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SADI-S: personal experience after 8 years

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Abstract

Aim: Biliopancreatic diversion with duodenal switch (BPD-DS) was simplified by the single anastomosis duodeno-ileal bypass with sleeve gastrectomy (SADI-S). It reduces the surgical duration and postoperative complications while maintaining effectiveness in weight loss and mitigating comorbidities.

Methods: This study aims to report personal experiences regarding short- and medium-term outcomes 8 years after the introduction of SADI-S in clinical practice and compare these with the current literature evidence.

Results: At our center, 4,854 bariatric procedures were executed from July 2016 to October 2024, with 157 (3.2%) patients undergoing SADI-S/SADI. This included 104 (66.2%) primary SADI-Ss, 8 (5.1%) conversions to SADI-S, and 45 (28.7%) SADI procedures. Conversion to SADI-S was planned in eight out of 157 after adjustable gastric banding (6 cases) and Roux-en-Y gastric bypass (2 cases). Median age and preoperative body mass index (BMI)

were 46 (40-53) years and 51.6 (46.7-56.7) kg/m^2, respectively. The median surgical duration was 120 min, with an interquartile range of 100 to 160 min. Reoperation was required for two of the four patients (2.5%) who experienced early postoperative complications. Furthermore, 5 (3.1%) patients developed late complications. At a median follow-up of 23 (12-31) months, the median %TWL, %EWL, and BMI were 42 (29.3-52.4), 82 (59.1-99.4), and 27.3 (21.2-33) kg/m^2, respectively. Seven years of follow-up were eligible in 13 out of 157 patients: median %TWL, %EWL and BMI were 43 (40.1-52.7), 69 (66.4-85.6), and 31.1 (26.2-32.2) kg/m^2, respectively.

Conclusion: SADI-S is regarded as an effective primary and conversion operation, balancing bariatric and metabolic outcomes with early and late complications.

Keywords: SADI-S, SADI, bariatric outcomes, long-term outcomes, learning curve, robotic SADI-S, complications

INTRODUCTION

Obesity remains one of the most challenging diseases to treat effectively[1]. Bariatric surgeons can choose from a variety of procedures, ranging from restrictive approaches to hypoabsorptive ones[2]. Although patients classified as obesity classes IV and V represent only a small fraction of those who undergo bariatric surgery, they are the most difficult to manage[3]. Indeed, some evidence suggests that hypoabsorptive procedures, like biliopancreatic diversion with duodenal switch (BPD-DS), are associated with better outcomes and comorbidity resolution rate compared to restrictive and mixed approaches[4,5]. However, such procedures are more technically demanding and are more appropriate in complex high-risk patients, especially those in classes IV and V[3,6].

The "proximal duodenal-ileal end-to-side bypass with sleeve gastrectomy", also known as the "single anastomosis duodeno-ileal bypass with sleeve gastrectomy" (SADI-S), was proposed by Sánchez-Pernaute and Torres in 2007 as a simplified alternative to the BPD-DS[7]. Unlike the BPD-DS, it involves only a single anastomosis, as it utilizes an omega loop reconstruction technique[7]. Compared to BPD-DS, the technical requirements of SADI-S result in a shorter operating time, which in turn can reduce postoperative complications and result in a shorter hospital stay[8,9]. Moreover, despite Roux-en-Y gastric bypass being one of the most commonly performed bariatric procedures worldwide, it is often associated with postoperative issues, such as reactive hypoglycemia and dumping syndrome, conditions that are less likely when the pylorus is preserved[9,10]. Nonetheless, since SADI-S does not require the stomach to be excluded, it can be effectively performed in patients with gastric dysplasia, metaplasia, or chronic gastritis[11].

The study by Sánchez-Pernaute *et al.* reported the therapeutic advantages of a longer common channel in reducing diarrhoea and malabsorption, following the initial description of the procedure[8,12]. Therefore, this derivative approach might be suitable for a broader range of patients. It has been well documented that SADI-S has comparable mid-term effectiveness to BPD-DS with respect to clinical response and comorbidities resolution[13,14].

Moreover, SADI-S can be performed as the second step of a two-stage procedure, one year after sleeve gastrectomy (SG)[10,15]. Nevertheless, it may also be carried out as a conversion procedure following other bariatric surgeries in cases of suboptimal clinical outcomes[16-18].

The encouraging medium-term results have been referenced in the position statements endorsed by both the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO)[9] and the American Society for Metabolic & Bariatric Surgery (ASMBS)[19]. As a result, SADI-S has gained international recognition as a reliable and safe bariatric procedure.

Furthermore, the increasing availability of novel robotic platforms has enhanced its appeal by offering outcomes similar to laparoscopy while reducing some of the technical difficulties associated with the procedure[20].

Our study aims to present our experiences regarding short- and medium-term outcomes over an eight-year period since the introduction of SADI-S in clinical practice, and to compare these results with the existing literature.

METHODS

A retrospective cross-sectional study was conducted at our referral center for bariatric and endocrine surgery, involving patients who underwent SADI-S as either a primary or conversion procedure between July 2016 and October 2024.

Data from each patient scheduled for bariatric surgery were prospectively collected and stored in a de-identified database, after obtaining informed consent for scientific studies. Clinical and demographic information was obtained from patient records and electronic databases.

The inclusion criteria encompassed all patients who underwent SADI-S, whether as a primary or conversion procedure from a previous bariatric surgery. No exclusion criteria were applied.

The primary endpoint was the incidence of early postoperative complications, occurring within 30 days. Secondary endpoints included late complications and overall clinical outcomes. Moreover, the learning curve has been assessed.

This research complied with the ethical standards of the Helsinki Declaration. We secured ethical approval from our Local Ethical Committee (Comitato Etico Territoriale Lazio Area 3, ID: 5538), and each participant provided informed consent.

For this retrospective analysis, the follow-up ended on 30th November 2024.

The indications for bariatric surgery and for SADI-S/SAD, including details of the preoperative workup, have been previously described[6,20]. Any identified nutritional deficiencies were addressed and corrected prior to surgery.

The technical aspects of the surgical procedures - laparoscopic/robot-assisted SADI-S/SADI- have also been thoroughly described in previous reports[6,20]. Nonetheless, certain information still needs to be documented. SADI-S is performed as a primary bariatric procedure: beginning with a SG, followed by the duodenum transition and concluding with the duodenum-ileal anastomosis. In contrast, SADI is a conversion surgery for patients who have previously undergone a SG; thus, only the duodenum transition and duodenum-ileal anastomosis are performed. In all cases, the common channel length was standardized to 300 cm [Figure 1]. All robot-assisted procedures in this series were performed using the DaVinci Xi platform. Since January 2024, a robotic stapler device has been routinely introduced into our clinical practice. All procedures included in the present study were carried out by the same experienced surgeon (M.R.).

The postoperative protocol management, including discharge criteria and follow-up strategy, has also been previously described[6,20].

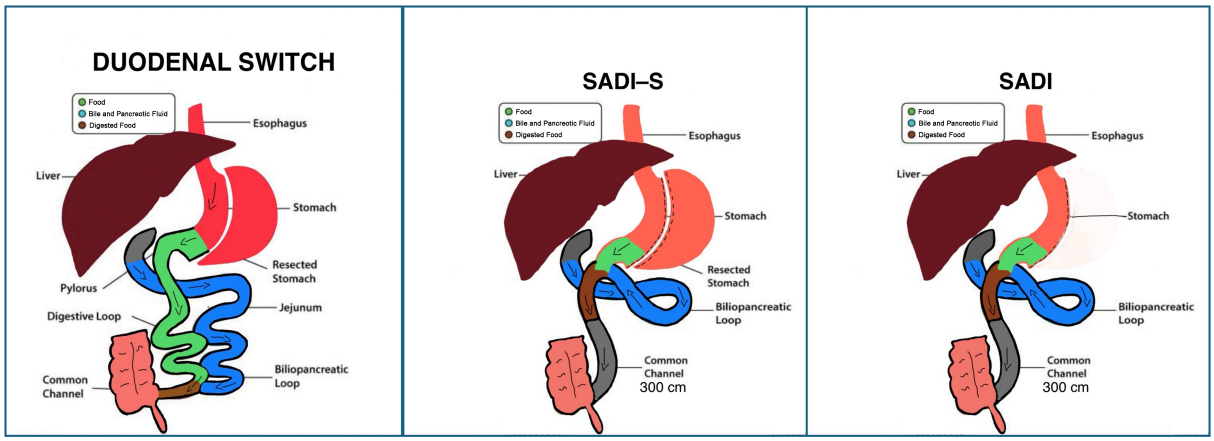

Figure 1. Images of duodenal switch, SADI-S, and SADI. SADI-S: Single anastomosis duodeno-ileal bypass with sleeve gastrectomy; SADI: single anastomosis duodeno-ileal bypass in previously sleeve gastrectomy.

Preoperative data included demographic characteristics [age, body mass index (BMI), sex as assigned at birth] and comorbidities. Operative parameters included per protocol the surgical technique employed (laparoscopic or robot-assisted), type of procedure performed, including primary SADI-S, conversion to SADI-S, or SADI, and operative time (OT). Postoperative variables included the need for intensive care unit (ICU) admission, early (within 30 days) and late postoperative complications, and bariatric outcomes.

OT was defined as the interval from skin incision to wound closure. For robot-assisted surgeries, OT also includes docking time. The severity of postoperative complications was ranked according to the Clavien-Dindo classification[21].

Continuous variables were expressed using the median with interquartile range (IQR), while dichotomous variables were reported as numerical values and percentages.

To assess the learning curve of SADI-S/SADI in terms of Textbook Outcomes (TOs), we utilized the cumulative sum (CUSUM) analysis[22]. Following the methodology outlined by Wang *et al.*, we used TOs to assess the clinical outcomes of laparoscopic/robot-assisted SADI-S/SADI[23]. Specifically, TOs were defined by the fulfillment of the following criteria:
- OT less than or equal to the third quartile specific to the surgical approach (laparoscopic/robot-assisted SADI-S/SADI);
- postoperative hospital stay less than or equal to the third quartile;
- complication grade lower than Dindo–Clavien grade II;
- no conversion, no readmission or postoperative mortality.
When all these conditions were met, TO was recorded.

Statistical analysis was performed using Stata version 18.0 (StataCorp, College Station, Texas 77845 USA). The probability threshold was set at a *P*-value of < 0.05.

RESULTS

Among the 4,854 bariatric procedures performed at our center between July 2016 and October 2024, 157 (3.2%) patients underwent SADI-S/SADI. Specifically, 104 (66.2%) primary SADI-Ss, 8 (5.1%) conversions to SADI-Ss, and 45 (28.7%) SADIs were carried out, respectively. Conversion to SADI-S was planned in

eight patients following previous procedures: six after adjustable gastric banding and two after Roux-en-Y gastric bypass. In the latter two cases, conversion was planned six months after surgical restoration of gastric and small bowel anatomy.

Table 1 summarizes the key demographic and clinical characteristics of the study population.

We enrolled 53 (33.8%) males and 104 (66.2%) females, with a median age of 46 (IQR: 40-53) years and preoperative BMI of 51.6 (IQR: 46.7-56.7) kg/m^2. For patients undergoing primary and conversion procedures, the median preoperative BMIs were 53 (IQR: 50.6-57.8) and 44.6 (IQR: 38.6-50.4) kg/m^2, respectively. Except for three cases, all conversion procedures were indicated due to weight recurrences; in these three patients, the indication for conversion surgery was a suboptimal response to the initial procedure. Comorbid conditions were present in 101 out of 157 patients. The median BMI at the time of initial bariatric surgery in patients who later underwent conversion to SADI-S/SADI was 51.4 (IQR: 44-54.4) kg/m^2, with a median interval of 63 (IQR: 37.5-93) months between the primary and conversion procedure to SADI-S/SADI.

A robotic approach was used in 35 cases (22.3%), while 122 (77.7%) procedures were laparoscopic. More in detail, we performed 78 laparoscopic SADI-Ss (49.7%), 34 robot-assisted SADI-Ss (21.6%), 44 laparoscopic SADIs (28%), and one robot-assisted SADI (0.7%).

The median OT was 120 min (IQR 100-160). When stratified by surgery procedure, median durations were: 102.5 min (IQR: 110-150) for laparoscopic SADI-S, 182.5 min (IQR: 167.5-207) for robot-assisted SADI-S, 93.5 min (IQR: 70.5-120) for laparoscopic SADI, and 120 min for robot-assisted SADI. No additional intra-abdominal procedures were conducted, and no intraoperative complications were observed. There were no conversions in our series and no 30-day mortality was reported. Early postoperative complications were recorded in four patients, of which two (2.5%) required reintervention; whereas five (3.1%) patients developed late complications. Postoperative complications of these procedures, although widely reported[6,20,24], are summarized in Table 2 and reported in extenso in the Supplementary Materials, as they represent the endpoints of this study.

At a median follow-up of 23 months (IQR: 12-31), the median %TWL, %EWL, and BMI were 42 (IQR: 29.3-52.4), 82 (IQR: 59.1-99.4), and 27.3 (IQR: 21.2-33) kg/m^2, respectively. Moreover, the median daily bowel movements were 2 (IQR: 1-3).

Table 3 shows the BMI, %TWL, and %EWL distribution at 1, 2, 3, 5, and 7 years, respectively. We used the CUSUM analysis to evaluate the experience of TOs, analyzing laparoscopic, robot-assisted SADI-Ss and SADIs together. As for the learning curve, the first 61 cases (P = 0.029) led to the breakdown of the learning curve [Figures 2 and 3].

DISCUSSION

This retrospective study supports the safety and effectiveness of SADI-S as a primary or conversion procedure in terms of complications and bariatric outcomes. We have been performing this bariatric procedure in our clinical practice since July 2016[6,20], beginning with a robotic SADI-S as our first case. Since then, laparoscopic SADI-S or SADI and robot-assisted SADI were performed in February 2017, February 2017, and March 2021, respectively[6,20]. In 2007, Sánchez-Pernaute *et al.* elaborated on a BDP-DS variation, reporting the description of SADI-S' surgical technique[7]. BDP-DS has been one of the cornerstones in the bariatric surgeons' armamentarium[25] since the 1990s when Hess[26] and Marceau[27]

Table 1. Characteristics of the study's population

Patients	157
Age (years)	46 (40-53)
Height (cm)	167 (160-172)
Weight (kg)	140 (125-160)
BMI (kg/m^2)	51.6 (46.7-56.7)
Male/female	53 (33.8%) / 104 (66.2%)
Smoking	
No	114 (72.6%)
Previously	25 (15.9%)
Yes	18 (11.5%)
Comorbidities (yes/no)	101 (64.3%) / 56 (35.7%)
HBP (yes/no)	71 (45.2%) / 86 (54.8%)
OSAS (yes/no)	58 (36.9%) / 99 (63.1%)
Diabetes	
No	112 (71.3%)
IGT	28 (17.9%)
T2DM	17 (10.8%)
Previous non-bariatric abdominal surgery	
No	72 (45.8%)
Laparoscopic	28 (17.9%)
Open	57 (36.3%)
Type of bariatric operation	
Primary SADI-S	104 (66.2%)
Conversion to SADI-S	8 (5.1%)
SADI	45 (28.7%)
Previous bariatric procedures	
No	104 (66.2%)
SG	45 (28.7%)
Adjustable gastric banding	6 (3.8%)
Roux-en-Y gastric bypass	2 (1.3%)
BMI (kg/m^2) in patients scheduled for primary SADI-S	53 (50.6-57.8)
BMI (kg/m^2) in patients scheduled for revisional SADI-S/SADI	44.6 (38.6-44.6)
BMI (kg/m^2) at the first bariatric operation in patients scheduled for revisional SADI-S/SADI	51.4 (44-54.4)
Time (months) between previous bariatric procedure and revisional SADI-S/SADI	63 (37.5-93)
Procedure performed	
Laparoscopic SADI-S	78 (49.7%)
Robot-assisted SADI-S	34 (21.6%)
Laparoscopic SADI	44 (28%)
Robot-assisted SADI	1 (0.7%)
OT (minutes)	120 (100-160)
Laparoscopic SADI-S	120.5 (110-150)
Robot-assisted SADI-S	182.5 (162-207)
Laparoscopic SADI	93.5 (70.5-120)
Robot-assisted SADI	120
ICU (yes/no)	6 (3.8%) / 151 (96.2%)
Postoperative hospital stay (days)	2 (2-3)
30-day postoperative complications (yes/no)	4 (2.5%) / 153 (97.5%)
Reoperation (yes/no)	2 (1.3%) / 155 (98.7%)
Pneumonia (yes/no)	2 (1.3%) / 155 (98.7%)
Bleeding (yes/no)	1 (0.7%) / 156 (99.3%)
Acute pancreatitis (yes/no)	1 (0.7%) / 156 (99.3%)
Trocar site hernia (yes)	1 (0.7%) / 156 (99.3%)
30-day hospital readmissions (yes/no)	1 (0.7%) / 156 (99.3%)
Late complications (yes/no)	5 (3.1%) / 152 (96.9%)
Incisional hernia (yes/no)	1 (0.7%) / 156 (99.3%)
Chronic diarrhea (yes/no)	4 (2.5%) / 153 (97.5%)

Malnutrition (yes/no)	3 (1.9%) / 154 (98.1%)
Other events (yes/no)	
Wernicke-Korsakoff syndrome	1 (0.7%) / 156 (99.3%)
Toxic megacolon	1 (0.7%) / 156 (99.3%)

BMI: Body mass index; HBP: high blood pressure; OSAS: obstructive sleep apnea syndrome; IGT: impaired glucose tolerance; T2DM: type 2 diabetes mellitus; SADI-S: single anastomosis duodeno-ileal bypass with sleeve gastrectomy; SADI: single anastomosis duodeno-ileal bypass in previously sleeve gastrectomy; SG: sleeve gastrectomy; OT: operative time; ICU: intensive care unit.

adopted DeMeester's duodenal switch for bariatric surgery to prevent the common occurrence of marginal ulcers associated with the Scopinaro procedure. Many authors indicate that BPD-DS offers significantly better bariatric outcomes than other procedures, along with longer-lasting benefits in resolving comorbidities. Nonetheless, BPD-DS is regarded as a procedure that requires significant technical expertise. Although complications are rare, the occurrence of a leakage, bleeding, or obstruction/stenosis can lead to severe effects, including prolonged hospitalization, intrabdominal infections, reinterventions, or even mortality[6,25]. Due to the considerations mentioned above, Sánchez-Pernaute *et al.* attempted to simplify the surgical technique without compromising the procedure's results[7]. Similar to its predecessor procedure, the restrictive component of SADI-S is achieved through SG, followed by the addition of a malabsorptive element through a single anastomosis between the duodenum and the ileum[7]. Both mechanisms enhance the efficacy of SADI-S: the restrictive component facilitates initial weight reduction during the first year, whereas prolonged weight loss after one year is mainly attributed to the malabsorptive aspect[28]. Regarding the primary endpoint of our study, our results show an early postoperative complication rate of 2.5%. Delving deeper, we reported two cases of pneumonia, one case of bleeding (intrabdominal collection), one case of acute pancreatitis, and one case of trocar site hernia. Thus, 2 out of 157 patients required surgical re-exploration. Our most recent systematic review[29] analyzing data from seventeen studies reported an overall early postoperative complication rate ranging from 0% to 6.7%[29], describing the following postoperative complications: leakage (15 patients), bleeding (12 patients), incisional hernia (8 patients), and reoperations (14 patients). Therefore, considering this systematic review, we can conclude that our experience is consistent with those of other authors. Aiming to understand the safety of bariatric procedures, we also focused on the late complications, reporting a rate of 3.1%. More in detail, we described 4 cases of chronic diarrhoea, 3 cases of malnutrition, 1 case of Wernicke-Korsakoff syndrome, and 1 case of toxic megacolon (2 years after the bariatric procedure, due to new-onset ulcerative colitis). Concerning long-term follow-up, Sánchez-Pernaute *et al.* reported a rate of 7.3% for reoperation due to severe malnutrition[30]. Upon further investigation of their preliminary experience, they reported seven such cases: two with a 2-m common channel, five with a 250-cm channel, and none among those with a 3-m common limb. Therefore, the length of the common channel plays a pivotal role in the malnutrition rate, balancing outcomes and complications. Postoperative malnutrition has been a subject of several researchers, including Shoar *et al.*, who performed a systematic review of 12 studies and found a lower incidence of nutrient deficiencies when the common channel is at least 3 m long[31]. Our results are similar to those reported by Cottam *et al.*[32].

The other side of the coin is the bariatric outcomes. When interpreting the clinical response, two critical covariates should be considered: time and patient adherence to diet therapy. Regarding this point, after 23 months of median follow-up, we observed median values of 27.3 kg/m^2 for BMI, 82% for %EWL, and 42% for %TWL. Palmieri *et al.* analyzed 17 studies that provide bariatric outcomes[29]. These data, however, might be impacted by the fact that most studies have an average follow-up period of two years, while only a few describe clinical outcomes beyond five years. Notably, SADI-S outcomes after ten years have been reported in only one study[30]. In all evaluated studies, the median %TWL was ≥ 25% (ideal clinical response[33]) at the 1-year follow-up, rising to 44% after 2 years and stabilizing at 3 and 5 years. Moreover, EWL ≥ 50% (the standard criterion for optimal clinical response[33]) has been recorded three months after

Table 2. Description of early and late complications

	Gender	Age (years)	BMI (kg/m^2)	Complication	Grade	Treatment
Early complications	Male	51	52.3	Severe acute necrotising pancreatitis	IV	Debridement and necrosectomy, anastomotic breakdown, gastrostomy and jejunostomy for feeding, open abdomen technique and vacuum-assisted therapy; conversion to one anastomosis gastric bypass 4 months later
	Female	41	54.6	Trocar site hernia	IIIb	Surgical revision: reduction of the herniated intestinal loop and defect closure
	Female	62	51.4	Pneumonia	II	Intravenous antimicrobial therapy
	Female	57	57.0	Intra-abdominal collection (haematoma) adjacent to stomach suture	II	Intravenous antimicrobial therapy
Late complications	Male	19	58.1	Wernicke-Korsakoff syndrome and severe malnutrition developed as a result of his noncompliance with the dietary plan and the vitamin and trace element supplement	IIIb	Conversion to Roux-en-Y gastric bypass
	Male	50	43.4	Chronic diarrhoea not associated with *Clostridium difficile*	II	Oral antibiotic therapy and supplementation with pre/probiotics
	Female	48	46.0	Electrolyte imbalance and initial malnutrition from rapid weight loss	II	Intravenous supplementation
	Female	48	51.8	Newly developed ulcerative colitis with toxic megacolon and bowel perforation	IV	Urgent total colectomy and end ileostomy
	Female	42	53.1	Sepsis brought on by pneumonia, malnutrition	V	Intravenous antimicrobial therapy, refusal to accept supplements and nutritional guidance, uncontactable during follow-up

Complications grade is reported according to the Clivien-Dindo classification. BMI: Body mass index.

surgery, thereafter increasing to 81.8%, 88%, 86%, and 83.4% at the 6 months, 1 year, 2 years, 3 years, and 5 years follow-ups, respectively. Nevertheless, the substantial reduction in BMI after 3 months, 6 months, 1 year, and 2 years (37.4, 33.7, 29.9, and 29.3 kg/m^2, respectively) exhibited a slight increase at 3 and 5 years. Furthermore, if we examine our analysis in more detail, the follow-up data [Table 3] show a nadir of bariatric results two years after the procedure. There is a plateau between 3 and 5 years, and finally, after 7 years, we see a slight weight gain. However, the number of patients eligible for different years of follow-up may partially influence these results. On the other hand, Sánchez-Pernaute *et al.* reported a similar trend, but the data should be interpreted taking into account the eligibility criteria for the study population[30]. At the same time, Surve *et al.* reported data consistent with ours, focusing on patients with more similar preoperative BMI values[13]. These discrepancies may be due to the different lengths of the common limb and the specific surgical indications for this procedure. Indeed, Sánchez-Pernaute *et al.* used a 200 cm long common channel at the beginning of their experience, which was later adjusted to 250 cm (occasionally 300 cm)[7,30]. By contrast, both our clinical practice[6,20] and the experience of Surve *et al.*[13,34] consistently employ a 300 cm common limb. Furthermore, according to current guidelines, there are no indications for specific bariatric procedures in different obesity classes[35], as can be observed in the different preoperative characteristics of the patients in the current literature. Nonetheless, to summarize, clinical outcomes associated with SADI-S are comparable to those following BPD-DS[14], and are significantly better than those of other surgeries such as gastric bypasses[36,37], particularly in patients with obesity classes IV and V.

Table 3. Distribution of BMI, %EWL, and %TWL at different follow-up time points

	1 year	2 years	3 years	5 years	7 years
Eligible patients	150	144	125	65	13
BMI (kg/m^2)	29.1 (26.3-32.8)	27.5 (24.5-31.2)	28.7 (26-30.9)	29 (27-30.5)	31.1 (26.2-32.2)
EWL (%)	73 (61.6-85.9)	82 (71.8-89.2)	79 (71-86.9)	82 (69.3-84.7)	69 (66.4-85.6)
TWL (%)	44 (33.9-51.3)	48 (40.1-54.3)	48 (41.4-54.3)	50 (41.9-54.2)	43 (40.1-52.7)

BMI: Body mass index; EWL: excess weight loss; TWL: total weight loss.

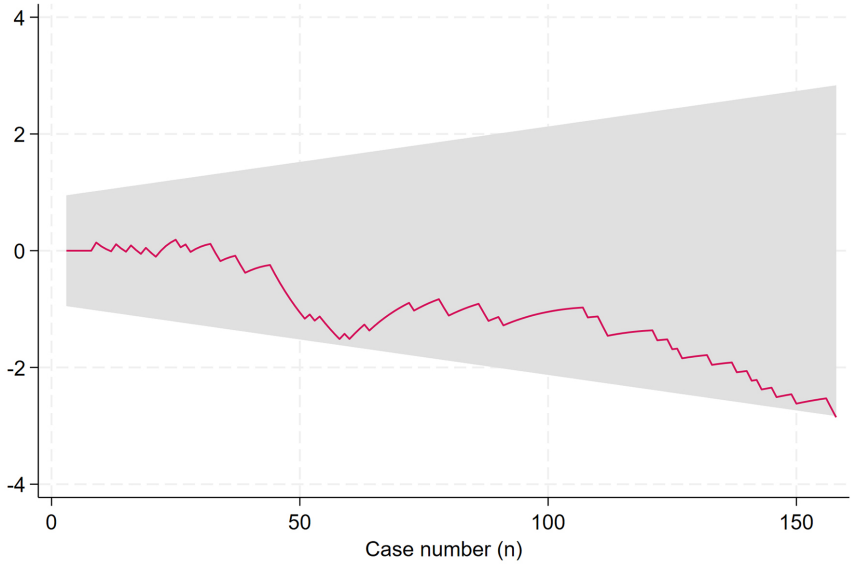

Figure 2. Recursive CUSUM plot of TOs with 95% confidence bands around the null. CUSUM: Cumulative sum; TOs: Textbook Outcomes.

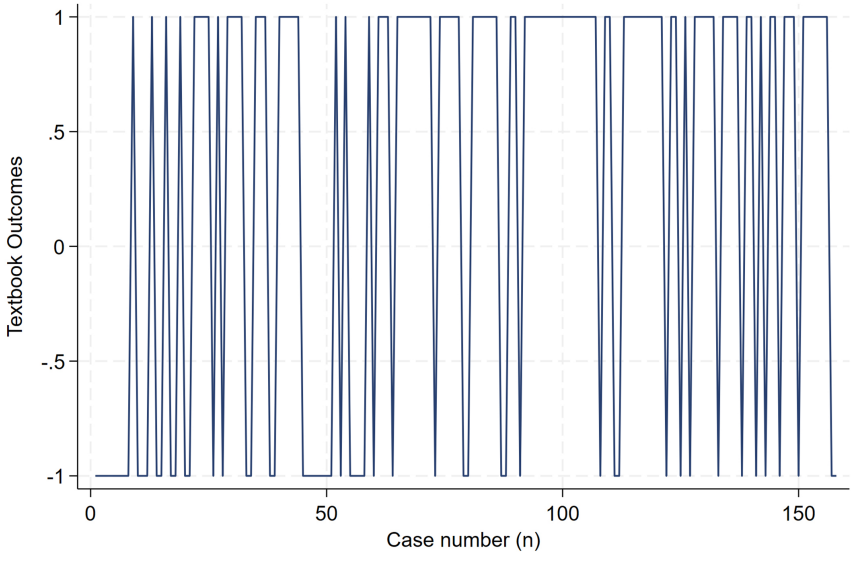

Figure 3. Case number series plot of TOs. TOs: Textbook Outcomes.

We are aware that the primary SADI-S is a niche surgery. The main indication for the primary SADI-S includes patients with classes IV and V obesity, especially in the presence of comorbidities. The contraindications are consistent with those applicable to all malabsorptive procedures, including organ transplantation, severe renal and hepatic impairment, intestinal bowel disease, and celiac disease[12]. On the other hand, suboptimal clinical response or weight gain after another bariatric surgery poses indications for conversion to SADI-S. In addition, SADI-S can be planned as a two-stage procedure in selected patients, such as class IV or V obesity or cases with intraoperative findings justifying this approach (hepatomegaly or severe intra-abdominal adhesions), as well as in comorbid complex cases without a higher BMI risk but an increased risk of postoperative complications. There is still no consensus in the literature[38-40] regarding the interval between the two procedures in a planned two-stage surgery, which can vary from 12 months to several years[15].

Closely related to these aspects, some technical considerations about the operation must be addressed. In our previous studies, we defined SADI-S as a complex bariatric procedure given that it is performed in challenging patients such as obesity classes IV and V. In addition, a multi-quadrant abdominal exploration and hand-sewn anastomotic reconstruction are required[6,20]. Laparoscopy presents some technical restrictions in class V obese patients. Transection of the duodenum can be difficult, and a single anastomosis is carried out between the duodenum and the ileum using an end-to-side hand-sewn technique. Enhanced proficiency and accuracy in tissue handling, especially in anatomically challenging areas, are the main advantages of a robotic platform, especially in complex multi-quadrant procedures like SADI-S. Therefore, robotic platforms might be the optimal technology for SADI-S-eligible patients with class V obesity[41]. Regrettably, illustrating certain benefits of robotic technology, such as less surgeon fatigue, is intricate due to their inability to be linked with a measurable metric.

Nevertheless, we first demonstrated the safety of the robotic approach to SADI-S compared to the laparoscopic one regarding postoperative complications[20]. Despite that, our recent analysis confirms that robotic SADI-S has been associated with longer OTs.

Lastly, we analyzed the procedure's learning curve regarding TO using the CUSUM analysis, identifying a change point after the first 61 cases. Our previous manuscript[20] described the learning curve for both laparoscopic and robotic procedures, indicating that the OT for robotic SADI-S significantly decreased after 7 cases, whereas the OT for laparoscopic SADI-S decreased after 47 cases. However, we could not identify a definitive inflection point in the learning curves for laparoscopic SADI-S. It is also important to consider the sequence in which the different procedures were conducted at our center. Notably, the eighth robotic SADI-S case was performed after 60 laparoscopic cases, suggesting a likely cumulative and cross-influential learning effect between the two modalities[20]. Similar to our findings, Wang *et al.* reported that 58 cases were required to overcome the learning curve for robotic SADI-S[23]. Nonetheless, it must be pointed out that all procedures in our study were performed by a single surgeon, which limits the generalizability of results. It is therefore key to note that results may vary depending on the surgical team or institutional context.

This study has several limitations that should be noted. First, it is a retrospective study over a long period. Given that SADI-S is a niche procedure, we would like to emphasize the small sample size and heterogeneous follow-up. The median follow-up duration was approximately 2 years, with only a small proportion of patients followed for 5 and 7 years (41.4% and 8.3%, respectively). Therefore, the long-term results should be interpreted with caution. Nevertheless, to our knowledge, this is the first national, single-center retrospective study reporting 8 years of experience with this bariatric surgery.

In conclusion, SADI-S is an effective bariatric treatment that can be employed as both a primary and conversion operation for weight gain or suboptimal clinical response. It integrates restrictive and malabsorptive elements, resulting in fewer malnutrition-related complications compared to BPD-DS. Much attention must be paid to postoperative follow-up, especially for patients not adhering to their supplement regimen. Further studies with extended follow-up, larger sample sizes, and randomized controlled designs remain essential to corroborate these findings.

DECLARATIONS

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Authors' contributions

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All authors have read and agreed to the published version of the manuscript.

Availability of data and materials

The data supporting the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and ethical restrictions.

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None.

Conflicts of interest

Pennestrì F, Procopio PF, Gallucci P, Laurino A, Greco F, Ciccoritti L, Giustacchini P, and Raffaelli M are advisory consultants for Medtronic (Minneapolis, Minnesota, USA). Additionally, Raffaelli M serves as an advisory consultant for Intuitive Surgical (Sunnyvale, California, USA) and AbMedica (Cerro Maggiore, Milano, Italy). All the authors declared that they received no funding for this study. The other authors declared they have no conflicts of interest.

Ethical approval and consent to participate

This study was conducted in accordance with the ethical guidelines of the Helsinki Declaration. Ethical approval was obtained from Comitato Etico Territoriale Lazio Area 3 (ID: 5538). Written informed consent for publication was obtained from all participants.

Consent for publication

Not applicable.

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