses, non-alcoholic steatohepatitis, nicotine abuse, degenerative skeletal diseases and gonarthrosis were also analyzed. There was a significant difference in DSD (42.8% in the R-SG vs. 30.9% in the R-RYGB; p<0.001), degenerative skeletal disease (22.7% in the R-SG vs. 17.8% in the R-RYGB; p=0.025) and reflux (13.7% in the R-SG vs. 21.7% in the R-RYGB; p<0.001). No significant difference was found regarding other cardiac and vascular diseases (p=0.934), varicoses (p=0.301), non-alcoholic steatohepatitis (p=0.670), nicotine abuse (p=0.680) and gonarthrosis (p=0.925). A summary of the comorbidities is shown in Table 2.

Table 2 Distribution of patients according to comorbidities

		R-SG		R-RYGB		p-value
		n	%	n	%	
ASA	ASA I	40	8.2	23	2.5	<0.001
	ASA II	223	45.7	428	47.2	
	ASA III	208	42.6	448	49.4	
	ASA IV	17	3.5	7	0.8	
Comorbidities	Yes	384	78.7	727	80.2	0.517
	No	104	21.3	180	19.8	

Diabetes (total) T2DM	Yes	117	26.0	206	24.8	0.651
	No	333	74.0	623	75.2	
T2DM (IDDM)	Yes	33	7.3	62	7.5	0.924
	No	417	92.7	767	92.5	
T2DM (NIDDM)	Yes	69	15.3	122	14.7	0.768
	No	381	84.7	707	85.3	
T2DM (dietary)	Yes	15	3.3	22	2.7	0.489
	No	435	96.7	807	97.3	
Arterial hypertension	Yes	257	52.7	441	48.6	0.150
	No	231	47.3	466	51.4	
Pulmonary	Yes	62	12.7	141	15.5	0.151
	No	426	87.3	766	84.5	
Pulmonary embolism	Yes	3	0.6	5	0.6	0.881
	No	485	99.4	902	99.4	
Other cardiac and vascular diseases	Yes	44	9.0	83	9.2	0.934
	No	444	91.0	824	90.8	
Reflux	Yes	67	13.7	197	21.7	<0.001
	No	421	86.3	710	78.3	
Degenerative Spine disease	Yes	209	42.8	280	30.9	<0.001
	No	279	57.2	627	69.1	
Varicoses	Yes	27	5.5	39	4.3	0.301
	No	461	94.5	868	95.7	
Non-Alcoholic Steatohepatitis (NASH)	Yes	15	5.0	34	5.7	0.670
	No	286	95.0	566	94.3	
Nicotine abuse	Yes	43	8.8	86	9.5	0.680
	No	445	91.2	821	90.5	
Degenerative skeletal disease	Yes	111	22.7	161	17.8	0.025
	No	377	77.3	746	82.2	
Gonarthrosis	Yes	76	15.6	143	15.8	0.925
	No	412	84.4	764	84.2	
Sleep apnea	Yes	90	18.4	116	12.8	0.005
	No	398	81.6	791	87.2	

3.2. Operation data and time

Because over 95% of surgeries were performed laparoscopically and the distribution of surgery type (laparoscopic vs. open vs. conversion) was not significant, we did not include surgery type in our analysis (Table 3). The mean operative time was significantly longer in R-RYGB patients than in R-SG patients (160.3 [158.8; 161.8] min vs. 128.3 [126.7; 129.8] min; p<0.001).

Table 3 Operative data

Type of surgery					
	R-SG		R-RYGB		p-value
	n	%	n	%	
Laparotomy	8	1.6	24	2.7	0.398
Laparoscopy	470	96.7	867	96.1	
Conversion	8	1.6	11	1.2	
Operative time [min]* (Mean [range])	128.3 [126.7; 129.8]		160.3 [158.8; 161.8]		<0.001

3.3. Intraoperative and postoperative complication rates and 30-day mortality:

A total of 40 intraoperative complications were documented. 17 (3.5%) of these complications occurred in the R-SG and 23 (2.5%) in the R-RYGB. At p=0.321, there was no significant difference between the two groups. In detail, we analyzed the intraoperative injury of the liver (p=0.173), spleen (p=0.102) and bile duct, perforation of the stomach (p=0.661), bleeding and occurrence of pneumothorax. With a p-value above 0.05, there was no significant difference between the two groups in the occurrence of documented intraoperative complications. The details of complications are summarized in Table 4.

Table 4 Intraoperative complications

		R-SG		R-RYGB		p-value
		n	%	n	%	
Intraoperative complication (total)	Yes	17	3.5	23	2.5	0.312
	No	471	96.5	884	97.5	
Injury of splenic	Yes	5	1.0	3	0.3	0.102
	No	483	99.0	904	99.7	
Injury of liver	Yes	1	0.2	0	0	0.173
	No	487	99.8	907	100	
Pneumothorax	Yes	0	0	0	0	.
	No	488	100	907	100	
Perforation of the stomach	Yes	3	0.6	4	0.4	0.661
	No	485	99.4	903	99.6	
Bile duct injury	Yes	0	0	0	0	.
	No	488	100	907	100	
Vascular injury	Yes	1	0.2	0	0	0.173
	No	487	99.8	907	100	
Bleeding	Yes	0	0	0	0	.
	No	488	100	907	100	
Other	Yes	11	2.3	18	2.0	0.736
	No	477	97.7	889	98.0	

The general and surgery-related postoperative complications were also analyzed. The general postoperative complications included urinary tract infections (p=0.182), cardiac (p=0.553), renal (p=0.249), and pulmonary complications (p=0.489), fever (p=0.596), and thrombosis (p=0.656). The total general postoperative complication rate was not significantly different between R-SG and R-RYGB (p=0.621). There was no significant difference in the incidence of individual complications between the two groups with a p-value greater than 0.05. An overview of the general postoperative complications is shown in Table 5.

The specific postoperative complications (SPC) were bleeding requiring transfusion or surgical intervention, anastomotic and staple suture leakage and stenosis, ileus, sepsis, abscess formation, and peritonitis. The rate of total SPC was significantly lower in the R-SG than in the R-RYGB (5.1% R-SG vs. 7.9% R-RYGB; p=0.049). Notably, there was a significant difference in anastomotic stenosis rate in favor of R-SG (0.4% vs. 2%; p=0.018). No significant difference was found between the two groups regarding the incidence of abscess formation (p=0.465), sepsis (p=0.194), peritonitis (p=0.590), anastomotic leakage (p=0.794), bleeding requiring transfusion (p=0.754), bleeding requiring reoperation (p=0.221), and wound infection (p=0.893). No significant difference was found in 30-day mortality between the two groups (0.2% R-SG vs. 0.2% R-RYGB; p=0.952). Table 5 summarizes the general and specific postoperative complications.

Table 5 General and special postoperative complications

		R-SG		R-RYGB		p-value
		n	%	n	%	
General postoperative complication						
Total	Yes	30	6.1	62	6.8	0.621
	No	458	93.9	845	93.2	
Urinary tract infection	Yes	2	0.4	10	1.1	0.182
	No	486	99.6	897	98.9	
Cardiac complication	Yes	2	0.4	6	0.7	0.553
	No	486	99.6	901	99.3	
Renal complication	Yes	2	0.4	1	0.1	0.249
	No	486	99.6	906	99.9	
Pulmonary complication	Yes	10	2.0	14	1.5	0.489
	No	478	98.0	893	98.5	
Fever	Yes	10	2.0	15	1.7	0.596
	No	478	98.0	892	98.3	
Thrombosis	Yes	1	0.2	1	0.1	0.656
	No	487	99.8	906	99.9	
Other	Yes	15	3.1	31	3.4	0.731
	No	473	96.9	876	96.6	
Special postoperative complication						
Total	Yes	25	5.1	72	7.9	0.049
	No	463	94.9	835	92.1	
Bleeding requiring transfusion	Yes	6	1.2	13	1.4	0.754
	No	482	98.8	894	98.6	
Bleeding requiring surgery	Yes	3	0.6	12	1.3	0.221
	No	485	99.4	895	98.7	
Anastomotic and staple line leak	Yes	9	1.8	15	1.7	0.794
	No	479	98.2	892	98.3	
Stenosis	Yes	2	0.4	18	2.0	0.018
	No	486	99.6	889	98.0	

		R-SG		R-RYGB		p-value
		n	%	n	%	
General postoperative complication						
Ileus	Yes	0	0	6	0.7	0.072
	No	488	100	901	99.3	
Abscess formation	Yes	5	1.0	6	0.7	0.465
	No	483	99.0	901	99.3	
Sepsis	Yes	5	1.0	4	0.4	0.194
	No	483	99.0	903	99.6	
Peritonitis	Yes	3	0.6	8	0.9	0.590
	No	485	99.4	899	99.1	
Wound infection	Yes	5	1.0	10	1.1	0.893
	No	483	99.0	897	98.9	
30-day mortality	Yes	1	0.2	2	0.2	0.952
	No	486	99.8	903	99.8	

4. Discussion

Since January 1, 2005, primary and repeat bariatric procedures have been recorded by the Institute for Quality Assurance Surgical Medicine at Otto-von-Guericke University Magdeburg as part of a quality assurance study on the surgical treatment of obesity to improve the quality of care. A comparison was made between patients with R-SG and R-RYGB after failed AGB.

Adjustable gastric banding (AGB) is one of the well-known bariatric surgical procedures [17]. According to various literature results, there are many advantages for using adjustable gastric banding for obesity treatment [18, 19]. One study [20] reported a permanent change in BMI with 47% EWL maintained for up to 15 years after AGB. However, due to the disadvantages of AGB and complications, the surgery rate has decreased in Europe and worldwide [21]. For this reason, several clinical trials recommend switching to other bariatric procedures to eliminate the complication or achieve a significant %TWL in patients with obesity [22, 23, 24, 25, 26]. The primary documented indications for removal of a failed gastric band were dysphagia, weight regain, band slippage, band erosion, band defect, and band sepsis [27, 28]. Therefore, due to the high risks of revision surgery, reoperation after failed bariatric surgery must be done in consultation with the patient [29]. Regarding revision surgery after AGB, there is no strict consensus on the optimal conversion method after failed AGB procedure. Some options, including band repositioning or conversion to other surgical procedures such as SG or RYBG, have been proposed [21, 30].

Since SG and RYGB are adequate procedures in Germany, switching from AGB to SG or RYGB is an exciting option for revision operations [31, 32, 33]. However, there are still no clear guidelines for conversion from AGB to RYGB and SG [34, 35, 36] and statements in the literature vary regarding the effectiveness of both surgical procedures [37, 38, 39]. Chansaenroj et al. [40] analyzed data from 275 patients after revision surgery of a failed AGB. Several factors, including percent excess weight loss at 10-year follow-up, revision surgery, and major complication, were considered. 53 patients (19.3%) had revision surgery (26 single anastomosis (mini-)gastric bypass (R-LSAGB), 17 sleeve gastrectomy (R-LSG), 9 Roux-en-Y gastric bypass (R-LRYGB), and another procedure). After revision surgery, there was a significant excess weight loss (EWL %) of over 50% compared to 45% in the post-gastric banding group at 10-year follow-up. In the conclusion of the study, the authors stated that revision surgery of failed AGB is safe and can be performed without increased complication rate. In our study, we did not analyze the effect of R-RYGB and R-SG on the change in BMI and EWL%. This should be done in other studies with long-term follow-up after revision surgery. In addition, we only analyzed the outcome of both surgical interventions (SG and RYGB). All other surgical interventions were not included in our analysis.

In the present study, data from 1395 patients between 2005 and 2019 were analyzed. Moreover, we analyzed short-term outcomes after SG and RYGB as revision surgery after failed AGB. With a total of 907 patients with R-RYGB and

488 patients with R-SG, our study represents a large reported series of RYGB and SG after failed AGB. Our study aims to investigate whether RYGB or SG is superior to revision surgery after failed AGB. The decision for R-SG or R-RYGB depends on the surgeon's experience, risk factors, and comorbidities. In our study, the reason for the choice of procedure (laparotomy, laparoscopy, and conversion, SG or RYGB), removal of the gastric band, and surgeon's experience in performing SG or RYGB were not studied. In the present study, a significant distribution of demographic aspects was found between the two groups. Patients in the R-SG were heavier than those in the R-RYGB, with a mean BMI of 45.8% kg/m^2 (44%; p=0.001). The reason for this distribution and the effect of BMI on postoperative outcomes were not investigated. The overall comorbidity rate was not significantly different between the two groups. However, more patients in the R-SG suffered from sleep apnea than patients in the R-RYGB.

In contrast, patients in the R-RYGB had a higher ASA classification than patients in the R-SG. While patients in the R-RYGB group had a lower incidence of DSD and degenerative skeletal disease, patients in the R-SG group had fewer reflux symptoms than patients in the R-RYGB group. Other comorbidities analyzed were not individually significant between the two groups. It was also noted that the number of female patients was a large proportion compared to the number of male patients in both groups. The reason for this distribution could be that a large proportion of male patients are operated only when they have severe obesity-associated diseases. However, this is only our conjecture. The study did not thoroughly investigate the reason for the difference in gender distribution and the effect on postoperative outcome. However, Stroh et al. [41] examined the influence of gender on postoperative outcomes after bariatric surgery. Anastomotic leakage, gastric perforation, bleeding, wound infection, and stenosis were analyzed. Special complications occurred in 4.87% of patients after SG and in 5.30% of patients after RYGB. Overall, the number of special complications was significantly higher in men than in women (p=0.001).

Despite the advantages of the two surgical methods as primary and secondary surgery [42, 43] some disadvantages are usually expected after the two surgical procedures and should be considered when performing revision surgery [44, 45]. Theunissen and colleagues [46] compared the postoperative outcome of 107 patients with RYGB as revision surgery after AGB failure with 1020 primary RYGB (P-RYGB). Complications ranged from wound infections, urinary tract infections, cardiopulmonary to anastomotic leakage and reoperation. There was no significant difference in major complication rate (2.8 vs. 2.3%, p=0.73) between R-RYGB and P- RYGB. Cadière et al. [47] retrospectively compared early and late complications after P-RYGB vs. R-RYGB between January 2004 and August 2008. The median preoperative BMI was 42 kg/m^2 for P-RYGB and 39 kg/m^2 for R-RYGB (p=0.002). Early complications occurred in 24 patients (22.2%) after R-RYGB and in 37 patients (10.2%) after P-RYGB (p<0.001). Late complications occurred significantly more frequently after R-RYGB than after P-RYGB (30.6% vs. 12.7%; p< 0.001). Mognol et al. [48] analyzed data from 70 patients who underwent R-RYGB after failed AGB. Indications for band removal were weight regain, inadequate weight loss, gastric band migration, and symptomatic proximal gastric pouch dilatation, and psychological band intolerance. 14.3% of patients developed an early complication, and 8.6% developed a late major complication. The author found that RYGB can be used as a revision procedure with acceptable long- and short-term outcomes after failed AGB. Yazbek et al. [49] analyzed postoperative outcomes after R-SG compared with P-SG. 800 patients were included in the study. 90 out of 800 patients underwent revision surgery SG after failed AGB. Complications and percent excess weight loss (%EWL) were analyzed. The author found that the postoperative complication rate was higher after R-SG than after P-SG. Despite this complication rate, SG provides a positive outcome as a revision surgery after failed AGB. One study [50] compared data from 32 patients after R-SG with 64 patients after P-SG. The 30-day complication rate was higher in the R-SG group than in the P-SG group (14.71% vs. 6.25). The length of hospital stay was 3.22 days in the R-SG vs. 2.59 days in the P-SG. In addition, several clinical trials have compared the long- and short-term outcomes of R-RYGB and R-SG [49, 51]. In our study, we did not compare the results of primary surgery with those of revision surgery. We only focused on the outcomes of both procedures as revision surgery after failed AGB.

Janik et al. [11] investigated the safety of R-SG and R-RYGB after failed laparoscopic adjustable gastric banding (LAGB). 2708 patients were included in the study. The anastomotic leakage rate was higher in R-RYGB than in R-SG (2.07% vs. 1.18%, p=0.070). The incidence of bleeding was significantly higher in the R-RYGB group than in the R-SG group (2.66% vs. 0.44%, p<0.001). This was also true for the 30-day readmission rate (7.46% in the R-RYGB vs. 3.69% in the R-SG; p<0.001), 30-day reoperation (3.25% vs. 1.26%, p<0.001), and length of hospital stay. The study showed a significant difference in terms of postoperative outcomes in favor of R-SG. Angrisani et al. [52] reported comparable results in terms of postoperative outcomes after SG and RYGB as revision surgery after failed AGB. No significant differences were documented between the two groups in terms of BMI change and percent excess weight loss. The present study compared the short-term outcome after revision surgery between the two surgical procedures (R-SG and R-RYGB). Long-term outcomes were not investigated in our study. The distribution of total intraoperative complication rate was different between the two groups in our analysis. With a p-value above 0.05, there was no significant overall difference between the two groups in the occurrence of documented intraoperative complications.

The general postoperative complications ranged from urinary tract infections, cardiac, renal, and pulmonary complications, fever, and the occurrence of thrombosis. With a p-value greater than 0.05, there was no significant difference between the two groups in the overall complication rate. The rate of total SPC was significantly lower in the R-SG than in the R-RYGB in the two groups. In addition, there was a significant difference between the two groups in terms of the rate of occurrence of total specific postoperative complications in favor of R-SG. There was a significant difference in anastomotic stenosis rate in favor of R-SG. Other specific postoperative complications showed no significant disadvantages between the two groups.

Operative time differed significantly between the two groups, with the least time in the R-SG. Several clinical studies analyzed 30-day mortality after R-SG and R-RYGB. Here, both procedures showed similar results in this regard [53, 54]. Our analysis shows similar results. There was no significant difference regarding 30-day mortality after R-SG compared to R-RYGB.

5. Conclusion

A failed AGB is best treated with conversion to another bariatric procedure. The present study found that conversion to RYGB and SG can be performed for failed AGB with nearly comparable postoperative outcomes. In the short term, primary surgery appears to have the lowest intervention-related complication rates. However, R-SG showed lower intervention-related complication rates than R-RYGB. No significant differences were documented between R-SG and R-RYGB regarding intraoperative and general postoperative complications. This was also true for 30-day mortality. The mean operative time was significantly lower in the R-SG than in the R-RYGB group.

RYGB and SG as redo procedures after failed AGB are safe and beneficial. R-SG and R-RYGB provide a great outcome in terms of intraoperative and postoperative complication rates. Despite the advantages of both procedures, we cannot recommend any procedure in our study. However, it should be noted that proper patient selection is essential to avoid such possible adverse complications. The indication should be individualized depending on the intraoperative findings and the general condition of the patient. In addition, patients should be informed in detail about the advantages and disadvantages of both procedures. Due to the retrospective nature of the studies, these results should be interpreted with caution. Regarding long-term results, further studies with higher methodological quality are necessary.

Compliance with ethical standards

Acknowledgments

All authors equally contributed and acknowledge to read and approved the study.

Disclosure of conflict of interest

The authors declare that this article has not received funds from any entity, for its preparation and publication; and we have no conflicts of interest.

Statement of ethical approval

For this type of retrospective study, no formal consent was required. All data were gathered and analyzed in accordance with the privacy and ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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