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(RESEARCH ARTICLE)

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Effects of sleeve gastrectomy versus omega-loop gastric bypass. What is best for weight loss, perioperative adverse events, and comorbidities?

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Abstract

Aim of the study: This study investigated whether Sleeve Gastrectomy (SG) or Omega-Loop-Gastric-Bypass (OAGB) has the best benefit in weight loss, perioperative risk, and remission of comorbidities.

Methods: 29,407 patients after SG and OAGB were included in the German Bariatric Surgery Registry (GBSR). Outcome criteria were perioperative morbidity, perioperative complications, and remission of comorbidities after one year of follow-up.

Results: 15,169 patients had completed 1-year follow-up (770 patients after OAGB and 14,399 after SG). The %EWL was higher for OAGB than for SG (70.4 ± 18.5 for OAGB and 62.4 ± 22.6 for SG; $p<0.001$). BMI reduction was also a significant difference in favor of OAGB (17.5 ± 5.6 kg/m^2 for OAGB vs. 15.5 ± 5.9 for SG; $p<0.001$). There was no significant difference between the two groups in perioperative complications ($p<5\%$). Significant differences in favor of OAGB were found in remission of hypertension ($p<0.001$), IDDM ($p<0.001$), NIDDM ($p<0.001$), reflux ($p<0.001$), and sleep apnea ($p<0.001$).

Conclusion: Our analysis showed that OAGB surgery was associated with more significant BMI reduction and weight loss one year after surgery. In addition, OAGB surgery was significantly more effective in improving obesity-related comorbidities. Our results support the performance of OAGB over SG in patients with obesity and comorbidities. However, the contraindications and general condition of the patient should be considered in the context of this.

Keywords: Sleeve gastrectomy; Omega-Loop-Gastric-Bypass; Follow-up; Perioperative complications; Comorbidities.

1. Introduction

Worldwide, more people suffer from extreme obesity every year. Furthermore, the average body mass index (BMI) has been steadily increasing in all genders worldwide, with higher prevalence in developed than in developing countries [1]. In addition to obesity-related diseases such as arterial hypertension, sleep apnea, cancer, and type 2 diabetes mellitus (T2D), obesity causes an economic burden on the health care system and a reduction in life expectancy for patients with obesity [2].

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Despite the benefits of conservative therapy for obese patients, several clinical trials have shown a major advantage of bariatric and metabolic surgery over other pharmacological therapeutic modalities [3]. This effect was also particularly notable in terms of weight loss and remission of comorbidities [4]. Despite these advantages of bariatric surgery, it was possible to distinguish between the different bariatric surgical procedures regarding short- and long-term effects and effects on BMI and weight loss in patients with obesity.

Given the topic of this study, two surgical procedures, namely sleeve gastrectomy (SG) and Omega-Loop-Gastric-Bypass (OAGB) are compared. Several clinical studies have shown different results regarding the two procedures' short- and long-term effects [5]. Despite the described advantages of OAGB and the positive effects of this procedure on weight loss and remission of comorbidities compared with other bariatric procedures [6; 7], some points, such as the patient's medical history, the goal of the procedure, should be considered before choosing this type of intervention. This is also true for SG. Despite the safety of SG regarding the surgical technique, short-and long-term efficiency, SG has shown disadvantages compared to other surgical procedures [8].

Based on data from the German Bariatric Surgery Registry (GBSR), our study aims to present the short- and mid-term outcomes of sleeve gastrectomy and omega-loop gastric bypass in terms of perioperative outcomes, weight loss, and improvement of comorbidities.

2. Material and methods

All analyses were performed using SAS 9.4 software (SAS Institute Inc, Cary, NC, USA). Because this is an exploratory analysis, there is no correction for multiple testing, and any p-value <= 0.05 corresponds to a significant result. This study focuses solely on perioperative outcomes and one-year follow-up of OAGB and SG as primary interventions.

2.1. Patients and selection criteria

Our analysis included various medical aspects, such as comorbidities, demographic distribution, and duration of surgery. In addition, the specific postoperative complications such as sepsis, abscess formation, bleeding requiring transfusion, and bleeding requiring surgery were studied. Intraoperative complications were analyzed, such as splenic, biliary, hepatic, and vascular injuries, pneumothorax, gastric perforation, and intraoperative bleeding. In a first step, we compared the short-term outcome of patients after OAGB (n = 1553) with those who underwent primary SG (n = 27,854). In a second step, we analyzed the one-year follow-up results of both procedures (n = 770 after OAGB and 14,399 after SG). The indication for OAGB or SG was not standardized and was not documented in our study. In addition, because this is a registry data collection, we cannot describe the surgical steps for OAGB and SG. It depends on the surgeons and their experience.

The following criteria were considered in the present study:

- Patients with obesity and a valid age of at least 18 years (n = 73,228).
- Patients with obesity and primary surgery (n = 63,787).
- Patients with obesity and primary OAGB or SG (n = 29,407).
- Patients with obesity at one-year follow-up (182 to 547 days after surgery) (n = 15,169).

We extracted the following data from the German Bariatric Surgery Registry (GBSR).

2.2. Data preparation

The individual target variables are not explicitly recorded but must be derived from the data. These refer to:

- Weight loss: the difference between weight at baseline and weight at follow-up.
- BMI reduction: the difference between BMI at baseline and BMI at follow-up.
- %EWL: ratio of weight loss to excess weight as a percentage, where excess weight is defined as the difference between weight and ideal weight (based on height and BMI = 25) at baseline.
- Comorbidities, intraoperative, general, and specific postoperative complications are recorded individually and aggregated into one variable, e.g., intraoperative complications are reported if at least one intraoperative complication is selected.
- Follow-up period: 1 year considering a visit window of 182 to 547 days after surgery.

2.3. Descriptive statistics

For the distributions of (quasi-) continuous variables, mean and standard deviation (STD) or, in the case of root-transformed data, mean and range (because the range after inverse transformation is not symmetrical to the mean) and the number of patients included in the analysis (N) are reported. Absolute (N) and relative (%) frequencies are presented in contingency tables for categorical variables. However, it should be noted that the means from the original data and after back transformation are not identical.

2.4. Univariates / unadjusted analyses

Unadjusted analysis (for other variables) means that several influencing variables are not considered simultaneously. The focus here is on the univariate comparison of surgical procedures. Analysis of categorical outcomes was performed using the chi-square test. For continuous results, a robust t-test (Satterthwaite) was used. When the distribution was significantly different from the normal distribution (duration of surgery), a root function transformation to approximate a normal distribution was used to perform the test.

3. Results

We analyzed data from 15,169 patients from January 2005 to April 2021 who completed a one-year follow-up period after primary SG and OAGB. Over 98% of both procedures were performed laparoscopically. For this reason, we did not include the effect of this type of surgery in our analysis. However, the switch from laparoscopy to laparotomy was reported to be significantly more frequent in OAGB than in SG. The operating time was significantly longer at OAGB (mean 94.8 min) than at SG (78.9 min; p<0.001) (Table 1; 2; Figure 1).

Table 1 Distribution of surgical method and type at the time of primary surgery and at one-year follow-up

	At time of primary surgery		**At one-year follow-up**	
	N	**%**	**N**	**%**
OAGB	1553	5.3	770	5.1
SG	27854	94.7	14399	94.9
Total	29407	100	15169	100

Table 2 Distribution of surgery types for patients who had completed one-year follow-up

		SG		**OAGB**		
		n	**%**	**n**	**%**	**p-value**
Laparotomy		89	0.6	6	0.8	<0.001
Laparoscopy		14231	99.1	755	98.1	
Conversion		46	0.3	9	1.2	
Operating time (min)	N/mean/STD	14356 / 78.9 [74.7; 83.0]		770 / 94.8 [90.6; 99.1]		<0.001

3.1. Demographic Data

Patients with OAGB were older than those in the SG group (45.2 ± 10.9 years in OAGB vs. 43.7 ± 11.4 years in SG; p<0.001) but had significantly lower BMI (50.6 ± 7.4 kg/m2 in OAGB vs. 51.3 kg/m2 in SG; p<0.001). The gender distribution was significantly different in the two groups. The proportion of females was significantly higher than males in both groups (74.4% female vs. 25.6% male in OAGB and 67.1% female vs. 32.9% male in SG; p<0.001). The continuous parameters of the perioperative course for all patients who underwent SG and OAGB are shown in Table 3.

Table 3 Distribution of demographic variables at the time of surgery

		Method		p-value
		SG	OAGB	
Age (years)	mean value ± STD	14399 / 43.7 ± 11.4	770 / 45.2 ± 10.9	<0.001
BMI Kg/m^2	mean value ± STD	14389 / 51.3 ± 9.1	768 / 50.6 ± 7.4	<0.001
Gender (m/f)	%	32.9/67.1	25.6/74.4	<0.001
	(n)	4732/9667	197/573	

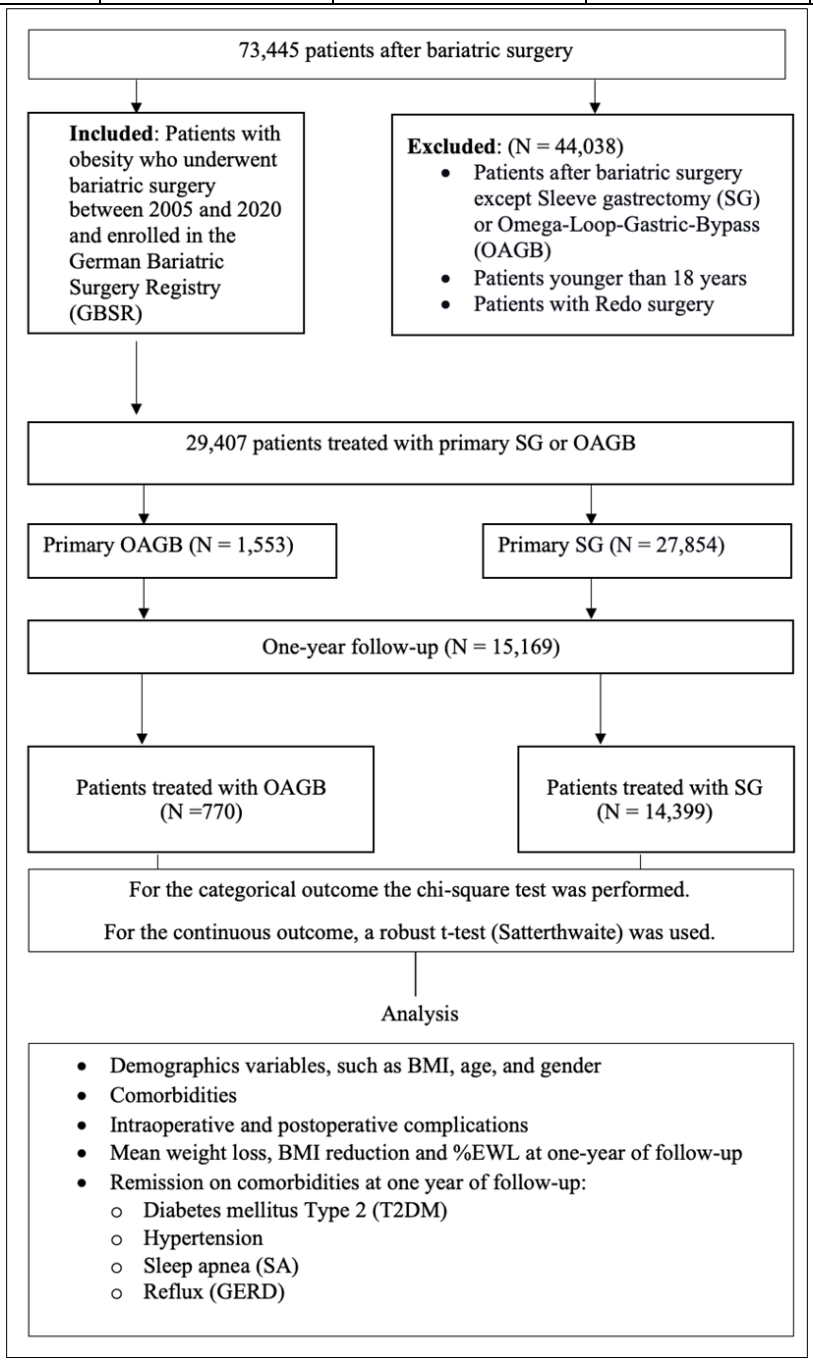

Figure 1 Flowchart of patient inclusion

3.2. Comorbidities

A summary of the distribution of comorbidities is given in Table 4. The percentage distribution of comorbidities was significantly higher in the OAGB group (96.4%) than in the SG group (92%; p<0.001). The ASA classification was distributed differently between the two groups. While ASA III was significantly more frequently documented in the OAGB group (57.7% vs. 52.3%), ASA IV was more frequent in the SG group (2.2% vs. 1.8%; p<0.001).

The distribution of comorbidities (T2d, hypertension, reflux, and sleep apnea) was significantly higher in the OAGB group than in the SG group.

Table 4 Distribution of comorbidities

		Method				p-value
		SG		OAGB		
		n	%	n	%	
ASA	ASA I	585	4.1	3	0.4	<0.001
	ASA II	5952	41.4	308	40.1	
	ASA III	7525	52.3	444	57.7	
	ASA IV	314	2.2	14	1.8	
Comorbidities (total)	Yes	13244	92.0	742	96.4	<0.001
	No	1155	8.0	28	3.6	
Diabetes (total) T2D	Yes	4427	33.3	312	43.1	<0.001
	No	8864	66.7	412	56.9	
T2D (IDDM)	Yes	1410	10.6	109	15.1	<0.001
	No	11881	89.4	615	84.9	
T2D (NIDDM)	Yes	2406	18.1	157	21.7	0.015
	No	10885	81.9	567	78.3	
T2D (dietary)	Yes	611	4.6	46	6.4	0.029
	No	12680	95.4	678	93.6	
Arterial hypertension	Yes	9206	63.9	526	68.3	0.014
	No	5193	36.1	244	31.7	
Pulmonary	Yes	2975	20.7	166	21.6	0.549
	No	11424	79.3	604	78.4	
Pulmonary embolism	Yes	166	1.2	2	0.3	0.021
	No	14233	98.8	768	99.7	
Other cardiac and vascular diseases (OCVD)	Yes	1562	10.8	69		0.100
	No	12837	89.2	701	91.0	
Cholecystolithiasis	Yes	530	3.7	58	7.5	<0.001
	No	13869	96.3	712	92.5	
Reflux	Yes	1590	11.0	194	25.2	<0.001
	No	12809	89.0	576	74.8	
Lymphedema	Yes	891	6.2	52	6.8	0.527
	No	13508	93.8	718	93.2	
Degenerative diseases of the skeletal system (DSD)	Yes	6894	47.9	478	62.1	<0.001
	No	7505	52.1	292	37.9	
Orthopedic therapy	Yes	3978	27.6	216	28.1	0.797
	No	10421	72.4	554	71.9	
Degenerative spine diseases	Yes	5163	35.9	281	36.5	0.720
	No	9236	64.1	489	63.5	
Gonarthrosis	Yes	3500	24.3	190	24.7	0.817

	No	10899	75.7	580	75.3	
Coxarthrosis	Yes	902	6.3	55		0.329
	No	13497	93.7	715	92.9	
Smoking	Yes	1380	9.6	66	8.6	0.351
	No	13019	90.4	704	91.4	
Varicosis	Yes	775	5.4	37	4.8	0.488
	No	13624	94.6	733	95.2	
Non-Alcoholic Steatohepatitis (NASH)	Yes	599	5.4	85	11.7	<0.001
	No	10594	94.6	640	88.3	
Alcohol	Yes	52	2.5	193	1.3	<0.001
	No	1990	97.5	14206	98.7	
Pseudotumor Cerebri	Yes	33	0.3	1	0.1	0.443
	No	11160	99.7	724	99.9	
Rheumatoid inflammatory diseases (RID)	Yes	153	1.4	11	1.5	0.737
	No	11039	98.6	714	98.5	
Polycystic ovary syndrome (PCOS)	Yes	174	2.3	6	1.1	0.071
	No	7391	97.7	533	98.9	
Chronic inflammatory gastrointestinal diseases	Yes	49	0.4	0	0	0.074
	No	11143	99.6	725	100	
Hypogonadism	Yes	25	0.7	1	0.5	0.806
	No	3602	99.3	185	99.5	
Transplantation	Yes	16	0.1	0	0	0.308
	No	11176	99.9	725	100	
Sleep apnea	Yes	4070	28.3	302	39.2	<0.001
	No	10329	71.7	468	60.8	

3.3. Intraoperative complications

There was no significant difference between the two groups in the overall rate of intraoperative complications (p=0.610). At least one intraoperative complication occurred in 9 patients (1.2%) after OAGB and 200 patients (1.4%) after SG. With an overall p-value greater than 5%, analysis of individual complications showed no significant results between the two groups. The details of intraoperative complications are summarized in Table 5.

Table 5 Intraoperative complications reported for Sleeve Gastrectomy and Omega-Loop-Gastric-Bypass

		Method				**p-value**
		SG		**OAGB**		
		n	**%**	**n**	**%**	
Intraoperative complication (total)	Yes	200	1.4	9	1.2	0.610
	No	14199	98.6	761	98.8	
Injury of splenic	Yes	43	0.3	3	0.4	0.655
	No	14356	99.7	767	99.6	
Injury of liver	Yes	14	<0.1	1	0.1	0.779
	No	14385	>99.9	769	99.9	
Pneumothorax	Yes	4	<0.1	0	0	0.644
	No	14395	>99.9	770	100	

Perforation of the stomach	Yes	10	<0.1	0	0	0.464
	No	14389	>99.9	770	100	
Bile duct injury	Yes	1	<0.1	0	0	0.817
	No	14398	>99.9	770	100	
Vascular injury	Yes	7	<0.1	1	0.1	0.339
	No	14392	>99.9	769	99.9	
Bleeding	Yes	5	<0.1	0	0	0.605
	No	14394	>99.9	770	100	
Other	Yes	137	1.0	4	0.5	0.224
	No	14262	99.0	766	99.5	

3.4. General and special postoperative complications

There was no significant disadvantage between the two groups for either general or specific postoperative complications (for general complications the p-value was 0.718 and for specific postoperative complications p=0.969). This was also true for the analysis of individual general and specific postoperative complications. With a p-value of over 5%, no significant difference was found between the two groups. A summary of the general and specific postoperative complications can be found in Table 6.

Table 6 General and special postoperative complications reported for Sleeve Gastrectomy and Omega-Loop-Gastric-Bypass

		Method				**p-value**
		SG		**OAGB**		
		n	**%**	**n**	**%**	
General postoperative complication						
Total	Yes	580	4	29	3.8	0.718
	No	13819	96	741	96.2	
Urinary tract infection	Yes	101	0.7	4	0.5	0.553
	No	14298	99.3	766	99.5	
Cardiac complication	Yes	50	0.3	5	0.6	0.174
	No	14349	99.7	765	99.4	
Renal complication	Yes	30	0.2	2	0.3	0.762
	No	14369	99.8	768	99.7	
Pulmonary complication	Yes	97	0.7	7	0.9	0.440
	No	14302	99.3	763	99.1	
Fever	Yes	104	0.7	3	0.4	0.283
	No	14295	99.3	767	99.6	
Thrombosis	Yes	14	<0.1	0	0	0.387
	No	14385	>99.9	770	100	
Other	Yes	314	2.2	12	1.6	0.246
	No	14085	97.8	758	98.4	
Special postoperative complication						
Total	Yes	490	3.4	26	3.4	0.969
	No	13909	96.6	744	96.6	
Bleeding requiring transfusion	Yes	100	0.7	3	0.4	0.316
	No	14299	99.3	767	99.6	
Bleeding requiring surgery	Yes	175	1.2	4	0.5	0.081
	No	14224	98.8	766	99.5	
Anastomotic leakage	Yes	125	0.9	11	1.4	0.108
	No	14274	99.1	759	98.6	
Anastomotic stenosis	Yes	7	<0.1	1	0.1	0.339
	No	14392	>99.9	769	99.9	
Ileus	Yes	4	<0.1	0	0	0.644

	No	14395	>99.9	770	100	
Abscess formation	Yes	69	0.5	2	0.3	0.385
	No	14330	99.5	768	99.7	
Sepsis	Yes	35	0.2	2	0.3	0.927
	No	14364	99.8	768	99.7	
Peritonitis	Yes	51	0.4	6	0.8	0.060
	No	14348	99.6	764	99.2	
Wound infection	Yes	80	0.6	2	0.3	0.275
	No	14319	99.4	768	99.7	

4. Results at one-year follow-up

4.1. Mean weight loss, %EWL and BMI reduction

Significant BMI reduction was more remarkable after OAGB than after SG (15.5 kg/m^2 at SG and 17.5 Kg/m^2 at OAGB; p<0.001). This was also true for percent excess weight loss (%EWL). This was significantly higher in the OAGB group (70.4 ± 18.5) compared to 62.4 ± 22.6 in the SG group (p<0.001). Mean weight loss was also significantly higher after OAGB than after SG (p<0.001). Table 7 summarizes the results of the two procedures for BMI reduction, %EWL, and mean weight loss.

Table 7 BMI reduction, %EWL, and mean weight loss at one-year follow-up

		Method		**p-value**
		SG	**OAGB**	
BMI reduction (Kg/m^2)	mean value ± STD	14291 / 15.5 ± 5.9	759 / 17.5 ± 5.6	<0.001
%EWL	mean value ± STD	14362 / 62.4 ± 22.6	767 / 70.4 ± 18.5	<0.001
Mean weight loss (kg)	mean value ± STD	14365 / 45.6 ± 18.0	768 / 50.5 ± 16.6	<0.001

4.2. Remission of Hypertension

With a p-value of <0.001, a significant remission of hypertension was found between the two groups in favor of OAGB. At baseline, more patients in the OAGB group (68.3%; n = 526) had hypertension than in the SG group (63.9%; n = 9206). After one year, hypertension disappeared in 3384 patients (23.5%) in the SG group and 244 (31.7%) in the OAGB group. Furthermore, an increase or recent development of hypertension was reported more frequently in the SG group than in the OAGB group (1% in SG vs. 0.5% in OAGB). 5814 patients (40.4%) in the SG group and 281 (36.5%) in the OAGB group had no improvement in antihypertensive medication (Table 8).

Table 8 Remission of hypertension, T2D, sleep apnea, and reflux-symptoms at one-year follow-up

Remission on obesity-associated diseases		**Method**				**p-value**
		SG		OAGB		
		n	%	n	%	
Hypertension	Complete remission	3384	23.5	244	31.7	<0.001
	De novo development of comorbidity	140	1.0	4	0.5	
	No change	5814	40.4	281	36.5	
	No comorbidities before and after surgery	5052	35.1	240	31.2	
IDDM	Complete remission	778	5.9	89	12.3	<0.001
	De novo development of comorbidity	81	0.6	1	0.1	
	No change	632	4.8	20	2.8	
	No comorbidities before and after surgery	11791	88.8	613	84.8	
NIDDM	Complete remission	1695	12.8	132	18.3	<0.001

	De novo development of comorbidity	39	0.3	2	0.3	
	No change	710	5.3	25	3.5	
	No comorbidities before and after surgery	10838	81.6	564	78.0	
Reflux	Complete remission	1119	7.8	159	20.7	<0.001
	De novo development of comorbidity	2244	15.6	75	9.8	
	No change	467	3.2	35	4.6	
	No comorbidities before and after surgery	10560	73.4	500	65.0	
Sleep apnea	Complete remission	1469	10.2	154	20.0	<0.001
	De novo development of comorbidity	120	0.8	4	0.5	
	No change	2601	18.1	147	19.1	
	No comorbidities before and after surgery	10200	70.9	464	60.3	

4.3. Remission of diabetes mellitus type II (T2D)

At baseline, more patients in OAGB suffered from T2D (43.1% in OAGB vs. 33.3%; p<0.001). Regarding remission of insulin-dependent diabetes mellitus (IDDM) at one year, a significant difference was found between the two groups in favor of OAGB (p<0.001). The rate of complete remission of IDDM by OAGB and SG is estimated to be 12.3% and 5.9%, respectively. In addition, no change in pharmaceutical management and insulin dose of IDDM was observed in 4.8% after SG and in 2.8% after OAGB. An increase in IDDM was documented in 0.1% of patients after OAGB compared with 0.6% after SG.

Regarding non-insulin-dependent diabetes mellitus (NIDDM), significant results were shown between the two groups in favor of OAGB (p<0.001). A complete remission rate was documented in 12.8% after SG and in 18.3% after OAGB. De novo of NIDDM was documented in 0.3% after OAGB and 0.3% after SG. No change was reported by 5.3% after SG and by 3.5% after OAGB. Table 8 shows the results of T2D after SG and AGB after one year (Table 8).

4.4. Remission of gastroesophageal reflux disease (GERD)

At baseline, 1590 (11%) patients in the SG group and 194 (25.2%) patients in the OAGB group suffered from gastroesophageal reflux disease. After one year, 1119 patients (7.8%) in the SG group and 159 patients (20.7%) in the OAGB group reported complete remission of reflux symptoms (p<0.001). In contrast, no change in symptoms was documented more frequently in the OAGB group than in the SG group (4.6% vs. 3.2%). 9.8% of patients after OAGB who had gastroesophageal reflux disease at baseline reported de novo reflux symptoms one year after AGB, whereas this was the case in 15.6% of patients who underwent SG (p<0.001) (Table 8).

4.5. Remission of sleep apnea (SA)

Both groups showed significant changes in sleep apnea symptoms. Complete remission of sleep apnea was more pronounced in the OAGB group than in the SG group (20% in OAGB vs. 10.2% in SG; p<0.001). De novo of symptoms was documented more frequently in the SG group (0.8% vs. 0.5%). However, no change in symptoms was more frequent in the OAGB group than in the SG group (19.1% vs. 18.1%) (Table 8).

5. Discussion

The present study compares the short- and mid-term outcomes of two bariatric surgical procedures: sleeve gastrectomy and omega-loop gastric bypass. A significant difference was found between the two groups regarding remission of comorbidities, BMI reduction, and weight loss in favor of OAGB. There was no significant difference between the two groups concerning perioperative adverse events.

Several clinical trials have found a positive effect of bariatric surgery on patients with obesity and their quality of life. Despite this overall effect, significant differences in short- and long-term outcomes have been noted between different bariatric surgical procedures [9]. This has also led to some uncertainty in the decision of which surgical procedures should be used.

Despite our extensive literature search, we did not find enough studies that accurately analyzed and compared the effect and outcome of the two procedures.

OAGB has shown positive results in many studies compared to other bariatric procedures in treating obesity-related diseases, such as T2D, hypertension, reflux, and sleep apnea [10]. Despite the advantages of this procedure and according to the recommendations of various clinical studies, there are many limitations in the use of this surgical method, so other surgical processes should be considered as alternatives.

The efficacy of sleeve gastrectomy has been proven over the past decades. The technical simplicity of the procedure, the limited surgical trauma and short operating time can explain the positive effect of this procedure. Nevertheless, many clinical studies have unfortunately shown a limited long-term effect of the method compared to other surgical methods [11].

It should be noted that (significant) results must always be discussed in context and terms of their relevance. Significant differences in numbers of patients may be obtained for minor cases, especially as this is exploratory without adjustment for multiple levels of testing. Effects are partially visible descriptively but not statistically likely because of the small number of cases.

5.1. Complications

Complications after SG and OAGB have been the subject of several studies [12]. However, the distribution of the type of complications differed between the two procedures [13]. Soong et al. [14] have reported similar results regarding perioperative outcomes after SG and OAGB. Based on our literature search, fewer studies compared the two procedures in terms of intraoperative and postoperative complications. There was no significant difference between the two procedures in both the overall complication rate and the analysis of individual complications in the present study. This was also true for general and specific postoperative complications.

5.2. BMI-reduction and %EWL

The present study showed a significant difference in %EWL between the two procedures, with a higher rate according to OAGB ($p < 0.001$). This was also true for BMI reduction ($p < 0.001$) at one-year follow-up. Our results follow the findings in the literature [15]. According to Salvi et al. [10], faster weight loss was reported in the first year after OAGB than after SG. Six years after surgery, weight loss was higher in the OAGB group than in the SG group (84% vs. 75.5%).

In contrast, the study by Shivakumar et al. [16] showed no significant difference between the two procedures three years after surgery. Our study and most existing studies see more advantages of OAGB compared to SG. Therefore, OAGB could be considered as the first choice if the goal of surgery is to achieve sufficient weight loss and BMI reduction. Of course, before making a decision, the risks and the patient's medical history should be considered, as well as the contraindications for each surgical procedure.

5.3. Remission on arterial hypertension

The treatment of hypertension in obese patients is challenging because conservative therapy is unsuccessful in most cases. For this reason, many studies have focused on the effects of bariatric surgery on the treatment of hypertension. In addition, many studies have analyzed the effects of different bariatric procedures on each other to achieve the best outcomes in patients with obesity. A study by Scavone et al. [17] showed significant results in terms of remission of hypertension after OAGB (93.7%). Based on his retrospective study, Hussain et al. [18] demonstrated the positive effect of OAGB on remission of hypertension (61% at one year and 58% at three years). However, the differential effect of SG versus OAGB on hypertension is controversial in the literature. Seetharamaiah et al. [5] showed no significant difference between the two groups regarding remission of hypertension. In contrast, our study found a significant difference between the two procedures in favor of OAGB. However, even if a one-year follow-up shows acceptable results regarding the evolution and disappearance of hypertension, further studies with more extended follow-up periods should be performed to make a reasonable conclusion about the effect of the two procedures on hypertension.

5.4. Remission on diabetes mellitus

Indeed, several studies have recommended that the presence of diabetes mellitus in patients with obesity is a compelling argument to perform metabolic surgery to achieve sufficient remission of the disease [19]. In his study, Vázquez et al. [20] reported 100% remission of T2D in patients with obesity two years after OAGB. A study by Almuhanna et al. [21] has shown complete remission of T2D in 73.8% of patients ten years after OAGB. However, the comparison between the different bariatric and metabolic surgical procedures showed different results. Shen et al. [22]

found a significant difference between SG and OAGB in remission of diabetes mellitus in favor of OAGB. The same result was demonstrated in the study by Vrakopoulou et al. [23]. Improvement of diabetes mellitus was observed more frequently in the OAGB group than in patients after SG.

This is also true for the results of our study: 12.3% of patients after OAGB had complete remission of IDDM compared with 5.9% after SG and 18.3% after OAGB had complete remission of NIDDM compared with 12.8% after SG. However, it should be noted that the change in diabetes mellitus was reported if there was a change in blood glucose levels or a reduction in medication or insulin use during the follow-up period.

5.5. Remission on Gastroesophageal reflux disease (GERD)

The presence of reflux disease limits the decision to perform bariatric surgery. Several studies have shown that the disease continues to worsen or even recurs after surgery [24]. In addition, long-term outcomes varied widely between different methods of bariatric surgery. Despite an intensive literature search, we did not find enough studies comparing the two surgical procedures (SG vs. OAGB). Nehmeh et al. [25] have reported an increase in acid reflux and bile reflux after OAGB, causing conversion surgery most times. Carandina et al. [26] analyzed the short- and long-term outcomes after OAGB in their study. 9.8% of patients developed bile reflux ten years after surgery. This was also the case with SG [27]. Because of the adverse effects of both procedures on patients with reflux, many studies have suggested switching from SG and OAGB to other surgical procedures, such as RYGB [28].

Our study showed a significant difference in favor of OAGB. However, the results of the two surgical procedures to improve reflux in patients with obesity are not satisfactory.

Therefore, in patients with obesity and reflux, perhaps another method, such as RYGB, should be used if the patient's general condition permits and there is no contraindication to the procedure. If there is a choice between sleeve gastrectomy and OAGB, sleeve gastrectomy should be preferred.

5.6. Remission on sleep apnea

Several clinical studies have reported an association between improvement in sleep apnea and metabolic surgery. Depending on the surgical procedures, the outcome and evolution of sleep apnea varied. Neuberg et al. [29] analyzed the effect of OAGB on sleep apnea in their study. Overall, significant improvement in sleep apnea was noted at the time of follow-up. Musella et al. [30] also compared the two surgical procedures in terms of resolution and improvement of sleep apnea. A clear significant difference was found in favor of OAGB vs. SG 12 months after surgery.

Our study shows that OAGB has a significant effect on sleep apnea compared to the group after SG. In addition, more de novo reflux symptoms were documented after SG than after OAGB. Thus, if the choice is between OAGB and sleeve gastrectomy, we believe that OAGB should be chosen as the surgical procedure.

6. Conclusion

OAGB and SG are safe and effective in treating patients with obesity. One year after surgery, remission of comorbidities, BMI reduction, and %EWL were significantly higher after OAGB than after SG. There was no significant difference between the two groups in the incidence of perioperative adverse events.

Based on the results of our study, it can be recommended that the OAGB method be preferred over the SG method when deciding between the two methods. However, we concluded that the indication for either method should be made with careful consideration of the patient's medical history and the long-term goal of surgery.

Compliance with ethical standards

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Disclosure of conflict of interest

Martin Hukauf was employed by the company StatConsult mbH, Magdeburg. The remaining authors declare that they have no competing 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.

Data availability statement

We extracted the data from the German Bariatric Surgery Registry (GBSR). Data available on request due to privacy/ethical restrictions.

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