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ORIGINAL CONTRIBUTIONS

Single Anastomosis Duodenal-Ileal Bypass with Sleeve Gastrectomy/One Anastomosis Duodenal Switch (SADI-S/OADS) IFSO Position Statement—Update 2020

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Abstract

Preamble

The International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) has played an integral role in educating both the metabolic surgical and the medical communities at large about the role of innovative and new surgical and or endoscopic interventions in treating adiposity-based chronic diseases. The single anastomosis duodenal-ileal bypass with sleeve gastrectomy/one anastomosis duodenal switch (SADI-S/OADS) is a relatively new procedure that has been proposed as an alternative to the conventional duodenal switch (DS) procedure. The IFSO published a position paper on SADI-S/OADS in 2018 with which concluded that this procedure was likely to be a safe and efficacious treatment for adiposity and its related diseases. However, it noted that there was insufficient long-term data and minimal high-level evidence available. The position statement called for patients to be enrolled in long-term multidisciplinary care encouraged the registration of patients in national registries, and called for more randomized controlled trials (RCT) (Obes Surg 28:1207–16, 2018) involving the procedure. The following position statement is an update of the previous position statement. It is issued by the IFSO SADI-S/OADS task force and has been reviewed and approved by both the IFSO Scientific Committee and Executive Board. This statement is based on current clinical knowledge, expert opinion, and published peer-reviewed scientific evidence. It will be reviewed again in 2 years.

Keywords Single anastomosis duodenal-ileal bypass with sleeve gastrectomy/one anastomosis duodenal switch (SADI-S/OADS) · IFSO · Systematic review · Position statement

Background

The concept of duodenal switch (DS) was proposed in 1987 by DeMeester et al. as an alternative to RYGB for the treatment of bile reflux [1]. Traverso and Longmire reported the advantages of pylorus preservation in a complex procedure such as the pancreaticoduodenectomy [2]. This technique was then adapted to bariatric surgery in 1989 by Hess and Marceau [3, 4], creating the biliopancreatic diversion procedure with duodenal switch (BPD-DS). The preservation of the gastric antrum and pylorus in Hess' and Marceau's technique, unlike in the Scopinaro BPD, was intended to avoid marginal ulcers that occurred quite frequently after the original BPD.

Like the traditional BPD, the BPD-DS has been demonstrated in long-term studies to provide significantly greater weight loss than other bariatric procedures with concurrent sustained improvement in metabolic health [5]. However, the side effects of the BPD-DS relating to malabsorption of fat-soluble vitamins, micronutrients, and protein as well as steatorrhea have limited the broad acceptability of this procedure. These side effects also mean that careful patient selection, education, and expert aftercare are required [6]. In the most recent IFSO global survey of bariatric surgical

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procedures, BPD and DS accounted for 0.5% of all procedures performed worldwide [7].

SADI-S/OADS was proposed in 2007 by Sanchez-Pernaute and Torres et al. as a modification of the standard DS. The modification was to anastomose the duodenum directly to an omega loop of ileum 200 cm proximal to the ileocaecal valve, eliminating the need for the Roux-en-Y jejunal ileal anastomosis [8]. The theoretical benefits over the DS included reduction of the operative risk by eliminating one anastomosis while potentially achieving similar weight loss and health benefits (Fig. 1).

Since the Sanchez-Pernaute and Torres' paper, other similar one anastomosis duodenal switch procedures have been reported in the literature: SIPS (stomach intestinal pylorus–sparing surgery) [9], single anastomosis duodenal-jejunal bypass with sleeve gastrectomy (SADJB-SG) [10], loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) [11], single anastomosis duodenal switch; distal loop duodeno-ileostomy (DIOS), and proximal duodeno-jejunotomy (DJOS) [12]. The previous IFSO position paper found that there was no medical evidence that demonstrated superiority of the standard DS or SADI-S/OADS, noting that many nutritional issues take years to present and we do not currently have sufficient long-term data on the SADI-S/OADS to comment on this issue [13].

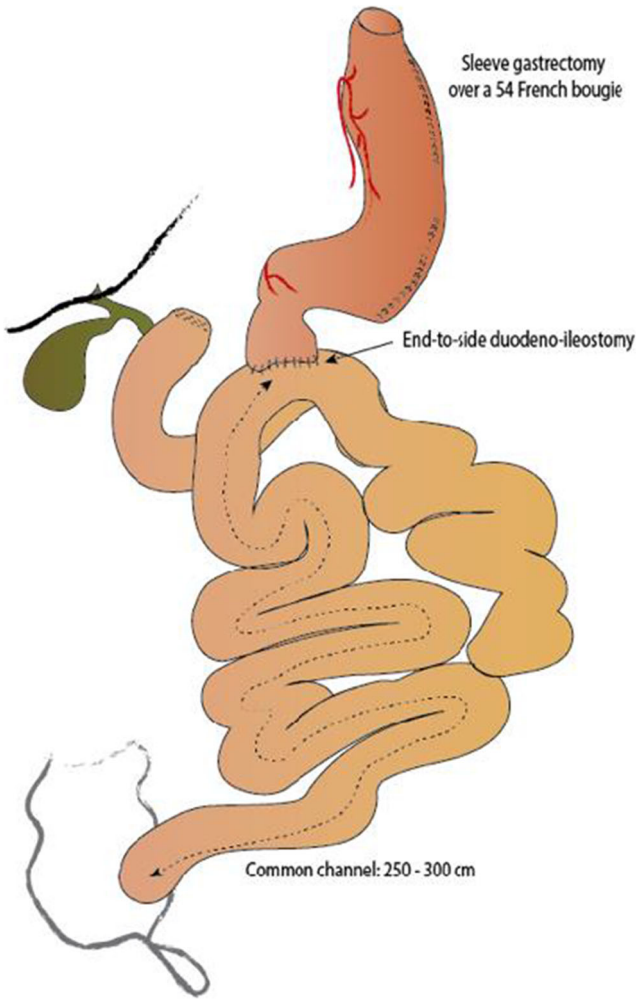

Fig. 1 SADI-S/OADS

The ASMBS in their 2016 position paper determined that the SADI-S/OADS should be considered an "investigational" procedure, as they felt that there was not enough randomized or prospective comparative data to draw any definitive conclusions regarding the safety, efficacy, and durability of these procedures compared with the standard DS procedure [14]. In their updated statement (2020), the ASMBS endorsed the SADI-S/OADS as an appropriate metabolic procedure; however, they noted a lack of evidence regarding intestinal adaptation, nutritional issues, optimal limb lengths, and long-term weight loss/regain after this procedure. As such, they recommended a cautious approach to the adoption of this procedure, with attention to ASMBS-published guidelines on nutritional and metabolic support of bariatric patients, in particular for DS patients [15].

The IFSO 2018 position statement also noted the need for more evidence but acknowledged that there is a need for guidance for emerging procedures and that this is the responsibility of organizations, such as IFSO. To ensure guidance is based on the best available literature, IFSO has developed a framework to inform position statements. According to this framework, the literature is reviewed and the following aspects are considered:

A: Safety–Is the procedure or modification of an existing procedure as safe or safer than existing procedures?
B: Efficacy–Is the procedure or modification of an existing procedure as effective or more effective than existing procedure?
C: Long-term consequences–Is there potential for unforeseeable long-term considerations? For example: procedures requiring resection or non-reversible anatomic modifications would mandate a higher level of evaluation.
D: Two-year expiration–at which time, the current level of evidence will be re-evaluated and the position statement will be re-affirmed, updated, or modified.

Considering the results of the systematic review performed in the 2018 position statement, the IFSO considered that the short-term data available demonstrated that these procedures satisfied safety and efficacy concerns. They noted, however, there was insufficient data to confirm long-term consequences. On this basis, the IFSO did not consider it appropriate to continue to call the SADI-S/OADS "investigational" but recommended that long-term follow-up be continued.

This current IFSO position paper supersedes the previous report and fulfills the fourth criteria of the IFSO framework for position papers. A task force was appointed by the Executive

Board of IFSO (Appendix 1). The task force undertook a systematic review, updating the previous review, to summarize the current evidence on these procedures with the aim of providing the most up-to-date information to guide practice.

Methods

Literature Search

We performed a comprehensive literature search to identify studies reporting any experience or outcomes with the SADI-S/OADS. The search was done in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. This review searched MEDLINE (1946 to March 2020), EMBASE (1974 to March 2020), PubMed (until March 2020), and the Cochrane Library (until March 2020). Search terms were broad, to encompass all single anastomosis pylorus–preserving procedures (SAPPP). These include terms specifying the bariatric procedure (*duodenal switch*, *biliopancreatic bypass*, *duodenoileal bypass*, *duodenojejunal bypass*, *bariatric surgery*), single anastomosis (*single anastomosis, loop anastomosis*, *one anastomosis*, *omega loop, mini*). A full list of search terms is presented in Table 2 in Appendix 2. Manual searching of reference lists from reviews, as well as references from selected primary studies, was performed to identify any additional studies.

Inclusion Criteria

Studies were selected based on any data or reported experiences with single anastomosis pylorus–preserving procedures. All study designs, study sizes, and follow-up time frames were accepted. Abstracts were included but separated from full manuscript publications.

Data Extraction

Information extracted from eligible studies included basic study data (year, country, design, study size), demographic data, surgical technique, follow-up, weight loss, evolution of co-morbidities, and complications.

Risk of Bias Assessment

All studies were assessed for their risk of bias based on the Newcastle-Ottawa Scale [16]. Each study was assessed independently by two investigators regarding study selection, comparability, and outcomes. The Newcastle-Ottawa Scale consists of 3 subscales which contribute to a maximum total score of 9. Studies scoring < 3 were regarded as being at high, between 4 and 6 moderate and > 6 at low risk of bias. This is consistent with the methodology used in the recently submitted IFSO position statement on Barrett's Esophagus in Bariatric Surgery (submitted for publication) (supplemental material).

Results

Literature Search

Using the search strategy described, we identified 5980 studies (authors GB and MH). After duplicates were removed, we screened titles and abstracts for 5161 records. There were 161 articles that were assessed for eligibility, of which 50 full-length publications were identified for inclusion (PRISMA Flow Chart—Fig. 2).

There are currently 42 case series and 8 case reports on SADI-D/OADS which are summarized in Table 1. This is an increase of 25 case series and 3 case reports since the last position statement was completed in 2018 [13].

All case reports were considered to have a high risk of bias. They had insufficient detail to meaningfully evaluate the procedure and were not considered in the preparation of the position statement.

The Newcastle-Ottawa Scores were calculated by two independent assessors (authors WB and GO). The initial concordance between reviewers was 90.4%. There were four papers where there was a discrepancy that lead to a different level of risk assessment. These papers were re-checked and a score agreed upon. The final assessment of bias indicated that one paper had a low risk of bias [38] and the remaining 41 a moderate risk. There were no case series that were assessed as having a high risk of bias. Tables are available in the supplemental material (attached).

Outcomes from SADI-D/OADS

The SADI-D/OADS has been reported in both the primary and the secondary setting:

Primary

There are 34 case series that include primary patients (detail in Table 1). In total, there are 4540 patients reported upon; however, this is an over-estimation due to shared patients between the reports from Sanchez-Pernaute, Torres, Surve, and Cottam [24–27, 30, 39, 40].

Most series report short-term weight loss at 12 or 24 months with variable means of reporting weight loss being used. Mean total body weight loss (TBWL) is reported as ranging from 23.6 to 39.0% at 12 months, 39.6 to 42.9% at 18 months, and 22.8 to 47.8% at 2 years. Mean excess weight loss (EWL) is reported as ranging from 62.4 to 102% at 12 months.

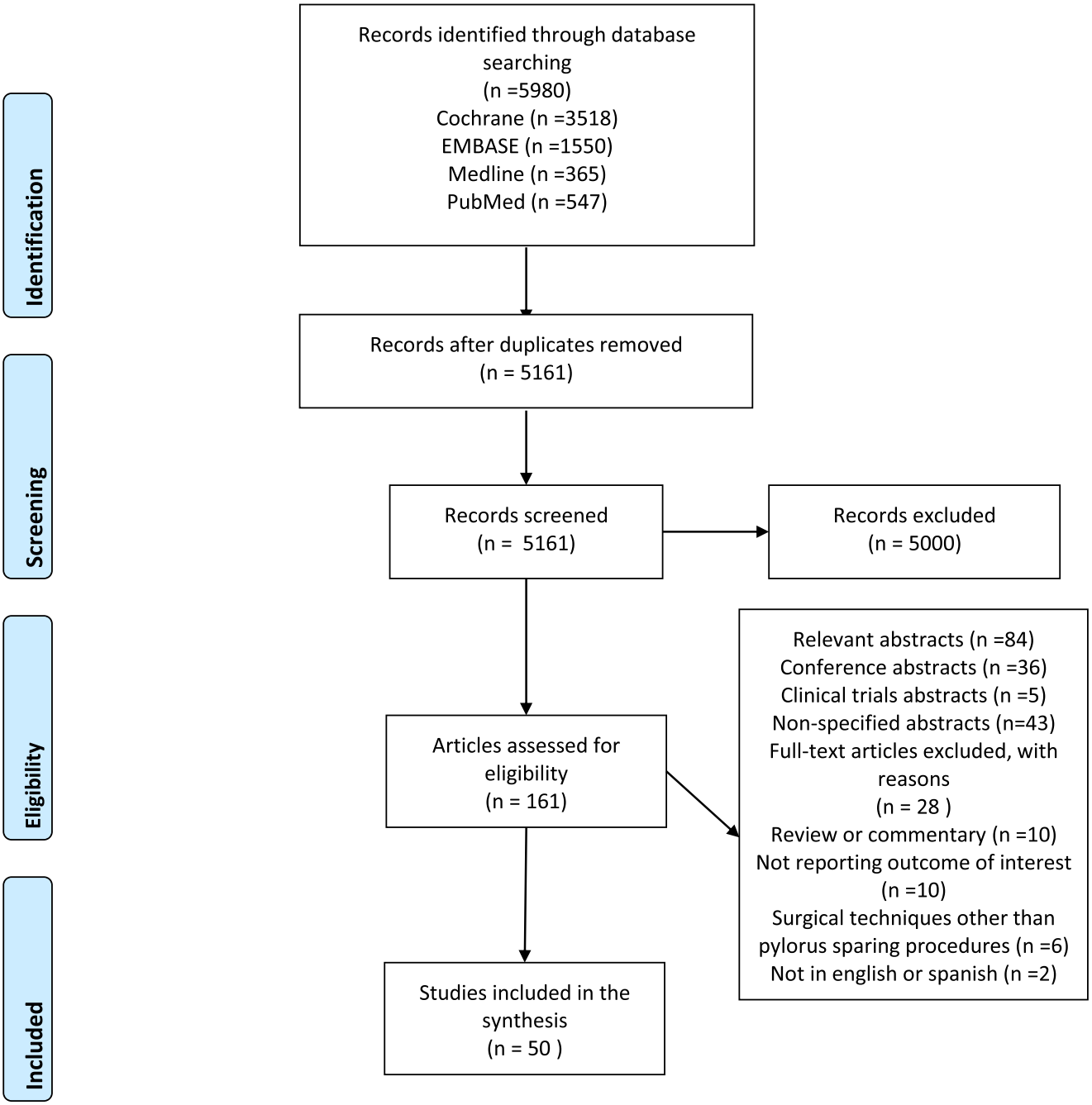

Fig. 2 PRISMA flow chart outlining the identification and screening process for included articles

The longest time point currently reported for follow-up is at 6 years. In this report, the TBWL achieved was 38% (110 patients, no stated follow-up) [40].

There are three reports with follow-up at 5 years. The TBWL achieved at 5 years was 38% (78% follow-up) [27], 34.78% (12/12 patients, weight loss pooled with RYGB) [31], and 22% (78% follow-up rate) [51].

Changes in type II diabetes mellitus (T2DM) diagnosis and treatment was reported in 28 case series that included primary patients. There was a significant improvement in both HBA1c and requirement for hypoglycemic agents (Table 1 for details).

Early complications included anastomotic leak, bleeding, and nausea.

Longer term complications included gastro esophageal reflux disease (GERD), bile reflux, flatulence, dumping syndrome, and nutritional issues. The nutritional issues reported included malnutrition, hypoalbuminemia, vitamin D deficiency, hypocalcemia, hyperparathyroidism, and iron deficiency. Revisional procedures for these issues are variably described.

Table 1 Studies included in the systematic review of the literature and study characteristics

Study data	Procedure	*n*	Primary or revision	Maximum time point and %follow-up	Male gender
Mitzman, 2016 (USA) [9]	Stomach intestinal pylorus–sparing (SIPS) surgery Retrospective cohort (single arm)	123 (proximal)	Primary	12 months 64/102 patients (62.7%)	36.6% (45)
Nelson, 2016 (USA) [17]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Cohort study (single arm)	69	Primary	12 months 24/69 patients (34.8%)	30.4% (21)
Surve, 2017 (USA) [18]	Stomach intestinal pylorus–sparing (SIPS) surgery Retrospective cohort (single arm)	120	Primary	24 months (27 patients) 73 patients (of possible 95) at 1 year 52/69 at 2 years 27/38 at 3 years	35.0% (42)
Cottam, 2016a (USA) [19]	Loop duodenal switch Matched cohort study (LDS vs GBP)	54 (distal)	Primary	18 months %follow-up: NR	29.6%
Grueneberger, 2014 (Germany) [20]	Duodeno-jejunostomy or duodeno-ileostomy with sleeve gastrectomy (DJOS and DIOS) Cohort study	16 (7 DJOS, 9 DIOS)	Primary and secondary. 5 revision DIOS (2 IGB, 1 LAGB, 2 RYGB), 4 revision DJOS (4 LAGB)	6 months %follow-up: NR	25% (3 DIOS, 1 DJOS)
Huang, 2013 (Taiwan) [11]	Loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) Cohort study (single arm)	22 (proximal)	Primary	6 months %follow-up: 100%	40%
Huang, 2016 (Taiwan) [21]	LDJB-SG (Patient crossover with Huang 2013) Matched cohort study (RYGB v LDJB-SG)	30 (proximal)	Primary	12 months %follow-up: 100%	40% (12)
Lee, 2015 (Taiwan) [22]	Duodenal-jejunal bypass with sleeve gastrectomy (DJB-SG) Matched cohort study (DJB-SG vs SG alone)	89 (proximal)	Primary	12 months %follow-up: 29.2% (26)	36.0% (32)
Lee, 2014 (Taiwan) [10]	Single anastomosis duodeno-jejunal bypass with sleeve gastrectomy (SADJB-SG) Cohort study (SADJB-SG vs MGB vs RYGB)	50 (proximal)	Primary	12 months %follow-up: 68% (34)	19 (38%)
Morales, 2012 (Chile) [23]	SADI-S Cohort study (single arm)	100 (distal)	Primary	Not specified. No long-term follow-up described.	19%
Sanchez-Pernaute, 2010 (Spain) [24]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Cohort study (single arm)	50^ (distal) ^shared patients	Primary	3 years %follow-up: 98% (49)	36% (18)

Table 1 (continued)

Sanchez-Pernaute, 2013 (Spain) [25]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Cohort study (single arm)	100^ (distal) ^shared patients	Primary (93) and revision (7 after SG)	4 years 75% at 1 year 46% at 2 years 20% at 3 years 4% at 4 years "Follow-up complete for 99% (99)"–pg 732, last paragraph	37% (37)
Sanchez-Pernaute, 2015a (Spain) [26]	SADI-S Cohort study (single arm)	16^ (distal) ^shared patients	Revision	Mean F/U 21 months (range 2–46 months) 87.5% (14 at 6 months) 62.5% (10 at 1 year) 31% (5 at 2 years)	25% (4)
Sanchez-Pernaute, 2015b (Spain) [27]	SADI-S Cohort study (single arm)	97^ (distal) ^shared patients	Primary and revision	Various, up to 5 years Main results reported for 1 year 86/90 (95.6%) at 1 year 74/80 (92.5%) at 2 years 66/70 (94%) at 3 years 46/53 (86.8%) at 4 years 24/36 (66.7%) at 5 years	46.4% (45)
Balibrea, 2017 (Spain) [28]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Cohort study (single arm)	30	Revision (after SG)	24 months 16/30 (53.3%)	26.7% (8)
Cottam, 2017 (USA) [29]	Stomach intestinal pylorus saving (SIPS) surgery Cohort study (SIPS vs BPD-DS)	61	Primary	24 months 40 at 12 months 19 at 24 months Overall, 19 patients at 24 months (31.1%)	37.7% (23)
Cottam, 2016b (USA) [30]	Sleeve gastrectomy with 300 cm loop duodenal switch Retrospective matched cohort (SG vs LDS-SG)	53	Primary	18 months 36 (67.9%)	35.8% (19)
Ramos-Levi, 2017 (Spain) [31]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Matched cohort study (SADI-S vs RYGB)	12	Primary	5 years	N/A
Moon, 2018 (USA) [32]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250 cm Retrospective cohort study	140	Primary	2 years 90/136 (66%) at 6 months 58/124 (46.8%) at 1 year 38/95 (40%) at 18 months 25/65 (38.5%) at 2 years	38 (27.1%)

Table 1 (continued)

Moon, 2019 (USA) [33]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250 cm Matched cohort study (SADI-S vs BPD/DS)	111	Primary	2 years 103/111 (92.8%) at 6 months 56/111 (50.5%) at 1 year 23/111 (23.4%) at 2 years	30 (27%)
Wu, 2018 (China) [34]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 200 cm Retrospective cohort study	22	Revision (LAGB to SADI-S)	2 years	5 (22.7%)
Dijkhorst, 2018 (Netherlands) [35]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250–300 cm Matched multicenter cohort study (SADI-S vs RYGB)	66	Revision	2 years (47%)	10 (15%)
Cottam 2018 (USA) [36]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)/(SIPS)–CC 300 cm Retrospective matched cohort study (SADI-S vs RYGB)	341	Primary	3 years 161/287 (56%) at 12 months 57/148 (39%) at 24 months 40/76 (53%) at 3 years	123 (36%)
Neichoy, 2018 (USA) [37]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)/(SIPS)–CC 300 cm Retrospective cohort study	225	Primary	2 years 93/133 (69.9%) at 1 year 30/48 (62.5%) at 2 years	50 (22.2%)
Ceha, 2018 (Netherlands) [38]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250 cm Retrospective matched cohort study (SADI-S vs RYGB)	32	Revision	1 year	6 (18.8%)
Zaveri, 2018 (USA) [39]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)/(SIPS)–CC 300 cm Retrospective cohort study	437	Primary	4 years 266/357 (74.5%) at 1 year 169/286 (59.1%) at 2 years 90/155 (58.1%) at 3 years 44/79 (55.7%) at 4 years	161 (36.8%)
		1328	Primary	6 years	425 (32%)

Table 1 (continued)

Surve, 2018 (USA, Spain, Australia) [40]	Single anastomosis duodenal switch procedures (SADS) (SADI-S CC 250 cm/SIPS CC 300 cm) Multicenter retrospective cohort study ^likely duplicated patients			1328 at 1 year 751 at 2 years 343 at 3 years 196 at 4 years 140 at 5 years 110 at 6 years	
Pereira, 2019 (Portugal) [41]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 300 cm Matched cohort study (SADI-S vs BPD/DS)	9	Primary	18 months	2 (22%)
Moon, 2019 (USA) [42]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250 cm Retrospective cohort study	10	Revision RYGB to SADI	2 years 57% follow-up at 2 years	1 (10%)
Moon, 2019 (USA) [43]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 250 cm Retrospective cohort study	9	Revision SG to SADI	2 years 5/8 (62%) at 2 years	4 (44.4%)
Zaveri, 2019 (USA) [44]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) (CC 300 cm) Multicenter retrospective cohort study	96	Revision	2 years	N/A
Pearlstein, 2019 (USA) [45]	Single anastomosis duodenal switch (SADS) (CC 300 cm) Retrospective matched cohort study between primary and revision SADS	40	Primary ($n = 20$) and Revision (LAGB to SADS) ($n = 20$)	> 12 months 18/20 more than 12 months	8 (40%) in each group
Enochs, 2019 (USA) [46]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 300 cm Retrospective matched cohort study among RYGB and SG	160	Primary	2 years 148/160 (92.5%) at 1 year 84/123 (68.3%) at 2 years	35 (21.8%)
Cottam, 2020 (USA) [47]	Single anastomosis duodenal switch (SADS) (CC 300 cm) Prospective multicenter study	118	Primary	1 year 91/118 (77.1%) at 1 year	38 (32.2%)

Table 1 (continued)

Surve, 2020 (Australia) [48]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 300 cm Retrospective cohort study	91	Primary	2 years 17/25 (68%) at 2 years)	30 (32.9%)
Finno, 2020 (Spain) [49]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S)–CC 300 cm Retrospective Comparative cohort study (SADI-S vs BPD/DS)	181	Primary (n = 151–83.4%) and revision	2 years 68/181	55 (30.3%)
Ruan, 2017 (China) [50]	Sleeve gastrectomy with duodeno-jejunal end-to-side anastomosis (SG-DJESA) (BP Limb 200 cm) Prospective study	7	Primary	4 years	4 (57.1%)
Ser, 2018 (Taiwan) [51]	Single anastomosis duodeno-jejunal bypass with sleeve gastrectomy (SADJB-SG) (BP Limb 150–350 cm–at least CC 400 cm) Retrospective cohort study	148	Primary	5 years 62/84 (73.8%) at 5 years	52 (35.1%)
Li, 2018 (China) [52]	Loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) (BP Limb 200 cm) Retrospective cohort study–two arms (LDJB-SG and RYGB)	9	Primary	1 year	6 (33.3%)
Nor Hanipah, 2019 (Taiwan) [53]	Loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) (BP Limb 200 cm) Prospective study	163	Primary	2 years	57 (35%)
Lin, 2019 (China) [54]	Loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) (BP Limb 200 cm) Retrospective study	28	Primary	3 years 28 patients at 1 year 19 patients at 3 years	12 (42.9%)
Sessa, 2019 (Italy) [55]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Matched cohort study (SADI-S vs GBP vs SG vs BPD)	9	Primary	12 months Mean: 8.3 ± 3.6 months	44.4% (4)
Case reports					
Huang, 2015 (Taiwan) [56]	LDJB-SG Case reports (×2)	2 (proximal)	Revision	6 months %follow-up: 100%	0%

Table 1 (continued)

Karcz, 2013 (Germany) [12]	Gastric plication (GP) or sleeve gastrectomy (SG) with duodeno-ileal omega switch (DIOS) or duodeno-jejunal omega switch (DJOS) Technical paper	N/A	Primary and revision	N/A	N/A
Summerhays, 2016 (USA) [57]	Loop duodenal switch (LDS) Case report	1 (proximal)	Revision	N/A	N/A
Vilallonga, 2015 (Spalin) [58]	Single anastomosis duodeno-ileal bypass after sleeve gastrectomy (SADI-S) Case series	3	Revision	3–9 months One patient with 3 month follow-up Two patients with 9 months follow-up	100% (3)
Chiappetta, 2017 (Germany) [59]	Conversion of SADI-S to RYGB Case report	1	Revision	32 months	0
Tsai, 2018 (Taiwan) [60]	Loop duodeno-jejunal bypass with sleeve gastrectomy (LDJB-SG) Case report	2/199	Primary	8 days in 1 patient 1019 days in 1 patient	1 (50%)
Vilallonga, 2017 (Spain) [61]	Conversion of SADI-S to SADJ-S and/or RYGB 2–CC 200 cm 3–CC 250 cm Case series Videosurgery article	5	Revision	Range 3–25 months	1 (20%)
Kirkpatrick, 2018 (USA) [62]	Single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S) Case report	1	Primary	3 years	1 (100%)

Study data	Start BMI (kg/m^2)	Weight loss achieved	T2DM resolution *requiring re-operation	Early complications	Long-term complications *requiring re-operation
Mitzman, 2016 (USA) [9]	49.4 ± 9.2	TBWL: 38.6 ± 0.7 (1 year)	NR	1 bleeding prepyloric ulcer* (converted to RYGB) 2 constipation, 2 diarrhea, 4 intra-abdominal hematoma, with 1 infection 1 gastric sleeve stricture 1 dysphagia	Not reported
Nelson, 2016 (USA) [17]	58.4 ± 8.3 (range 42.3–91.8)	TBWL: 37.3% EWL: 61.6%	9/18 patients with diabetes at baseline (50%)	1 duodenoileal obstruction with perforation of small bowel* 1 sleeve leak* 1 duodenal stump leak* 3 low oral intake, 1 post-operative bleed, 1 atelectasis 3 30-day readmission (tachycardia, DVT, viral gastroenteritis)	No reported

Table 1 (continued)

Surve, 2017 (USA) [18]	49.5 ± 9.4	TBWL: 34.2% (32.3–36.0) at 24 months	Abnormal BSL: 64/118 to 13/81 Abnormal HbA1c: 61/109 to 7/72	1 acute blood loss anemia 1 intra-abdominal hematoma*	1 diarrhea, 2 constipation 1 malnutrition, 2 hiatus hernia 4 sleeve stricture 2 retrograde filling of afferent limb 1 common channel lengthening
Cottam, 2016a (USA) [19]	47.6 ± 8.8	TBWL: 41% (39.3–42.7)	NR	1 nausea 1 abdominal wall spasms	1 sleeve stricture 1 dilated fundus* 1 GERD, 1 diarrhea, 1 miscounted small bowel*
Grueneberger, 2014 (Germany) [20]	DIOS: 40.6 (33.2–55.9), DJOS: 41.6 (35.7–47.9)	EWL: 46.5% (DJOS), 49.6% (DIOS)	HbA1c decrease 6.8 to 5.7% (DIOS), 8.0 to 5.9 (DJOS). DIOS: 8/9 people with diabetes, 1/9 with diabetes at end (87.5% remission)	1 trocar perforation	1 revision operation 10 significant reflux 14 PPI treatment 8 diarrhea 1 dumping syndrome 10 flatulence
Huang, 2013 (Taiwan) [11]	28.4 ± 4.03 (range 21.8–38.3)	End BMI 23.4 ± 3.4	11 (50%)	1 gastric stricture*	N/A
Huang, 2016 (Taiwan) [21]	28.2 ± 3.6	End BMI 22.4 ± 2.5 (− 5.8 ± 2.4)	16 (53.3%)	1 bleed 1 gastric stricture* 1 wound infection	1 ventral hernia* 4 reflux 13 erosive esophagitis
Lee, 2015 (Taiwan) [22]	35.1 ± 5.9	EWL: 87.2 ± 14.9% BMI: 23.9 ± 2.2	27/29 (93.1%) Mean decrease in HbA1c 2.8%	4 bleeding (*1 re-operation) 2 marginal ulcer, 1 ARDS, 2 wound infection, 1 vomiting, 1 dehydration, 1 atelectasis	1 stricture*
Lee, 2014 (Taiwan) [10]	38.4 ± 6.0	TBWL: 32.7% BMI: 25.9 ± 4.6 kg/m^2	HbA1c: 9.2 ± 2.1 to 6.1 ± 0.9% BSL: 150.9 ± 68.5 to 109.2 ± 39.3 mg/dl	1 wound infection, 1 gastric stasis, 1 prolonged intubation	
Morales, 2012 (Chile) [23]	37.05	NR	NR	3 sleeve leaks (*2 re-operation) 3 duodenal stump leaks (*1 re-operation) 1 bleed*, 2 intestinal injuries, 1 portal vein thrombosis, 1 sleeve stenosis*, 1 early trocar site hernia* 0 mortality	
Sanchez-Pernaute, 2010 (Spain) [24]	44.2 (range 33–67)	EWL: 114 ± 9.6% at 2 years, > 100% during the third year EWL: 95% at 12 months	BSL: 174.5 (91–292) to 97 (65–101) 90% abnormal BSL to no abnormal BSL. HbA1c: 7.6% (5.4–10.5) to 5.4 (4.1–6.5)	1 staple line bleed requiring endoscopic intervention 1 early hernia* 2 sleeve leaks 2 sleeve leaks	1 late subphrenic abscess (8 months post-operative) 4 clinical hypoalbuminemia (1 mortality 3-months post-operatively from respiratory decompensation) 2 symptomatic hypoalbuminemia*

Table 1 (continued)

Sanchez-Pernaute, 2013 (Spain) [25]	Primary: 44.6 (range 33–67) Revision: 48.5 (range 37.6–54.6)		BSL 178.2 (91–408) to 94.7 (1st year) and 79.6 (4th year) HbA1c: 7.9 (5.4–13) to 5.3 (1st year) and 5.0 (4th year) 45 of 49 patients (F/U > 1 year) had T2DM remission	1 duodeno-ileal anastomotic leak 1 gastric hemorrhage requiring endoscopic treatment 1 trocar site hernia*	
Sanchez-Pernaute, 2015a (Spain) [26]	44 (range 35.5–55.8)	BMI 35 (31.6–37) at 2 years	75% (3/4) remission after SADI-S		1 symptomatic hypoalbuminemia
Sanchez-Pernaute, 2015b (Spain) [27]	44.3 (range 33–67)	TBWL: 39% (1 year) 39% (2 years) 35% (3 years) 37% (4 years) 38% (5 years)	71.6% (1 year) 77% (2 years) 75.8% (3 years) 63.3% (4 years) 52% (5 years)	1 anastomotic leak 1 hemoperitoneum* 1 incarcerated umbilical hernia*	
Balibrea, 2017 (Spain) [28]	33.2 ± 5.0	EWL: 44.3% ± 35.0	5 patients (of 7 with follow-up)	1 pulmonary atelectasis 1 rectus sheath hematoma (percutaneous embolization) 2 anastomotic leaks*	3 severe hypoalbuminemia* requiring TPN 1 pneumonia 1 acute hepatitis 7 severe iron deficiency anemia 3 dumping
Cottam, 2017 (USA) [29]	50.2 ± 8.6	BMI: 29.1 ± 4.7 (24 months) TBWL: 38.7% ± 9.3	86% patients with diabetes HbA1c < 6.0 7 of 36 patients with abnormal HbA1c at 1 year (35 of 54 at baseline)	8 nausea, 3 vomiting, 2 low oxygen saturation, 2 ileus 1 small bowel perforation* 1 sleeve stricture 1 post-operative bleed	1 diarrhea with malnutrition* 3 abdominal pain, 6 GERD, 4 nausea/vomiting, 1 inadequate weight loss, 2 constipation, 1 gastric stenosis
Cottam, 2016b (USA) [30]	46.2 ± 7.6	TBWL: 39.6% (38.5–40.7)	NR	1 nausea 1 post-operative bleed 1 wound infection	4 nausea, 2 constipation, 1 abdominal pain 3 diarrhea (*1 re-operation) 1 dilated fundus* 2 sleeve strictures requiring endoscopic dilatation
Ramos-Levi, 2017 (Spain) [31]	44 ± 3.8	N/A	100% HbA1c 5.15	N/A	N/A
Moon, 2018 (USA) [32]	57.3 ± 9.2 range (40.2–92.7)	TBWL 37.1% at 1 year TBWL 42.9% at 18 months TBWL 44.7% at 2 years	77% partial or complete remission at 1 year 100% partial or complete remission at 2 years 100% HbA1c < 5.6% at 2 years	11 30-day re-admission 13 re-operations*	50% low vitamin D levels 28% abnormal hemoglobin 27.8% secondary hyperparathyroidism

Table 1 (continued)

				10 overall leak* (5 anastomosis leak—3 converted to RYGB and 2 to OAGB/MGB; 3 sleeve leak; 2 duodenal stump leak)	
		EWL 62.4% at 1 year	HbA1c 5.3 ± 0.5 at 1 year;	1 small bowel perforation*	20% abnormal Albumin
		EWL 70.6% at 18 months	5.1 ± 0.4 at 2 years	1 wound infection*	1 malnutrition (converted to RYGB)*
		EWL 74.3% at 2 years		1 twisting of bowel*	1 internal hernia*
				1 gastroenteritis	1 bile reflux (converted to BPD/DS)*
				1 deep venous thrombosis	1 cardiovascular-related mortality
					1 liver cirrhosis
Moon, 2019 (USA) [33]	56.3 ± 9.4	TBWL 22 ± 7.4% at 6 months	100% remission at last follow-up	13 30-days readmission	1 incisional hernia*
		TBWL 38.5 ± 10.2% at 1 year		5 anastomosis leak*	1 cholelithiasis*
		TBWL 44.2 ± 9.8% at 2 years		3 sleeve leak*	1 abdominal pain that required adhesiolysis*
				2 bleeding	1 malnutrition with diarrhea
		EBMIL 67.2 ± 18.5% at 1 year		1 wound infection	46.7% abnormal hemoglobin at 2 years
		EBMIL 78.8 ± 19.7% at 2 years		1 abdominal pain	6.7% abnormal albumin at 2 years
				1 perforation	13.3% abnormal serum calcium at 2 years
				1 dehydration	
Wu, 2018 (China) [34]	36.5 ± 9.7 (range 28.3–54.5)	TBWL 22.3% at 1 year	100% partial or complete remission at 2 years	1 early trocar hernia*	Not reported
			94.4% complete remission at 2 years		
			5.6% partial remission at 2 years		
		TBWL 25.8% at 2 years	HbA1c 5.5 ± 0.6% at 1 year;		
			5.7 ± 0.8% at 2 years		
		EWL 70.7% at 1 year			
		EWL 81.6% at 2 years			
Dijkhorst, 2018 (Netherlands) [35]	45.6 ± 6.9	TBWL 21.5 ± 8.1% at 1 year	N/A	3 re-admission	1 incisional hernia*
		TBWL 26.4 ± 10.4% at 2 years			1 anastomotic leak*
				1 abscess*	2 revision procedures–re-sleeve*
					1 Severe chronic diarrhea*
					2 choleodocholithiasis*
					16 anemia (34%)
					13 vitamin D deficiency (28%)
					3 secondary hyperparathyroidism (7%)
					3 Hypocalcemia (7%)

Table 1 (continued)

Cottam 2018 (USA) [36]	49.6 ± 9	EWL 78.3 ± 21% at 1 year	HbA1c < 6% in 90%	57 Early complications	11 stricture (11 EGD dilation; 4 multiple dilations)
		EWL 86.7 ± 24.5% at 2 years			10 diarrhea
		EWL 86.1 ± 27.5% at 3 years	HbA1c < 5.7% in 81%	4 vomiting	5 malnutrition
				1 constipation	3 cholelithiasis
				1 Diarrhea	2 cholecystitis
				1 hypotension	1 afferent loop syndrome
				2 dizziness	1 afferent loop kink
				1 ketoacidosis	3 gastric outlet obstruction
				1 bradycardia	2 small bowel perforation*
				4 ileus	2 GERD
				2 portal vein thrombosis	1 dilated fundus
				2 drain bleed	19 re-operation* (4 multiple re-operations; (4 common channel lengthening*; 1 common channel shortening*)
				3 abdominal hematoma	11 abnormal vitamin D at 2 years
				8 wound infection	10 abnormal vitamin B at 2 years
				2 abscess	4 abnormal calcium at 3 years
				1 gastric perforation	2 abnormal albumin at 2 years
				2 leak	
				1 bowel obstruction	
				1 small bowel perforation	
				1 cholecystitis	
				8 re-operations*	
Neichoy, 2018 (USA) [37]	52.4 ± 9.1	TBWL 37 ± 9.4% at 1 year	88.8% remission	5 anastomotic leak (3 underwent re-operation* 1 converted to BPD/DS who developed small bowel leaks secondary to open abdomen; 2 percutaneous drainage)	5 diarrhea (4 underwent common channel lengthening*)
		EWL 71.3 ± 20.4% at 1 year		1 small bowel injury	3 edema (1 required common channel lengthening*)
		TBWL 41.8 ± 11.3% at 18 months		3 stricture of (hand-sewn) anastomosis who required endoscopic dilation	3 malnutrition (1 required common channel lengthening*; 1 required feeding tube; 1 J tube)
		EWL 81.1 ± 23.7% at 18 months		2 deaths (1 secondary to PE; 1 due to small bowel leaks).	1 stricture
		TBWL 47.8 ± 10.4% at 2 years			2 dysphagia due to sleeve stricture (both converted to RYGB*)
		EWL 88.7 ± 20.3% at 2 years			1 superior mesenteric venous thrombosis
					1 liver abscess

Table 1 (continued)

					2 deaths related to surgery
Ceha, 2018 (Netherlands) [38]	57.5 ± 7.6	TBWL 10.6% at 12 months from revision	2 (22%) patients with complete remission 1 (11%) patient improved	1 anastomotic leak 1 bleeding 2 re-operations* 5 emergency visits 11 defecation problems	6 vitamin D deficiency
Zaveri, 2018 (USA) [39]	49.8 ± 8.8	EWL 77.7 ± 20.9% at 1 year EWL 85.9 ± 24.3% at 2 years EWL 83.1 ± 25.5% at 3 years EWL 85.8 ± 27.4% at 4 years 93.1% EWL > 50% at 4 years	78.6% complete remission at 1 year 77.8% complete remission at 2 years 81.3% complete remission at 3 years 81.3% complete remission at 4 years 97.6% partial or complete remission at 4 years HbA1c < 6% in 52/55 (94.5%) patients at 4 years	36 early complications 10 nausea 10 wound infection 8 readmission 6 Re-operations* 6 bleeds (4 with operative management*, 2 conservative) 2 intra-abdominal abscess (1 requiring percutaneous drainage; 1 peritoneal lavage*) 2 portal vein thrombosis 1 anastomotic leak* 1 small bowel injury* 1 DKA 1 dehydration with readmission 1 mortality	78 long-term complications 25 secondary hyperparathyroidism 13 stricture (8 endoscopic dilatation; 5 partial gastrectomy*) during the first year 12 nausea/vomiting 9 diarrhea (7 common channel lengthening*) 6 hypocalcemia 4 afferent limb syndrome* 2 dilated fundus* (partial gastrectomy) 1 constipation 1 chronic wound infection 1 malnutrition* (common channel lengthening) 1 hypoproteinemia* (common channel lengthening) 1 reversed loop* (converted to RYGB) 1 non-specific abdominal pain* (laparotomy-adhesiolysis) 2 mortalities (1 cardiovascular-related; 1 respiratory failure)
Surve, 2018 (USA, Spain, Australia) [40]	51.6	N/A	N/A	9 (0.6%) anastomosis leak	2 (0.1%) bile reflux 5 (0.3%) anastomosis stricture 2 (0.1%) ulcer
Pereira, 2019 (Portugal) [41]	52 ± 3.7 48.9 ± 4.1	TBWL 42.3 ± 5.7 EBMIL 82.1 ± 12.2	Patients with T2DM were excluded. 100% remission.	1 duodenal leak 1 hemoperitoneum 1 sleeve leak * N/A 1 duodenal stump leak*	N/A 50% abnormal calcium at 1 yea

Table 1 (continued)

Moon, 2019 (USA) [42]		TBWL 25% at 1 year (mixed with BPD/DS patients) TBWL 25.7% at 2 years (mixed with BPD/DS patients)		1 sleeve leak*	100% abnormal hemoglobin at 2 years 25% abnormal albumin at 1 year 100% abnormal vitamin D at 2 years 50% secondary hyperparathyroidism at 2 years 1 malnutrition and dysphagia (common channel lengthening*)
Moon, 2019 (USA) [43]	53.4 ± 9.4	TBWL 20.1% at 1 year (mixed with RYGB and BPD/DS patients) TBWL 18.8% at 2 years (mixed with RYGB and BPD/DS patients)	100% remission	Not reported	Not reported
Zaveri, 2019 (USA) [44]	42.8 ± 9.2	EWL 65% at 1 year EWL 65.6% at 2 years TBWL 20% at 1 year TBWL 20.5% at 2 years	93.7% partial or complete remission at 1 year 81.2% complete remission at 1 year 12.5% improvement at 1 year 94.5% HbA1c < 6% at 1 year	3 wound infection (1 re-operation*) 2 nausea	4 chronic diarrhea 1 afferent limb syndrome* 1 stricture (endoscopic dilation) 9 abnormal calcium levels 19 secondary hyperparathyroidism 22 abnormal vitamin D 10 abnormal vitamin K1
Pearlstein, 2019 (USA) [45]	Primary group: 46 ± 6 Revision group: 45.8 ± 6.8	Primary group: EWL 68 ± 29% at 12 months EWL 83.2 ± 28 at > 12 months Revision group: EWL 57.2 ± 10.3% at 12 months EWL 70.6 ± 13.8% at > 12 months	Revision group: mean HbA1C at last follow-up 5.4%	1 bowel perforation* (revisional group)	1 incarcerated incisional hernia* (revisional group)
Enochs, 2019 (USA) [46]	48.2 ± 8.1	EWL 83.3 ± 20.4% at 1 year EWL 88.6 ± 20 at 2 years	Mean HbA1c: 5.1 ± 0.8% at 1 year Mean HbA1c: 4.9 ± 0.7% at 2 years	NA	17% abnormal vitamin D at 2 years 2.8% Abnormal albumin at 2 years 33.8% Abnormal ferritin at 2 years 23% abnormal iron at 2 years. Others NA
	47.4 ± 5.7			2 abdominal abscess (that required percutaneous drainage)	4 new onset GERD

Table 1 (continued)

Cottam, 2020 (USA) [47]		EWL 54.5 ± 16.2% at 6 months	96.3% complete remission at 1 year		
			Mean HbA1c at 1 year: 5.3%	1 pancreatitis (not related to surgery)	1 abnormal serum calcium at 1 year
		TBWL 28.2 ± 6.3% at 6 months			43% of secondary hyperparathyroidism at 1 year
		EWL 70.5 ± 18.2% at 1 year			53% vitamin D insufficiency
		TBWL 36.6 ± 8.1% at 1 year			5% of hypoalbuminemia
					1 death (CArdiac arrest–not related to surgery)
					1 chylous fistula* (not related to surgery)
					1 afferent limb syndrome* (Pexy of afferent limb)
					4 cholelithiasis*
Surve, 2020 (Australia) [48]	43.2 ± 5.7	TBWL 34.6 ± 9.2% at 1 year	94.2% remission	4 Short-term complications	Not reported
			5.7% improved	2 bleeding (conservatively managed)	8 abnormal vitamin B12
		EWL 69.2 ± 164% at 1 year		1 DKA (readmitted to ICU)	4 abnormal ferritin
		TBWL 38.8 ± 9.9% at 2 years		1 hypoxemia related to obesity hypoventilation syndrome	6 abnormal serum calcium
		EWL 77 ± 15.7% at 2 years			
Finno, 2020 (Spain) [49]	50.9 ± 6.3	EWL 74.7 ± 17.1% at 2 years	85.7% remission at 2 years	24 short-term complications	2 internal hernia*
		TBWL 37.5 ± 9.6% at 2 years		1 duodeno-ileal anastomosis leak	2 incisional hernia
				2 duodenal stump leak	1 adherence bowel occlusion
				1 gastric leak	10 (5.6%) symptomatic GERD (3 bile reflux*)
				7 hemoperitoneum 2 intraluminal bleeding	5 revisional surgery* (all converted to BPD/DS; 3 due to bile reflux; 2 due to insufficient weight loss)
				1 pancreatitis	
				1 death due to post-operative hemoperitoneum	
				13 Re-interventions*	
Ruan, 2017 (China) [50]	27.7 ± 2.5 (non-obese or grade I obese patients)	BMI 21.8 ± 1.7 at 12 months	57.1% complete remission at 4 years	1 anastomotic bleed	3 occasional fatty diarrhea
		BMI 22.4 ± 1.7 at 24 months	14.3% complete remission at 6 months, relapse at 12 months		1 iron deficiency anemia
		BMI 23.1 ± 1.4 at 48 months	28.6% improvement at 4 years		3 mild hair loss

Table 1 (continued)

Ser, 2018 (Taiwan) [51]	34.2 ± 5.9	TBWL 25.9% at 1 year	52.5% complete remission at 1 year	15 minor complications	19 GERD (11 underwent revision*–5 underwent to hiatal hernia repair and 6 converted to RYGB)
		TBWL 22.8% at 2 years	14.4% partial remission at 1 year	7 major complications* (4 leak, 2 major bleeding, 1 respiratory failure/acute respiratory distress syndrome)	2 weight regain and T2DM relapse (converted to RYGB)*
		TBWL 22.5% at 5 years	11.9% improvement at 1 year		2 symptomatic gall stone*
		EWL 83.1% at 1 year	36.5% complete remission at 5 years		1 ileus (intestinal obstruction)*
		EWL 76.1% at 2 years	HbA1c 6.2% at 1 year		1 peritonitis*
		EWL 58.6% at 5 years	HbA1c 6.5% at 5 years		1 umbilical hernia*
Li, 2018 (China) [52]	29.4 ± 1.1	EWL 94.78 ± 11.49 at 6 months EWL 102 ± 12.03 at 1 year	HbA1c 6.17 ± 0.4 at 1 year	8 Nausea and vomiting	N/A
Nor Hanipah, 2019 (Taiwan) [53]	30.2 ± 5.1	TBWL 17.6 ± 7.8 kg at 2 years	38% complete remission at 2 years	5 bleeding (1 required operative management*)	2 incisional hernias*
		EWL 78.5% at 2 years	16% partial remission at 2 years	2 leak* (revised to RYGB)	
			77% glycemic control (Hba1c < 7%)	2 sleeve strictures*	
			Mean HbA1c 6.4% at 2 years		
Lin, 2019 (China) [54]	26.5 ± 2.8	TBWL 23.6% at 1 year	75% remission at 1 year	1 anastomotic leak* (revised to RYGB)–(excluded for the analysis)	5 underweight–no associated deficiencies
	(non-obese or grade I obese patients)	TBWL 20.3% at 3 years	68.4% remission at 3 years		10 hypocalcemia at 1 year
			1 relapse at 3 years		13 vitamin D deficiency at 1 year (16 at baseline)
			Mean HbA1c 6.3 ± 0.9% at 3 years		7 anemia at 1 year
Sessa, 2019 (Italy) [55]	51.2 ± 8.9	EWL: 20.8 ± 20.5			
		At mean follow-up of 8.3 ± 3.6 months.	Patients with T2DM were excluded	No complications were reported	N/A
Case reports					
Huang, 2015 (Taiwan) [56]	29 and 31 kg/m^2	26 and 28 kg/m^2	NR	None	N/A
Karcz, 2013 (Germany) [12]	N/A	N/A	N/A	N/A	N/A
				Videosurgery article, detailing technique of DJOS-GP, DJOS-SG, DIOS-GP, and DIOS-SG. Review of literature performed. No outcomes reported.	

Table 1 (continued)

Summerhays, 2016 (USA) [57]	N/A	N/A	N/A	Internal hernia*	
Vilallonga, 2015 (Spalin) [58]	34.3–46.5	BMI 28–33 kg/m^2	One patient with T2DM at baseline had lower insulin requirements at follow-up.		N/A
Chiappetta, 2017 (Germany) [59]	53.4	%TBWL: 20.0	NR		Intractable reflux and weight regain
Tsai, 2018 (Taiwan) [60]	N/A	N/A	N/A	2 gastroesophageal leaks (Endoscopic stent placement)	N/A
Vilallonga, 2017 (Spain) [61]	49.9 (range 43.2–55.3) at SADI-S 24.8 (range 20.4–28.2) reversal	4 patients Weight regain from reversal +BMI: 9.8 (range + 6.5−+ 12.1)	N/A	1 intra-abdominal fluid collection requiring percutaneous drainage	Severe protein-calorie malnutrition* Multiple nutritional deficiencies* Severe diarrhea*
Kirkpatrick, 2018 (USA) [62]	69	TWL 54.8% EWL 83%	N/A	None	Liver cirrhosis Hypoalbuminemia

BMI body mass index, *T2DM* type 2 diabetes mellitus, *SADI-S* single anastomosis duodeno-ileal bypass with sleeve gastrectomy, *SIPS* stomach intestinal pylorus–sparing surgery, *N/A* non available, *RYGB* Roux-en-Y gastric bypass, *CC* common channel, *TWL* total weight Loss, *EWL* excess of weight loss, *OAGB/MGB* one anastomosis gastric bypass/mini-gastric bypass, *BPD/DS* biliopancreatic diversion with duodenal switch, *EBMIL* excess of body mass index loss, *LAGB* laparoscopic adjustable gastric banding, *PE* pulmonary embolism, *DKA* diabetic ketoacidosis, *GERD* gastroesophageal reflux disease, *ICU* intensive care unit, *SADJB-SG* single anastomosis duodeno-jejunal bypass with sleeve gastrectomy, *LDJB-SG* loop duodeno-jejunal bypass with sleeve gastrectomy

^ Indicates shared patients between studies as mentioned in the table.

Secondary

There are 13 case series that include revisional patients (detail in Table 1). In total, there are 347 patients included in these reports. Again, this is an over-estimation due to shared patients between the reports of Sanchez-Pernaute, Torres, and Zaveri [44].

The weight loss achieved appears to be similar to primary patients. Whilst one report had revisional patients included at 5 years [27], the majority of reports were limited to 2-year follow-up.

The effect on T2DM appears similar to the primary procedures.

Early complications were uncommon in all series with anastomotic leaks, bleeding, and nausea being the predominant issues. Late complications were nutritional with several reports of hypoalbuminemia and iron deficiency. GERD was also reported as was dumping syndrome and flatulence. A long-term need for re-operation has not been reported although revisional procedures have been described [25].

Discussion

Since the last position statement was released, there have been a further 25 case series and 3 case reports published looking at the outcomes of SADI-S/OADS. There are currently no higher levels of evidence from randomized controlled trials nor population level registry data. There is at least a moderate risk of bias in all but one of the papers identified in our systematic review, and the recommendations within this position statement must be considered with this limitation in mind.

The current evidence suggests that SADI-S/OADS can help a person with obesity achieve and maintain significant weight loss with an improvement in metabolic health. The papers published since the last IFSO statement confirm this finding, with evidence now out to 5 years in 4 primary case series.

Nutritional issues including malnutrition, hypoalbuminemia, iron deficiency, hypocalcemia, low vitamin D, and hyperparathyroidism have now been reported in both primary and revisional series as outlined in Table 1. This finding emphasizes the need to maintain patients who have undergone a SADI-S/OADS procedure in a lifelong follow-up program.

Bile reflux appears to be an uncommon problem; however, it is variably reported. The impact of limb length is also variably reported. In this respect, it is perhaps important to note that more recent publications report increasing lengths of the common channel (i.e., 250–300 cm or even 400 cm [51] versus 200 cm initially [25]). There remain clinical concerns about both of these issues; however, more data is needed to better inform practice. More data is also required on the importance of pylorus preservation.

As the obesity treatment modalities continue to advance, certain basic principles such as respect for evidence, ethical commitment, use of accepted methodology for data analysis, and inclusion of patients in proper protocols remain as fundamental requirements. IFSO is engaged in developing and implementing new therapeutical options according to these standards.

Recommendation of the IFSO SADI-S/OADS Taskforce

Based on the existing data we recommend the following:

1. SADI-S/OADS offers substantial weight loss that is maintained into the medium term
2. SADI-S/OADS provides an improvement in metabolic health that is maintained into the medium term
3. Nutritional deficiencies are emerging as long-term safety concerns for the SADI-S/OADS procedure and patients undergoing this procedure need to be aware of this, and counseled to stay in long-term multidisciplinary care.
4. Surgeons performing the SADI-/OADS, as well as other bariatric/metabolic procedures, are encouraged to participate in a national or international registry so that data may be more effectively identified.
5. IFSO supports the SADI-S/OADS as a recognized bariatric/metabolic procedure, but highly encourages RCT's in the near future.

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Compliance with Ethical Standards

Conflict of Interest Dr. Wendy Brown reports grants from Johnson and Johnson, grants from Medtronic, grants from GORE, personal fees from GORE, grants from Applied Medical, grants from Apollo Endosurgery, grants and personal fees from Novo Nordisc, and personal fees from Merck Sharpe and Dohme, outside the submitted work.

Guillermo Ponce de Leon Ballesteros reports no conflicts of interest.

Dr. Geraldine Ooi reports no conflicts of interest.

Dr. Kelvin Higa reports no conflicts of interest.

Dr. Jacques Himpens is a consultant with Medtronic and Johnson and Johnson.

Dr. Antonio Torres reports no conflicts of interest.

Dr. Scott Shikora reports no conflicts of interest.

Dr. Lilian Kow reports no conflicts of interest.

Miguel F. Herrera reports no conflicts of interest.

Ethics Statement Ethical approval is not required for this type of study.

Patient Consent Patient consent is not required for this type of study.

Appendix 1. Members of the IFSO-appointed task force reviewing the literature on SADI-DS/OADS

Geraldine Ooi–Australia.
Wendy Brown–Australia.
Lilian Kow–Australia.
Antonio Torres–Spain.
Jacques Himpens–Belgium.
Miguel Herrera–Mexico.
Guillermo Ponce de Leon Ballesteros–Mexico.
Scott Shikora–USA.
Kelvin Higa–USA.

Appendix 2

Table 2 List of search terms used

Duodenal switch	Single anastomosis	Pylorus preserving
Duodeno-jejunostomy	One anastomosis	Pylorus sparing
Duodeno-ileostomy	Billroth II	Pyloric sparing
Duodenoileal bypass	Single loop	Pyloric preserving
Duodenojejunal bypass	Loop	
Biliopancreatic diversion, BPD	Stomach intestinal pyloric sparing surgery omega	
Gastric bypass		
Sleeve gastrectomy		
Bariatric surgery		

SAPPP single anastomosis pylorus–preserving procedure; *LDJB-SG* single anastomosis duodenal switch, loop duodeno-jejunal bypass with sleeve gastrectomy; *SADJB-SG* single anastomosis duodeno-jejunal bypass with sleeve gastrectomy; *SADI-S, SADI* mini-duodenal switch, mini-gastric bypass, single anastomosis duodeno-ileal bypass with sleeve gastrectomy; *LDS, DJB-SG* single anastomosis loop duodenal switch; *DIOS-SG* pylorus-preserving loop duodeno-ileostomy with sleeve gastrectomy; *DJOS-SG* pylorus-preserving loop duodeno-jejunostomy with sleeve gastrectomy

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