



# Best practice approach for redo-surgeries after sleeve gastrectomy, an expert's modified Delphi consensus

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## Abstract

**Background** Sleeve gastrectomy (SG) is the most common metabolic and bariatric surgical (MBS) procedure worldwide. Despite the desired effect of SG on weight loss and remission of obesity-associated medical problems, there are some concerns regarding the need to do revisional/conversional surgeries after SG. This study aims to make an algorithmic clinical approach based on an expert-modified Delphi consensus regarding redo-surgeries after SG, to give bariatric and metabolic surgeons a guideline that might help for the best clinical decision.

**Methods** Forty-six recognized bariatric and metabolic surgeons from 25 different countries participated in this Delphi consensus study in two rounds to develop a consensus on redo-surgeries after SG. An agreement/disagreement  $\geq 70.0\%$  on statements was considered to indicate a consensus.

**Results** Consensus was reached for 62 of 72 statements and experts did not achieve consensus on 10 statements after two rounds of online voting. Most of the experts believed that multi-disciplinary team evaluation should be done in all redo-procedures after SG and there should be at least 12 months of medical and supportive management before performing redo-surgeries after SG for insufficient weight loss, weight regain, and gastroesophageal reflux disease (GERD). Also, experts agreed that in case of symptomatic GERD in the presence of adequate weight loss, medical treatment for at least 1 to 2 years is an acceptable option and agreed that Roux-en Y gastric bypass is an appropriate option in this situation. There was disagreement consensus on efficacy of omentopexy in rotation and efficacy of fundoplication in the presence of a dilated fundus and GERD.

**Conclusion** Redo-surgeries after SG is still an important issue among bariatric and metabolic surgeons. The proper time and procedure selection for redo-surgery need careful considerations. Although multi-disciplinary team evaluation plays a key role to evaluate best options in these situations, an algorithmic clinical approach based on the expert's consensus as a guideline can help for the best clinical decision-making.

**Keywords** Sleeve gastrectomy · Revision · Conversion · GERD · Consensus · Bariatric surgery

## Abbreviations

SG	Sleeve gastrectomy (SG)
GERD	Gastroesophageal reflux disease
MDT	Multi-disciplinary team
EGD	Esophagogastroduodenoscopy (EGD)
UGI	Upper gastrointestinal
RYGB	Roux-en Y gastric bypass

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OAGB	One anastomosis gastric bypass
BPD/DS	Biliopancreatic diversion/duodenal switch
SADI-S	Single Anastomosis Duodeno-Ileal bypass with Sleeve Gastrectomy
SASI	Single Anastomosis Sleeve Ileal Bypass
SG-TB	Sleeve gastrectomy with transit bipartition
HH	Hiatal hernia
ESG	Endoscopic sleeve gastroplasty
BPL	Biliopancreatic limb

Sleeve gastrectomy (SG) is now the most common metabolic and bariatric surgical procedure worldwide [1]. Despite the desired effect of SG on weight loss and remission of obesity-associated medical problems, there are some concerns regarding the need to perform revisional/conversional surgeries after SG to treat long-term complications or to improve the results that were not achieved as a result of the SG as first bariatric/metabolic operation. There is no consensus around preoperative considerations and the proper time to perform conversion/revision after SG. In addition, there is no consensus to select best approach to address symptomatic gastroesophageal reflux disease (GERD) [2, 3] and weight regain/insufficient weight loss [4] after SG. Also, there is a need for consensus on technical considerations during conversion/revision after SG. This study aims to make an algorithmic clinical approach based on an expert-modified Delphi consensus regarding redo-surgeries after SG, to give bariatric and metabolic surgeons a guideline that might help for the best clinical decision.

## Methods

Forty-six worldwide recognized bariatric and metabolic surgeons from 25 different countries participated in this Delphi consensus study to develop a consensus on redo-surgeries after SG as there is no strong evidence in most aspects of them.

The initial idea was raised by Global Laparoscopy & Robotics (GLR) international group and then well-known bariatric and metabolic surgeons included presidents of the IFSO, IFSO-chapters/IFSO member societies, and recognized academic/private expert surgeons and opinion leaders in bariatric and metabolic surgical procedures were invited. After discussion and exchange of opinions among the members, seventy-two (72) statements were selected for the first round of voting (Table 1) using the modified Delphi consensus method using an online platform (Survey Monkey) (<https://www.surveymonkey.com/r/Redo-after-SG>).

The link of the first round of consensus building was sent out on June 21, 2022, and was live until June 29, 2022. All invited experts voted on all 72 statements with only agree

or disagree choices and an agreement/disagreement  $\geq 70.0\%$  was regarded as consensus as previously Delphi consensuses in different aspects of bariatric and metabolic surgical procedures [5–8].

The results of the first round with some available evidence on 21 of statements with  $< 70.0\%$  consensus was shared with the experts, and they were invited to vote on the remained 21 non-consensus statements during the second round of consensus building which was live from July 11, 2022, to July 18, 2022.

## Results

Forty-six experts in Bariatric and Metabolic Surgery, from 25 countries (Appendix), voted on the 72 and 21 statements in the first and second rounds, respectively. Table 1 summarizes the detailed results of first and second round's votes on each of the 72 statements. A consensus of  $\geq 70\%$  was reached for 62 of 72 statements and experts did not achieve consensus on 10 statements after two rounds of online voting (Table 1).

More than 91% of experts believed that multi-disciplinary team (MDT) evaluation should be done in all revision/conversion procedures after SG and they have reached on consensus that there should be at least 12 months of medical and supportive management before you perform revision/conversion after SG for insufficient weight loss, weight regain, and GERD.

Most of experts agreed to do both esophagogastroduodenoscopy (EGD) and upper gastrointestinal series (UGI) before any revision/conversion surgery after SG; however, there was not any consensus to do pre-op PH-metry and esophageal manometry or impedance reflux monitoring.

About 87% of experts agreed that in case of symptomatic GERD in the presence of adequate weight loss, medical treatment for at least 1 to 2 years is an acceptable option and remarkably more than 97% of them agreed that Roux-en Y gastric bypass (RYGB) is an appropriate option in this situation. Surprisingly, there were consensus against other surgical procedures (banded RYGB, OAGB, BPD/DS, SADI-S, SASI, SG-TB, cruroplasty/HH repair alone, and other investigational techniques (Table 1)).

More than 97% of experts agreed that RYGB is an appropriate option in symptomatic GERD after SG in the presence of inadequate weight loss or weight regain (WR) and there was consensus against other bariatric surgical procedures and endoscopic sleeve gastroplasty (ESG) in this situation (Table 1).

RYGB also was advised by about 98% of experts in symptomatic GERD after SG in the presence of excessive weight loss.

**Table 1** Consensus statement voting results

Statement	Round 1	Round 2	Final result
<b>Preoperative considerations about conversion/revision after sleeve gastrectomy (SG)</b>			
1. Multi-disciplinary team (MDT) evaluation should be done in all revision/conversion procedures after SG	91.30% AGREE	–	CONSENSUS (AGREE)
2. Minimum time to revision/conversion after SG for incomplete weight loss/weight regain should be 12 months	78.2% AGREE	–	CONSENSUS (AGREE)
3. Minimum time to revision/conversion after SG for GERD should be 12 months	50% AGREE	73.9% AGREE	CONSENSUS (AGREE)
4. EGD is necessary before any revision/conversion after SG	95.6% AGREE	–	CONSENSUS (AGREE)
5. UGI contrast study is necessary before any revision/conversion after SG	82.6% AGREE	–	CONSENSUS (AGREE)
6. Pre-op PH-metry is necessary before any revision/conversion after SG due to GERD	58.7% DISAGREE	60.8% DISAGREE	NO CONSENSUS
7. Esophageal manometry or Impedance Reflux Monitoring is necessary before any revision/conversion after SG due to GERD	60.8% DISAGREE	60.8% DISAGREE	NO CONSENSUS
<b>Symptomatic GERD after SG + adequate WL</b>			
8. Continue medical treatment for at least 1 to 2 years is an acceptable option	86.9% AGREE	–	CONSENSUS (AGREE)
9. RYGB is an acceptable option	97.7% AGREE	–	CONSENSUS (AGREE)
10. Banded/RYGB is an acceptable option	82.6% DISAGREE	–	CONSENSUS (DISAGREE)
11. OAGB is an acceptable option	71.7% DISAGREE	–	CONSENSUS (DISAGREE)
12. Cruroplasty/HH repair alone is an acceptable option	69.5% DISAGREE	82.6% DISAGREE	CONSENSUS (DISAGREE)
13. Other investigational techniques(Teres repair/modified hill or right crus gastropexy/cardiopexy/cardioplication/retroperitoneal gastropexy/right hiatus gastropexy) alone are acceptable options	69.5% DISAGREE	86.9% DISAGREE	CONSENSUS (DISAGREE)
14. BPD/DS is an acceptable option	86.9% DISAGREE	–	CONSENSUS (DISAGREE)
15. SADI-S is an acceptable option	82.6% DISAGREE	–	CONSENSUS (DISAGREE)
16. SASI is an acceptable option	82.6% DISAGREE	–	CONSENSUS (DISAGREE)
17. SG-TB is an acceptable option	80.4% DISAGREE	–	CONSENSUS (DISAGREE)
18. LINX is an acceptable option	52.1% DISAGREE	63.0% DISAGREE	NO CONSENSUS
<b>Symptomatic GERD after SG + inadequate WL/WR</b>			
19. Re-sleeve is an acceptable option	91.3% DISAGREE	–	CONSENSUS (DISAGREE)
20. RYGB is an acceptable option	97.7% AGREE	–	CONSENSUS (AGREE)
21. Banded/RYGB is an acceptable option	71.7% DISAGREE	–	CONSENSUS (DISAGREE)
22. OAGB is an acceptable option	60.8% DISAGREE	82.6% DISAGREE	CONSENSUS (DISAGREE)
23. BPD/DS is an acceptable option	69.5% DISAGREE	93.4% DISAGREE	CONSENSUS (DISAGREE)
24. SADI-S is an acceptable option	71.7% DISAGREE	–	CONSENSUS (DISAGREE)
25. SASI is an acceptable option	78.2% DISAGREE	–	CONSENSUS (DISAGREE)
26. SG-TB is an acceptable option	73.3% DISAGREE	–	CONSENSUS (DISAGREE)
27. ESG (endoscopic SG) is an acceptable option	82.6% DISAGREE	–	CONSENSUS (DISAGREE)
28. Medication alone is an acceptable option	52.1% DISAGREE	60.8% DISAGREE	NO CONSENSUS
29. LINX is an acceptable option	76.9% DISAGREE	–	CONSENSUS (DISAGREE)
30. Cruroplasty/HH repair should be done during any conversion bariatric procedure	53.3% AGREE	54.3% AGREE	NO CONSENSUS
<b>Symptomatic GERD after SG + excessive WL</b>			
31. RYGB is an acceptable option	97.8% AGREE	–	CONSENSUS (AGREE)
32. Banded/RYGB is an acceptable option	91.3% DISAGREE	–	CONSENSUS (DISAGREE)
33. OAGB is an acceptable option	86.9% DISAGREE	–	CONSENSUS (DISAGREE)
34. Cruroplasty/HH repair is an acceptable option	56.8% AGREE	52.1% AGREE	NO CONSENSUS
35. BPD/DS is an acceptable option	93.3% DISAGREE	–	CONSENSUS (DISAGREE)
36. SADI-S is an acceptable option	93.3% DISAGREE	–	CONSENSUS (DISAGREE)
37. SASI is an acceptable option	95.5% DISAGREE	–	CONSENSUS (DISAGREE)
38. Endosuture is an acceptable option	86.6% DISAGREE	–	CONSENSUS (DISAGREE)

Table 1 (continued)

Statement	Round 1	Round 2	Final result
39. SG-TB is an acceptable option	93.4% DISAGREE	–	CONSENSUS (DISAGREE)
40. LINX is an acceptable option	50.0% AGREE	53.3% DISAGREE	NO CONSENSUS
WR/Incomplete WL after SG			
41. RYGB is an acceptable option	84.7% AGREE	–	CONSENSUS (AGREE)
42. OAGB is an acceptable option	84.7% AGREE	–	CONSENSUS (AGREE)
43. BPD/DS is an acceptable option	76.0% AGREE	–	CONSENSUS (AGREE)
44. SADI-S is an acceptable option	88.8% AGREE	–	CONSENSUS (AGREE)
45. SASI is an acceptable option	52.1% AGREE	52.1% AGREE	NO CONSENSUS
46. SG-TB is an acceptable option	53.3% DISAGREE	71.7% DISAGREE	CONSENSUS (DISAGREE)
47. I do Nothing	80.4% DISAGREE	–	CONSENSUS (DISAGREE)
Non-improvement of obesity-associated medical problems			
48. RYGB is an acceptable option	89.1% AGREE	–	CONSENSUS (AGREE)
49. OAGB is an acceptable option	80.4% AGREE	–	CONSENSUS (AGREE)
50. BPD/DS is an acceptable option	80.4% AGREE	–	CONSENSUS (AGREE)
51. SADI-S is an acceptable option	89.1% AGREE	–	CONSENSUS (AGREE)
52. SASI is an acceptable option	54.3% AGREE	53.3% AGREE	NO CONSENSUS
53. SG-TB is an acceptable option	52.1% DISAGREE	71.1% DISAGREE	CONSENSUS (DISAGREE)
54. I do nothing	78.2% DISAGREE	–	CONSENSUS (DISAGREE)
Excessive WL + food intolerance after SG without GERD			
55. RYGB is an acceptable option	80.0% AGREE	–	CONSENSUS (AGREE)
56. OAGB is an acceptable option	65.2% DISAGREE	91.3% DISAGREE	CONSENSUS (DISAGREE)
57. BPD/DS is an acceptable option	91.3% DISAGREE	–	CONSENSUS (DISAGREE)
58. SADI-S is an acceptable option	93.4% DISAGREE	–	CONSENSUS (DISAGREE)
59. SASI is an acceptable option	84.7% DISAGREE	–	CONSENSUS (DISAGREE)
60. SG-TB is an acceptable option	86.6% DISAGREE	–	CONSENSUS (DISAGREE)
61. Only conservative management (nutritional support)	54.3% Agree	71.7% Agree	CONSENSUS (AGREE)
Neurological complications			
62. Nutritional support and medical treatment is only option	76.0% Agree	–	CONSENSUS (AGREE)
Dumping after SG			
63. Nutritional support and medical treatment is only option	73.3% Agree	–	CONSENSUS (AGREE)
Revision/conversion due to weight regain/ incomplete weight loss			
64. It is safe in adolescents	80.4% Agree	–	CONSENSUS (AGREE)
65. It is safe in elderly patients(over 65 y/o)	93.4% Agree	–	CONSENSUS (AGREE)
Operative considerations in conversion			
66. RYGB alimentary limb length should be at least 75 cm in presence of GERD	97.8% Agree	–	CONSENSUS (AGREE)
67. BP limb length should be more in conversional OAGB and RYGB in presence of WR or incomplete WL	84.7% Agree	–	CONSENSUS (AGREE)
Operative considerations in revision			
68. Strictureplasty/seromyotomy is an acceptable option in stricture	56.5% Agree	56.5% Agree	NO CONSENSUS
69. Endoscopic procedures (Bougie dilatation, Stent, Botulinum toxin,..) are acceptable options in stricture	82.6% Agree	–	CONSENSUS (AGREE)
70. Omentopexy is an acceptable option in rotation	63% DISAGREE	86.9% DISAGREE	CONSENSUS (DISAGREE)
71. Bypass procedures proximal to stricture is the best option in stricture/rotation	91.3% Agree	–	CONSENSUS (AGREE)
72. Fundoplication is an acceptable option in the presence of a dilated fundus and GERD	67.3% DISAGREE	78.2% DISAGREE	CONSENSUS (DISAGREE)

Most of experts felt that in weight regain or incomplete weight loss after SG and non-improvement of obesity-associated medical problems in the absence of GERD, SADI-S, RYGB, OAGB, and BPD-DS are acceptable options.

In excessive weight loss in addition to food intolerance after SG in absence of GERD, there was consensus on conservative management (nutritional support) and RYGB and consensus disagreements on other metabolic/bariatric surgical procedures.

More than 93% and 80% of experts believe that revision/conversion bariatric procedures due to weight regain/ incomplete weight loss are safe in elderly patients (over 65 y/o) and adolescents, respectively.

About 97% of experts advised to make an at least 75 cm alimentary limb length in RYGB in the presence of GERD and about 85% of them agreed that biliopancreatic limb length should be longer in conversional OAGB and RYGB in the presence of weight regain or incomplete weight loss.

There was 82.6% consensus that endoscopic procedures, such as bougie dilatation, stent, and botulinum toxin, are acceptable options in stricture, and 91.3% of experts agreed that bypass procedures proximal to stricture is the best option in stricture/kinking.

There was disagreement consensus on efficacy of omentopexy in rotation and efficacy of fundoplication in the presence of a dilated fundus and GERD.

No consensus was achieved for 10 statements and the details are shown in Table 1.

Finally, an algorithm was drawn to summarize the results of consensus and an easier to use tool for best clinical approach to redo-surgeries after SG (Fig. 1).

## Discussion

SG is still the most performed metabolic and bariatric procedure worldwide. Long-term complications include mainly GERD/Barrett esophagus and insufficient weight loss/weight regain, which both are the main indications for redo-surgeries after SG [9, 10]. In some cases, excessive weight loss, food intolerance, neurological problems, and dumping syndrome might require particular attention and might indicate redo-surgeries.

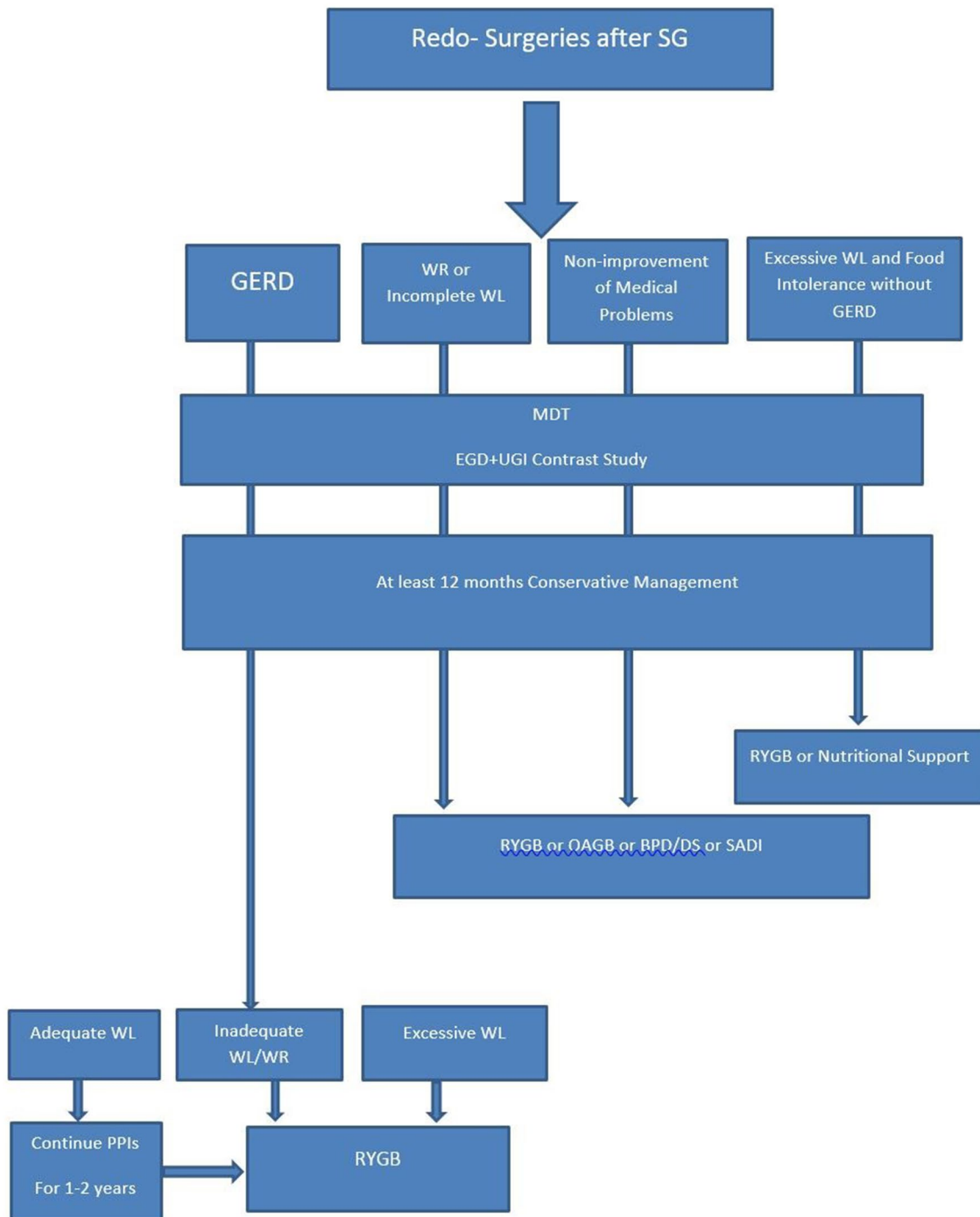
Limited evidence exists regarding perioperative considerations and indications in redo-surgeries after SG and often both of the long-term complications are simultaneously present in different entity. This Delphi consensus includes 72 statements regarding "Redo-Surgeries" after SG, helping to provide a surgical standard after non-successful weight loss and obesity-associated medical problems, and complications after SG.

## Preoperative considerations about conversion/revision after SG

When it came to preoperative considerations, the group of experts agreed with a significant consensus of 95.6% that EGD is necessary before any revision/conversion after SG and with 91.30% that MDT evaluation should be done in all revision/conversion procedures after SG. These agreements are concordant with primary bariatric surgery recommendations and with the actual IFSO position statement on the Role of Esophago-Gastro-Duodenal Endoscopy (2020), which recommend EGD routinely for all patients after SG at 1 year and then every 2–3 years, to enable early detection of Barrett's esophagus or upper GI malignancy until more data are available to confirm the incidence of these cancers in practice [11, 12]. For this reason, it is self-evident that prior to any revision/conversion, especially for reflux symptoms, EGD is recommended by most of the consensus group.

In the general population, diagnostic testing for GERD includes EGD, esophageal pH monitoring in refractory symptoms where GERD diagnosis is in question, esophageal manometry to rule out esophageal dysmotility (*e.g.*, achalasia, scleroderma), and barium esophagogram for evaluation of dysphagia [13]. Remarkably, there was no consensus regarding esophageal pH monitoring, esophageal manometry, or impedance reflux monitoring (disagreement 60.8%). This means that actually these diagnostic procedures are not really considered necessary primary to conversion/revision. A systematic review on manometric and pH-monitoring changes after laparoscopic SG by Balla et al. showed a decrease of the lower esophageal sphincter resting pressure in six of twelve studies included and a worsening of the DeMeester score in nine of twelve articles [14]. Furthermore, a study by Borbely et al. revealed, in evaluation for persistent GERD even after RYGB with questionnaires, endoscopy, 24-h pH-impedance manometry, and barium swallow, a high percentage of hiatal hernias, hypotensive lower esophageal sphincter, and severe esophageal motility disorders [15]. Nevertheless, Tolone et al. demonstrated that using high-resolution manometry, and impedance-pH monitoring, SG can negatively impact on esophageal function and reflux exposure [16]. Therefore, esophageal pH monitoring, impedance reflux monitoring, and esophageal manometry may be indicated in symptomatic patients, which have a negative EGD, but not as a standard diagnostic procedure in patients with positive EGD. Since conversion to RYGB is the most performed redo-surgery after SG in patients with GERD [17], the diagnostic tools can be considered in a special cohort of patients, to exclude hiatal hernias, hypotensive lower esophageal sphincter, and severe esophageal motility disorders beyond GERD.

Finally, the experts agreed with a second-round consensus of 73.9% that minimum time to revision/conversion



**Fig. 1** Algorithmic approach to redo-surgeries after SG

after SG for GERD should be 12 months. In a recently published meta-analysis in total, 915 patients ( $SG = 764$  patients, 83.5%) underwent redo-surgery due to GERD, and the interval between primary surgery and redo-surgery was  $31.23 \pm 16.32$  months (1 to 67 months) [17]. This important range from 1 to 67 months underlines the heterogeneity of the patients, indicating that depending

on the severity and response to conservative treatment, indication for redo-surgery in patients with severe GERD after SG might be given at different timeline. For sure, a conservative treatment option based on patient symptoms and severity of GERD should always be taken into consideration prior to redo-surgery. In case of Barrett's esophagus, surveillance upper endoscopy and endoscopic

eradication therapy should also be applied in addition to redo-surgery [18].

### **Symptomatic GERD after SG and adequate weight loss**

In patients with symptomatic GERD and adequate weight loss after SG, an important consensus of 86.9% was achieved, indicating primary medical treatment for at least 1 to 2 years. The experts agreed with a significant consensus of 97.7% that conversion to RYGB is the only acceptable surgical treatment option in symptomatic GERD. This statement is congruent with the current literature since in a systematic review and meta-analysis by Chiappetta et al. evidence underlines that RYGB is an efficient surgical treatment option for GERD and that conversion in RYGB was the most performed redo-surgery (73.2%) in GERD in the literature [17]. Parmar et al. just published in 2017 that conversion of SG to RYGB is mainly effective for GERD symptoms, but not for further weight loss [19].

The consensus group agreed that BPD-DS (86.9%) and other investigational techniques such as teres repair/modified hill or right crus gastropexy/cardiopexy/cardioplication/retroperitoneal gastropexy/right hiatus gastropexy alone (86.9%), banded RYGB (82.6%), SADI-S (82.6%), SASI (82.6%), cruroplasty/hiatal hernia repair alone (82.6%), SG-TB (80.4%), and OAGB (71.7%) are not acceptable surgical options in symptomatic GERD.

Since only case reports and small cohort studies regarding cruroplasty/hiatal hernia repair alone and other investigational techniques alone exist, quality of evidence is low and the results of the current literature are not promising [20–23]. Even though, it seems, that reflux symptoms continue [24].

Interestingly, there was no consensus on LINX® magnetic sphincter device as an acceptable option for symptomatic GERD after SG. We have to question why experts cannot find a consensus for LINX® after two rounds but disagree for all other surgical treatment options except RYGB. There have always been debate and concerns about any foreign body around the sleeve like banded SG [25].

### **Symptomatic GERD after SG and inadequate weight loss/weight regain**

Conversion to RYGB in symptomatic GERD and inadequate weight loss and weight regain was, for this group, the only acceptable surgical option with a consensus of 97.7%. Even though OAGB provides further weight loss after failed primary restrictive surgery [26, 27], it seems that OAGB comparing to RYGB is less optimal in reflux control [28] and that particularly in the long-term bile reflux might be a critical issue [29]. Finally, in a recent expert consensus

on patient selection for OAGB, there was no consensus reached on OAGB as conversional surgery in patients with GERD after restrictive procedures [8]. In concordance with the current literature, 82.6% of the committee disagreed for offering OAGB as redo-surgery in symptomatic GERD and inadequate weight loss/weight regain.

No consensus was achieved regarding medication alone as a treatment option (disagreement 60.8%) and cruroplasty/hiatal hernia repair should be done during any conversion bariatric procedure (disagreement 54.3%). Medical treatment options are rising in poor long-term weight results after MBS and treatment with GLP-1 analogues, be it liraglutide or semaglutide, or similar compounds, stand out as effective treatment with little side-effect burden [30]. Nevertheless, clinical evidence is missing as a potential treatment option for symptomatic GERD and inadequate weight loss/weight regain. The role of cruroplasty and hiatal hernia repair is still discussed in the current literature. On the one hand, according to the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) guidelines, all detected hiatal hernias should be repaired during bariatric surgery, but there is no strong evidence to support this recommendation. No consensus was achieved for cruroplasty and hiatal hernia repair. It is important to evidence intrathoracic gastric pouch migration, a newly described entity, which may be addressed in redo-surgery [22, 31]. Further studies are necessary to underline its significance.

### **Symptomatic GERD after SG and excessive weight loss**

Again, conversion to RYGB remains the only surgical option proposed by the committee with a consensus of 97.8% in patients with symptomatic GERD after SG and excessive weight loss. A disagreement was stated for all the other surgical procedures (banded RYGB, OAGB, BPD-DS, SADI-S, SASI, endosuturing, and SG-TB). No consensus was achieved for cruroplasty/hiatal hernia repair as an acceptable option (52.1%) and LINX® magnetic sphincter device as an acceptable option (53.3%). Again, concordant to the current literature evidence for LINX® magnetic sphincter device is low, since only a few cohort studies exist [32–34]. Cruroplasty/hiatal hernia repair might not be taken into consideration, since SG remains a high-pressure system and GERD seems to improve only after RYGB [35].

### **Weight regain/incomplete weight loss after SG**

In absence of GERD and weight regain/incomplete weight loss after SG, the committee agreed finally with quite all revisional bariatric procedures: RYGB (84.7%), OAGB (84.7%), BPD-DS (76%), and SADI-S (88.8%) are all accepted procedures by the committee. A great majority

disagree to “do nothing” (80.4%) and the only procedure without consensus was SASI. The data underline the old, but current knowledge, that a restrictive procedure might be converted in a hypoabsorptive/malabsorptive procedure [36] in case of weight regain. All current gastric bypass procedures, which are all IFSO-accepted procedures [37, 38], are therefore included by the committee. Since we are talking about obesity, as a chronic disease, non-responders after SG might undergo new intervention, and “doing nothing” is in this expert consensus not accepted.

### **Non-improvement of obesity-associated medical problems**

The experts agreed that in case of non-improvement of obesity-related comorbidities, RYGB, OAGB, BPD/DS, and SADI-S are acceptable options as revisional surgeries (89.1%, 80.4%, 80.4%, and 89.1%, respectively). This is in agreement with the current available literature which shows that these operations give good results for obesity-related comorbidities [27, 28, 39–41].

Interestingly, there was no consensus reached to using SASI as an acceptable option in this scenario. This is mainly due to limited literature available related to the role of SASI for comorbidities resolution. The group disagreed that SG-TB is an acceptable option in this scenario. This is interesting as there is some literature which shows better metabolic results with SG-TB compared to SG alone [42]. Since this method is not very popular in the world at the moment, small number of cases are being performed and a limited number of surgeons do this type of procedure.

Overall, 78.2% of the experts agreed that not doing anything is not an option. This is understandable as revisional bariatric surgery is safe in these days and gives excellent results for comorbidity resolution and remission.

### **Excessive WL/food intolerance after SG without GERD**

The experts reached consensus in only 2 questions in relation to excessive WL/food intolerance after SG without GERD. 71.7% voted that conservative management including nutritional support should be used to manage this scenario whereas 80% agreed that the only surgical option was RYGB which is understandable as RYGB is still considered the gold standard operation and there is enough evidence to support this. Normally the literature quotes that

for revisional surgery after failed SG, a longer limb RYGB should be performed. However, these patient cohort would be that rare scenario where a shorter limb RYGB could be recommended as they already have excessive WL. Understandably, OAGB, BPD-DS, SADI-S, SASI, and SG-TB were not considered an acceptable option as there is no evidence to support this unique and rare scenario. Particularly these operations are considered more malabsorptive than RYGB and hence there is concern of malnutrition in patients who already have excessive WL.

### **Neurological complications**

76% of the expert committee reached a consensus that the patients should be only offered nutritional support and medical management for neurological complications after SG. Hence, the etiology of neurologic complications such as Wernicke encephalopathy [43] and orthostatic intolerance [44] should be determined, and the patients should be followed up robustly under the bariatric team with strict compliance to post-operative nutritional guidelines to prevent these complications from happening [45].

### **Dumping after SG**

Dumping is rare after SG and understandably, there was consensus in the first round that nutritional support and conservative management should be the only way to manage these patients. There is enough literature to show that dumping is more common after gastric bypass due to the change in anatomical configuration [46]. Hence, it is unlikely to get better after conversion of SG to another procedure [46].

### **Revision/conversion due to weight regain/incomplete weight loss in extreme of ages**

There was consensus that revisional surgery for weight regain or incomplete weight loss can be offered safely in adolescents [47] and in patients over 65 years of age [48]. There is enough evidence published to prove that bariatric surgery is safe and effective in this patient cohort [47, 48]. Parmar et al. showed that excess weight loss of 50.4, 67.4, and 74.0% in the > 70 age group at 6, 12, and 24 months, respectively, was not different from 51.3, 70.8, and 73.9% in < 60 year olds. The effect on the comorbidity resolution was similar in the two groups [48].



## Operative considerations in conversion/revision

There were some questions related to the technical aspects to be considered during revisions.

There is lot of debate about tailoring of biliopancreatic limb (BPL) in case of revisional cases compared to primary operation [26–28]. The consensus group of experts agreed with 84.7% consensus that the BPL should be increased in RYGB and OAGB when they are used in revisional cases. Many systematic reviews have shown that longer BPL gives better results in revisional cases and also in patients with higher BMI [17, 49]. Similarly, the experts overwhelmingly agreed that the alimentary limb should be at least 75 cm if the conversion to RYGB is for GERD. This is to prevent the bile from the jejunum-jejunal anastomosis to reach up to the gastro-jejunal anastomosis.

There was no consensus that a standalone stricturoplasty/seromyotomy is an acceptable option in stricture. In addition, there was consensus in disagreement that omentopexy is acceptable in rotation of SG. In cases of stricture or rotation of the sleeve, a conversion to bypass proximal to the stricture/rotation was considered the best option [50]. There is sufficient evidence to support this as the conversion is technically safe and gives good long-term results [17, 19]. Majority of the experts disagreed that fundoplication is an acceptable option in the presence of a dilated fundus and GERD as this procedure is still novel and life-threatening complications like wrap necrosis that have been reported with this [51]. More and more evidences are being published regarding the safe role of endoscopic interventions in case of strictures of SG [52, 53] and majority of the experts agreed that it is an acceptable option.

Overall, the aim of this consensus exercise was to provide some guidance regarding the investigations, interventions, and technical factors to be considered in patient needing revisional/conversion surgeries after failed SG. We also attempt to provide an algorithm to help surgeons in future in decision-making (Fig. 1—Algorithm).

## Conclusion

Redo-surgeries after SG are still a point of discussion among bariatric and metabolic surgeons. The proper time and procedure selection for redo-surgery need careful considerations. Although MDT plays a key role to evaluate best options in these situations, an algorithmic clinical approach based on the expert's consensus as a guideline can help for the best clinical decision-making.

## Appendix: List of modified Delphi consensus experts (in alphabetical order)

Name	Country
1. Syed Imran Abbas	UAE
2. Ali Aminian	USA
3. Luigi Angrisani	Italy
4. Ahmad Bashir	Jordan
5. Estuardo Behrens	Guatemala
6. Mohit Bhandari	India
7. Sonja Chiappetta	Italy
8. Ben Clapp	USA
9. Ricardo Cohen	Brazil
10. Jerome Dargent	France
11. Maurizio De Luca	Italy
12. Bruno Dillemans	Belgium
13. Mohamed Hayssam Elfawal	Lebanon
14. Khaled Gawdat	Egypt
15. Ashraf Haddad	Jordan
16. Jaques Himpens	Belgium
17. Chih-Kun Huang	Taiwan
18. Farah Hussain	USA
19. Kazunori Kasama	Japan
20. Radwan Kassir	France
21. Mohammad Kermansaravi	Iran
22. Amir Khan	UK
23. Lilian Kow	Australia
24. Matthew Kroh	USA
25. Muffazal Lakdawala	India
26. Juan Antonio Lopez Corvala	Mexico
27. Kamal Mahawar	UK
28. Karl Miller	Austria
29. Mario Musella	Italy
30. Abdelrahman Nimeri	USA
31. Patrick Noel	UAE
32. Mariano Palermo	Argentina
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43. Antonio Torres	Spain
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## Declarations

**Disclosures** Dr. Bruno Dilemans has an equity interest in Johnson & Johnson and Medtronic & Olympus. Dr. Farah Husain has an equity interest in Ethicon J&J. Dr. Ashraf Haddad has an equity interest consultant for Medtronic and Speaker for EziSurge Medical. Dr. Sonja Chiappetta has an equity interest in Novo Nordisc and Johnson and Johnson. Dr. Ricardo Cohen has an equity interest in Johnson & Johnson and Scientific Advisory Board for Baritek; GI Dynamics. Dr. Karl Miller has an equity interest in J&J as consultant. Dr. Ali Aminian has an equity interest in Honorarium and research support from Medtronic and Ethicon. Dr. Kamal Mahawar has been paid honoraria by Medtronic, Ethicon, Olympus, Gore, and several NHS trusts for education activities and mentoring in the field of bariatric surgery (predominantly One Anastomosis Gastric Bypass). Dr. Natan Zundel has an equity interest in Johnson & Johnson and Medtronic, Olympus, Apolo, VHP, LivsMed. Drs Mohammad Kermansaravi, Chetan Parmar, Scott Shikora, Syed Imran Abbas, Luigi Angrisani, Ahmad Bashir, Estuardo Behrens, Mohit Bhandari, Benjamin Clapp, Jerome Dargent, Maurizio De Luca, Khaled Gawdat, Mohamed Hayssam Elfawal, Jaques Himpens, Chih-Kun Huang, Kazunori Kasama, Radwan Kassir, Amir Khan, Lilian Kow, Matthew Kroh, Muffazal Lakdawala, Juan Antonio Lopez Corvala, Mario Musella, Abdelrahman Nimeri, Patrick Noel, Mariano Palermo, Luis Poggi, Tigran Poghosyan, Gerhard Prager, Arun Prasad, Aayad Alqahtani, Karl Rheinwalt, Rui Ribeiro, Asim Shabbir, Antonio Torres, Ramon Villalonga, and Cunchuan Wang have no conflict of interest or financial ties to disclose.

**Ethical approval** Not applicable.

**Informed consent** Not applicable.

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