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CLINICAL RESEARCH

Excessive Weight Loss after Sleeve Gastrectomy: A Systematic Review

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Abstract
Background The clinical significance of sleeve gastrectomy (SG) as a primary bariatric intervention is still under debate. This article aims to systematically analyze excessive weight loss (EWL) in patients after SG.
Methods A systematic literature search on SG from the period January 2003 to December 2010 was performed. Data described from systematic reviews dealing with gastric bypass procedures was used as comparator.
Results The final study included 123 papers describing 12,129 patients. Most of the papers describe EWL at 12 months (43.9% of all papers). For SG, the maximum EWL occurred 24 and 36 months postoperatively with a mean EWL of 64.3% (minimum 46.1%, maximum 75.0%) and 66.0% (minimum 60.0%, maximum 77.5%), respectively. At 12 months, the mean EWL in patients receiving SG was significantly lower when compared to patients who underwent gastric bypass (SG 56.1%, gastric bypass 68.3%; $p<0.01$, two-sided Wilcoxon test). Although patients with gastric bypass still had higher EWL rates at 24 months compared to patients after SG, these differences were not significant (SG 61.3%, gastric bypass 69.6%; $p=0.09$, two-sided Wilcoxon rank-sum test). Reoperations after SG are necessary in 6.8% (range 0.7–25%) of cases with patients receiving SG as a stand alone procedure and in 9.6–28.5% of cases with patients undergoing SG as a planned first stage procedure.
Conclusions SG is an effective bariatric procedure with a lasting effect on EWL. Compared with gastric bypasses, there is no difference in EWL at the time point of 24 months.

Keywords Sleeve gastrectomy · Gastric bypass · Excessive weight loss

Abbreviations

BMI	Body mass index (kg/m^2)
DS	Duodenal switch
EWL	Excess weight loss
SG	Sleeve gastrectomy
RSG	Re-sleeve gastrectomy
RYGB	Roux-en-Y gastric bypass
SD	Standard deviation

Introduction

The incidence of patients with a BMI of more than 40 kg/m^2 is on the rise throughout the developed countries worldwide [1]. Even though bariatric procedures have been performed for almost 20 years, beginning with publications of the SOS study group (SOS=Swedish Obese Subjects), bariatric procedures have only recently become recognized as serious and successful therapeutic options for obese patients [2–5]. The pertinent literature suggests that surgical approaches enable patients to significantly lose weight on a long-term basis. Not only that, but also the protective effects of these procedures on the metabolic syndrome (including diabetes mellitus), cancer incidence, and even on survival have been proven [3, 6].

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Looking at the frequency of bariatric procedures, gastric bypass and gastric banding are the two most often applied surgical methods [7–11]. Compared to gastric bypass, gastric banding has overall lower success rates in terms of weight loss and remission of metabolic syndrome, and it involves a decent amount of complications. However, gastric bands are relatively easy to apply, there is almost no need for supplementation postoperatively, and they can be reversed in case of insufficient weight loss, all strong arguments for its use. On the other hand, procedures such as biliopancreatic diversion with duodenal switch (BPD/DS) or biliopancreatic diversion according to Scopinaro show even better results when compared to gastric bypass [12, 13]. However, the latter procedures are technically very demanding, possible complications are difficult to handle, and the necessary long-term follow-up of patients is challenging.

Sleeve gastrectomy (SG) was initially a part of BPD/DS. However, several years ago SG became recognized as a stand-alone bariatric procedure, particularly so for critically ill or super-obese patients [10, 14–16]. More recently, SG has been increasingly accepted as a serious alternative to gastric bypass and gastric banding [14]. Not only is the excessive weight loss (EWL) after SG sufficient and lasting in many patients, but SG is also relatively easy to learn, there are no necessary anastomoses, the remaining stomach is still approachable for endoscopy, and postoperative supplementation of vitamins and micronutrients is rarely required. In case of weight loss failure, second step procedures such as re-sleeve, gastric bypass, and BPD/DS are still possible [17, 18]. Despite all these advantages, the potential of SG as a primary bariatric intervention is still under debate. This controversy encouraged us to look more closely at the role of SG by systematically analyzing the EWL in pertinent literature. Based on the presented data in previous systematic reviews, this paper uses gastric bypass as the comparator.

Materials and Methods

A systematic review of the literature on SG was conducted with several databases (PubMed; Medline; Cochrane library; Embase; DIMDI). The following search terms were used in different combinations: sleeve gastrectomy, laparoscopic sleeve, gastric sleeve, bariatric sleeve, vertical gastric sleeve, vertical gastrectomy, longitudinal gastrectomy, and gastric sleeve resection. In addition, the medical subject headings (MeSH) “gastrectomy” and “bariatric surgery” and the advanced search options of PubMed were used. Particularly relevant journals such as Obesity Surgery, Surgical Endoscopy, and Surgery for Obesity and Related Diseases were also searched electronically. Equivalent free text searches and cross-references were performed. English and German language citations for human studies published up to December 31, 2010, were included. Case reports, review articles, and studies where SG was used in the treatment of diseases other than morbid obesity were not included. For multiple publications of the same data or cumulative data, the last publication which fulfilled the inclusion criteria was used. Abstracts and unpublished data were not included. Overall, a total of 1,623 reports were identified. The abstracts were screened and if selection criteria were met, full text articles were evaluated to ascertain eligibility.

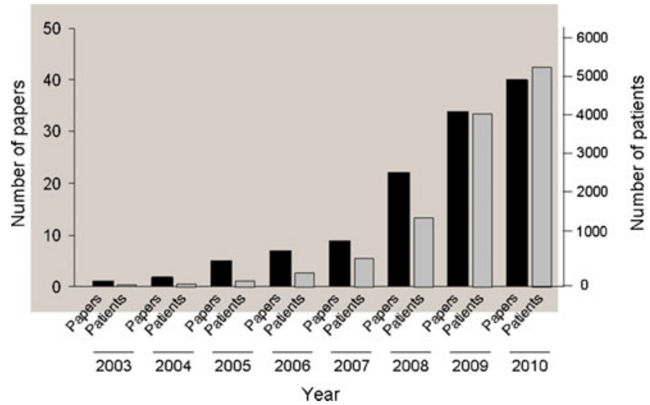


Fig. 1 Depiction of both the number of publications dealing with SG and the included patients over the last 8 years

To describe the empirical distribution of continuous parameters, the weighted means, the minimum and the maximum were calculated. The distribution of categorical parameters was described by absolute and relative frequencies

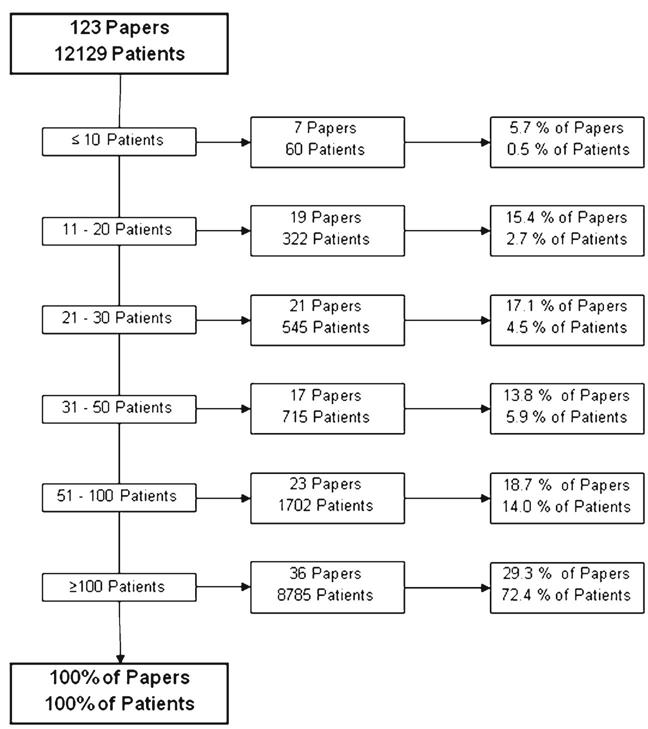


Fig. 2 The distribution of papers dealing with SG based on the included number of patients

(count and percentage). The course of EWL over time was illustrated by plotting weighted means and by corresponding minimums and maximums. Possible differences in EWL between SG and gastric bypass were analyzed using the Wilcoxon rank-sum test and visualized by box plots.

In case of missing standard deviation, the corresponding author was contacted three times via email. The time period between the first and second email was 4 weeks, and the time period between second and third email was 6 weeks. After that, no further attempts were made to retrieve the missing data.

Based on the systematic reviews by O'Brien et al. and Garb et al., data concerning gastric bypass in papers analyzing at least 100 patients were used as the comparator [8, 19].

Results

In the period from 2003 to 2010, 123 papers were found describing 12,129 patients who underwent SG (see Attachment 1). Of these patients, 64.7% were females. The timeline of both publications dealing with SG and included patients is shown in Fig. 1. There is a dramatic increase of published data concerning SG beginning in 2008. Figure 2 depicts the distribution of papers according to the included number of patients. Based on the literature search, 48% of the published papers include more than 50 patients, accounting for 86.4% of all 12,129 patients.

Table 1 describes a quantitative assessment of relevant parameters mentioned in all papers and in papers describing ≥100 patients. A majority of the papers describe EWL at 12 months (43.9% of all papers, 50.0% of papers with ≥100 patients). Follow-up periods of more than 36 months are described in less than 10% of papers. The number of papers describing follow-up periods of more than 3 years including the number of patients per time point of follow-up is shown in Table 2 and Fig. 3. Throughout the literature, co-morbidities associated with obesity are not always well documented. For instance, the presence of diabetes in patients was mentioned in less than 50% of the papers. Major difficulties were based on the fact that the majority of authors did not provide standard

Table 1 Quantitative assessment of the appearance of relevant parameters in all papers and in papers including ≥100 patients

Parameter	All papers (123 papers)		Papers with ≥ 100 patients (36 papers)	
	Mentioned in (*n*) papers (%)	Mean (minimum/ maximum)	Mentioned in (*n*) papers (%)	Mean (minimum/ maximum)
Age (years)	114 (92.7%)	42.7 (30.0–53.4)	33 (91.6%)	42.8 (32.8–49.9)
Initial BMI (kg/m^2)	116 (94.3%)	48.0 (27.0–68.8)	33 (91.6%)	48.6 (42.2–65.4)
Hypertension	49 (39.8%)	n/a	14 (38.8%)	n/a
Diabetes	54 (43.9%)	n/a	16 (44.4%)	n/a
Hyperlipidemia	28 (22.7%)	n/a	29 (80.5%)	n/a
Sleep apnea	35 (28.4%)	n/a	24 (66.6%)	n/a
Duration of surgery (min)	50 (40.6%)	86.8 (29.0–207.0)	17 (47.2%)	83.9 (58.0–143.0)
Bougie size	93 (75.6%)	n/a	28 (77.7%)	n/a
Distance to pylorus (cm)	38 (30.8%)	5 (2.0–10.0)	10 (27.7%)	5.84 (4.0–10.0)
Morbidity	70 (56.9%)	7.0%	27 (75.0%)	7.9%
30-day mortality	65 (52.8%)	0.16%	26 (72.2%)	0.19%
EWL (3 months)	24 (19.5%)	34.7 (20.0–54.8)	6 (16.6%)	34.3 (24.3–40.6)
SD available	12 (9.9%)		2 (5.5%)	
EWL (6 months)	42 (34.1%)	45.2 (31.1–71.6)	12 (33.3%)	43.9 (31.1–55.1)
SD available	19 (15.7%)		5 (13.8%)	
EWL (12 months)	54 (43.9%)	58.9 (30.0–83.3)	18 (50.0%)	58.8 (42.3–78.0)
SD available	22 (17.8%)		7 (19.4%)	
EWL (18 months)	5 (4.1%)	57.3 (51.5–62.6)	3 (8.3%)	56.9 (51.5–62.6)
SD available	1 (0.8%)		1 (2.7%)	
EWL (24 months)	11 (8.9%)	64.5 (46.0–75.0)	7 (19.4%)	64.3 (46.1–75.0)
SD available	5 (4.1%)		2 (5.5%)	
EWL (36 months)	6 (4.8%)	65.9 (60.0–77.5)	3 (8.3%)	65.8 (64.4–67.1)
SD available	4 (3.3%)		1 (2.7%)	
EWL (48 months)	3 (2.4%)	60.9 (56.3–66.0)	1 (2.7%)	52.7 (26.3–79.0)
SD available	2 (1.6%)		1 (2.7%)	

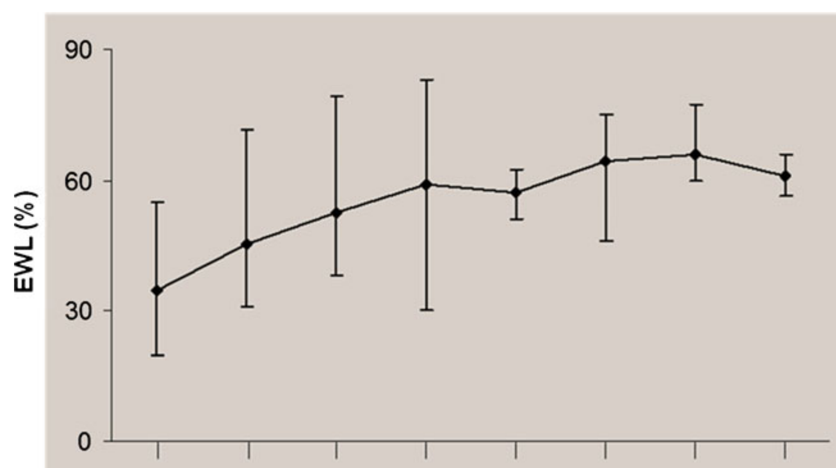
Table 2 Depiction of number of patients at the according follow-up time points in papers describing follow-up periods of more than 3 years

Author	Year	Number of patients	12 months *n* (%)	18 months *n* (%)	24 months *n* (%)	36 months *n* (%)	48 months *n* (%)	60 months *n* (%)	72 months *n* (%)
Weiner	2007	120	80 (66.7)	68 (56.7)	60 (50.0)	–	22 (18.3)	8 (6.7)	–
Armstrong	2009	185	37 (20.0)	27 (14.6)	10 (5.4)	2 (1.1)	–	–	–
Bohdjalian	2009	26	26 (100)	–	26 (100)	26 (100)	26 (100)	26 (100)	–
Uglioni	2009	70	70 (100)	–	68 (98.0)	66 (95.0)	–	–	–
Bellanger	2010	529	294 (55.6)	–	206 (38.9)	81 (15.3)	–	–	–
Himpens	2010	53	–	–	–	30 (56.6)	–	–	30 (56.6)
Skroubis	2010	151	–	–	–	–	113 (75.0)	–	–
Todkar	2010	23	–	–	–	23 (100)	–	–	–

deviations of the achieved EWL. Again, the SD of EWL at 12 months was mentioned in only 17.8% of all papers and in 19.4% of papers describing ≥100 patients. Morbidity and mortality rates of papers describing more than 100 patients with SG are shown in Table 3. The overall morbidity in the particular articles ranges from 0% to 17.5% whereas the mortality rates are between 0% and 1.2%. Taking a closer look at morbidity rates reveals that an insufficiency of the staple line is the leading cause of morbidity in most papers.

In Fig. 3, the EWL of patients receiving SG is shown over time. The maximum EWL occurred 24 and 36 months postoperatively with a mean EWL of 64.3% (minimum 46.1%, maximum 75.0%) and 66.0% (minimum 60.0%, maximum 77.5%), respectively. After that, a slide but not a significant decrease of EWL was evident. After 48 months, patients with SG have a mean EWL of 60.9% (minimum 56.3%, maximum 66.0%).

A statistical analysis regarding EWL between SG and gastric bypass was performed based on the preconditions as described in the "Materials and Methods" section. Concerning gastric bypass, the existing reviews by O'Brien and Garb were used. Here, only papers analyzing more than 100 patients were included. Further, it was mandatory to have standard deviations for the EWL both for gastric bypass and SG. Based on these criteria, there was only data available at 12 and 24 months that qualified for statistical analysis (Fig. 4). There were 17 papers dealing with SG and 12 papers dealing with gastric bypass available at the time point of 12 months; at 24 months, seven SG papers and 10 gastric bypass papers were accessible. At 12 months, the EWL in patients receiving gastric bypass was significantly higher when compared to patients who underwent SG (mean EWL—gastric bypass 68.3%, SG 56.1%; $p<0.01$, two-sided Wilcoxon rank-sum test). Even though patients



Time (Months)	3	6	9	12	18	24	36	48
Mean (Minimum-Maximum)	34.8 % (20.0% - 54.8%)	45.2 (31.1% - 71.6%)	52.5 (38.0% - 78.3%)	59.0 (30.0% - 83.3%)	57.3 (51.5% - 62.2%)	64.5 (46.1% - 75.0%)	66.0 (60.0% - 77.5%)	60.9 (56.3% - 66.0%)
Number of papers	24	42	9	54	5	11	6	3

Fig. 3 Excessive weight loss (EWL) of patients receiving SG at various time points postoperatively. Further the number of papers that present EWL of the given time points are mentioned

Table 3 Morbidity and mortality rates in papers describing more than 100 patients with SG

Author	Year	Patient number	Morbidity overall *n* (%)	Insufficiency *n* (%)	Bleeding *n* (%)	Stricture *n* (%)	Respiratory tract *n* (%)	Wound infection *n* (%)	Hernia *n* (%)	Mortality % (*n*)
Cottam et al.	2006	126	18 (14.3)	2 (11.0)	–	1 (5.5)	2 (11.1)	–	–	0.8% (1)[a]
Hamoui et al.	2006	118	18 (15.3)	2 (11.2)	–	–	9 (50.0)	–	–	1.7% (2)[a]
Lee et al.	2007	216	16 (7.4)	3 (18.8)	–	–	1 (6.25)	–	–	0% (0)[b]
Weiner et al.	2007	120	21 (17.5)	3 (14.3)	1 (4.8)	–	–	1 (4.8)	–	0.8% (1)[a]
Felberbauer et al.	2008	126	6 (4.8)	3 (50.0)	–	–	–	–	–	0% (0)[c]
Lalor et al.	2008	164	4 (2.9)	2 (50.0)	1 (25.0)	1 (25.0)	–	–	–	0% (0)[b]
Moy et al.	2008	135	14 (10.4)	2 (14.3)	–	–	5 (35.7)	3 (21.4)	–	0.7% (1)[a]
Nocca et al.	2008	163	20 (14.1)	16 (80.0)	1 (5.0)	–	–	3 (15.0)	–	0% (0)[c]
Parikh et al.	2008	135	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Rubin et al.	2008	120	0 (0.0)	0 (0)	0 (0)	–	–	–	–	0% (0)[b]
Tucker et al.	2008	148	9 (6.1)	2 (22.2)	1 (11.1)	1 (11.1)	–	3 (33.3)	–	0% (0)[b]
OuYang et al.	2008	138	7 (5.1)	2 (28.6)	3 (42.9)	1 (24.3)	–	–	–	0% (0)[b]
Arias et al. et al.	2009	130	13 (9.8)	1 (7.7)	–	–	–	4 (30.8)	1 (7.7)	0% (0)[b]
Armstrong et al.	2009	185	6 (3.2)	–	2 (33.3)	–	–	1 (16.7)	1 (16.7)	0% (0)[b]
Fuks et al.	2009	135	10 (7.4)	6 (60.0)	–	–	2 (20.0)	1 (10.0)	–	0% (0)[b]
Jakobs et al.	2009	157	11 (7.9)	4 (36.4)	–	–	1 (9.1)	–	–	0.6% (1)[a]
Menenakos et al.	2009	261	38 (14.5)	10 (26.3)	5 (13.6)	–	–	–	–	1.2% (3)[ac]
Sammour et al.	2009	100	10 (10.0)	4 (40.0)	–	–	–	–	–	0% (0)[ac]
Sanchez et al.	2009	540	28 (5.2)	12 (42.9)	7 (25.0)	1 (3.6)	1 (3.6)	1 (3.6)	–	0.4% (2)[c]
Stroh et al.	2009	144	25 (17.3)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1.4% (1)[b]
Albanopoulos et al.	2010	353	46 (13.0)	19 (41.3)	8 (17.4)	–	–	–	–	0.8%(3)[ac]
Basso et al.	2010	200	12 (6.0)	7 (58.4)	5 (41.7)	–	–	–	–	0.5% (1)
Bellanger et al.	2010	529	16 (3.0)	–	2 (12.5)	–	1 (6.3)	1 (6.3)	–	0.2% (1)[c]
Birkmeyer et al.	2010	854	50 (5.9)	7 (14.0)	5 (10.0)	–	3 (6.0)	19(38.0)	–	0% (0)
Buesing et al.	2010	200	6 (3.0)	2 (33.3)	2 (33.3)	–	–	–	–	1.0% (2)[c]
Daskalakis et al.	2010	230	23 (10.0)	10 (43.5)	10 (43.5)	n.a.	–	–	–	0.9% (1)[a]
DeMaria et al.	2010	1,328	235 (17.7)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Gandsas et al.	2010	292	6 (2.1)	1 (16.7)	2 (33.4)	–	1 (16.7)	1 (16.7)	–	0% (0)[c]
Karcz et al.	2010	236	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Lacy et al.	2010	294	n.a.	11	7	4	n.a.	n.a.	n.a.	0% (0)[b]
Nath et al.	2010	100	17 (17.0)	2 (11.8)	2 (11.8)	–	–	1 (5.9)	1 (5.9)	0% (0)[b]
Semanscin et al.	2010	104	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Skroubis et al.	2010	151	11 (7.3)	6 (54.5)	1 (9.1)	–	–	–	–	0% (0)[ac]
Srinivansa et al.	2010	253	32 (12.6)	6 (18.8)	5 (15.6)	3 (9.4)	–	–	–	0% (0)[b]
Stamou et al.	2010	287	24 (8.2)	6 (25.0)	3 (12.5)	–	–	–	–	0.3% (1)[b]

[a] late mortality (everything more than 30 days)

[b] not described into detail

[c] 30 days mortality

with gastric bypass still had higher EWL rates at 24 months compared to patients after SG, these differences were not significant anymore (mean EWL—gastric bypass 69.6%, SG 61.3%; $p=0.09$, two-sided Wilcoxon rank-sum test).

The mean reoperation rate in patients receiving SG primary planned as a stand alone procedure was 6.8% (range 0.7–25.0%; Table 4). On the other hand, the range of reoperation rates was 9.6–28.5% in patients receiving SG as a planned first step procedure (Table 5).

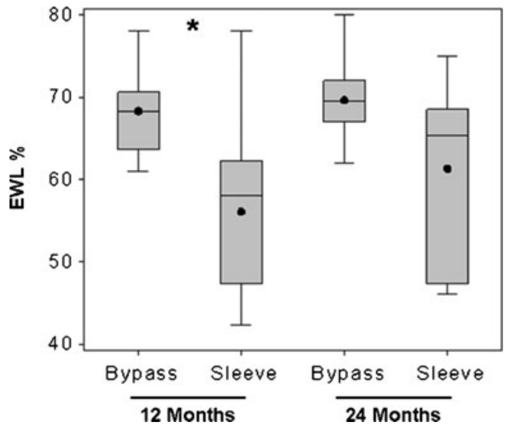


Fig. 4 Statistical comparison of EWL in patients after SG and gastric bypass at 12 months and 24 months postoperatively. *$p < 0.01$, Wilcoxon rank-sum test (two-sided)

Discussion

Though detected "incidentally", sleeve gastrectomy has become a serious stand-alone bariatric procedure over the last years [10, 15, 20]. Based on the published data, the efficacy of SG (e.g., weight loss, co-morbidities) seems to be rather close to the gastric bypass procedure. However, the importance of SG as a primary bariatric procedure is still a source of controversy. The here presented analysis of 123 papers including 12,129 patients, however, strongly supports the importance of SG. In comparison to gastric bypass, SG is as effective in EWL as gastric bypass at 24 months. Furthermore, the long-term success of the SG (as described by EWL) is now described for up to 6 or even 8 years [21, 22]. There is one randomized controlled study available showing that SG is significantly more effective concerning EWL compared to RYGB in patients with a BMI of <50 kg/m^2 [23].

In planning this study, data describing patients who underwent gastric bypass was considered a valid comparator. Thus, the systematic review by O'Brien et al [19]. and more recently the review by Garb et al [8]. were used. In agreement with these two reviews, the data quality of the articles dealing with bariatric procedures, including SG, have room for improvement. There is a lack of basic clinical data in many papers (see Table 1). Not only fundamental parameters such as age and initial BMI but also data describing co-morbidities were frequently missing. The same is true for other important questions regarding to SG such as whether the incidence on leakage of the stapler line is depending on infection with *Helicobacter pylori*, on staple line reinforcement, or on postoperative

Table 4 Reoperation rates in patients receiving SG initially planned as stand-alone bariatric procedures

Author	Year	Study type	Operated patients (*n*)	Reoperation *n* (%)	Time of follow-up (months)	Reason for reoperation			Procedures
						Insufficient weight loss *n* (%)	Reflux	Stricture	
Baltasar	2005	Retrospective	31	1 (3.2)	27	1 (100)	–	–	DS
MoonHan	2005	Retrospective	60	1 (0.7)	12	1 (100)	–	–	DS
Hamoui	2006	Retrospective	118	6 (5.1)	13	6 (100)	–	–	DS
Himpens	2006	Retrospective	40	2 (5)	36	2 (100)	–	–	DS
Langer	2006	Retrospective	73	2 (8.6)	33	1 (50)	1 (50)	–	RYGB
Melissas	2007	Prospective	23	1 (4.3)	12	1 (100)	–	–	DS
Weiner	2007	Prospective	120	16 (13.3)	60	n/a	n/a	n/a	RYGB DS/RSG
Felberbauer	2008	Retrospective	126	4 (3.2)	19	4 (100)	–	–	RYGB
Fuks	2008	Prospective	135	2 (1.5)	13	2 (100)	–	–	DS
Kasama	2008	n/a	26	2 (8.6)	18	1 (50)	–	1 (50)	RYGB/DS
Nocca	2008	Prospective	163	3 (1.8)	24	3 (100)	–	–	RYGB/DS
Ou Yang	2008	Prospective	138	6 (4.3)	24	5 (83)	–	1 (17)	RYGB
Tagaya	2008	n/a	30	1 (3.3)	18	–	–	1 (100)	RYGB
Bohdjalian	2009	n/a	26	4 (15.4)	60	3 (75)	1 (25)	–	RYGB
Sanches-Santos	2009	Retrospective	540	18 (3.3)	17	15 (83)	3 (17)	–	RYGB/DS
Uglioni	2009	Prospective	70	5 (7)	36	5 (100)	–	–	DS
Himpens	2010	Retrospective	53	13 (25)	72	n/a	n/a	n/a	DS
Lacy	2010	Prospective	294	2 (0.7)	n/a	–	2 (50)	2 (50)	RYGB
Langer	2010	Retrospective	73	8 (11)	20	5 (63)	3 (37)	–	RYGB
Sabbagh	2010	Prospective	9	1 (11)	24	1 (100)	–	–	DS

Table 5 Reoperation rates in patients receiving SG initially planned as first step bariatric procedure

Author	Year	Study type	Operated patients *n*	Reoperation *n* (%)	Time of follow-up	Reasons for reoperation			Procedure
						Insufficient weight loss *n* (%)	Reflux	Stricture	
Cottam	2006	Prospective	126	36 (28.5)	13	n/a	n/a	n/a	DS
Ianelli	2009	Prospective	77	15 (19.5)	24	15 (100)	–	–	DS
Diamantis	2010	Retrospective	25	3 (12)	18	3 (100)	–	–	RYGB
Basso	2010	Prospective	100	29 (9.6)	36	29 (100)	–	–	DS

treatment with proton pump inhibitors [24–26]. This was the main reason for focusing purely on EWL in this analysis.

SG is a rather young bariatric procedure, which explains why the follow-up examinations in many papers rarely exceed 12 months. However, some papers do not describe the number of patients who have been followed up. Together with the fact that standard deviations for EWL were missing in up to 90% of certain time points, a systematic comparison of the EWL between SG and gastric bypass was only possible for 12 and 24 months. Another factor that made an analysis difficult is that some important papers describe BMI loss (instead of EWL) [15].

According to the here presented data, 6.8% of all patients with SG will eventually need reoperations. However, this number can increase up to 25% [10]. The vast majority of patients will need reoperations due to insufficient weight loss or weight regain after SG. Here, it would be very interesting to compare systematically patients with adequate and lasting EWL with those who either do not lose weight initially or regain weight. To our knowledge, this has not been done yet. The goal of such a project would be to determine patient cohorts that might not be candidates for SG in the first place. Other reasons are patients requiring second stage procedures because of serious reflux and patients with stenosis of the sleeve. Reflux occurs in up to 24.9% of patients [27]. One conclusion could be that patients with known gastroesophageal reflux disease may not be ideal candidates for SG. In any case, careful preoperative assessment including patient history of reflux symptoms, gastroscopy, or even 24-h pH monitoring should be performed. Reoperations after SG are possible and include techniques such as re-sleeve, the completion to duodenal switch, or even gastric bypass [10, 17, 18].

Setting aside the here proven efficacy of SG in terms of EWL, one major issue of this procedure is the possibility of surgical complications due to insufficiency of the stapler line. Of the 10% overall morbidity rates of SG, insufficiency of the stapler line (also referred as leakage or fistula) contributes to morbidity up to 80% and can even be responsible for mortality [28–30]. Even though there are many approaches to resolving the stapler insufficiency (including reinforcement of the stapler with several foreign materials), it is an ongoing issue and might be one of the serious downsides of SG [1, 20, 31].

Conclusion

Sleeve gastrectomy is a sufficient bariatric procedure concerning EWL. The EWL after SG does not differ from gastric bypass 24 months after surgery. Reoperations due to insufficient weight loss or secondary complications include re-sleeve, gastric bypass, and duodenal switch. All reoperations can be managed safely, making SG an ideal and effective first stage procedure in bariatric surgery.

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Attachment 1 Complete literature list of the 123 analyzed papers

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