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ORIGINAL ARTICLE

Feasibility of laparoscopic sleeve gastrectomy in patients with severe obesity and complex abdominal wall hernias with loss of domain

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Abstract

Purpose The literature recommends that patients with complex abdominal wall hernias (CAWH) and severe obesity should be managed with staged treatment, undergoing metabolic and bariatric surgery (MBS) before hernia repair. However, CAWH with loss of domain (LOD) presents a more challenging situation. This study presents the feasibility of Laparoscopic Sleeve Gastrectomy (LSG) in patients with CAWH and LOD.

Methods This is a retrospective cohort of unselected consecutive patients with CAWH and LOD defined based on Tanaka and Sabbagh's criteria who underwent LSG from 2016 to 2023. We documented a 90-day complication rate according to the Clavien-Dindo classification.

Results Sixteen patients, aged 55 ± 10.6 years with a mean BMI of 41.75 ± 4.75 kg/m^2, met the inclusion criteria. The median hernia sac volume (HSV) was 3331.0 ml (IQR 2647.25—3616.25), achieving a median volume ratio of 44.69% (IQR 33.58—55.69) and 30.88% (IQR 25.14—34.70) according to Tanaka's and Sabbagh's criteria, respectively. There were no intraoperative complications or conversions. Three patients experienced major 90-day complications, with two requiring reoperations. There was no 90-day mortality.

Conclusion LSG in patients with severe obesity and CAWH with loss of domain is safe and feasible but has a higher-than-expected rate of serious morbidity due to the complexity of this patient population.

Keywords Abdominal hernia · Bariatric Surgery · Postoperative complications

Abbreviations

CAWH	Complex abdominal wall hernias
MBS	Metabolic and bariatric surgery
LOD	Loss of domain
LSG	Laparoscopic Sleeve Gastrectomy
HSV	Hernia sac volume
BMI	Body Mass Index
ASMBS	American Society for Metabolic and Bariatric Surgery
IFSO	International Federation for the Surgery of Obesity and Metabolic Disorders
IH	Incisional hernias
ACV	Abdominal cavity volume
VR	Volume ratio
CT	Computed tomography
VLCD	Very Low-Calorie Diet
TWL	Total Weight Loss
GERD	Gastroesophageal reflux disease
EHS	European Hernia Society
CPT	Current Procedural Terminology
MBSAQIP	Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program
ACS-NSQIP	American College of Surgeons National Surgical Quality Improvement Program
GLP-1 RAs	Glucagon-like peptide-1 receptor agonists

Key points

- Complex abdominal wall hernias (CAWH) in patients with severe obesity should be managed with staged treatment.
- CAWH with loss of domain (LOD) poses a clinical challenge for bariatric surgeons.
- Laparoscopic Sleeve Gastrectomy with CAWH and LOD is feasible, but has a high rate of serious complications due to the complexity of this group of patients.

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Introduction

Laparoscopic Sleeve Gastrectomy (LSG) has become the most-performed bariatric procedure worldwide [1]. Recent evidence suggests that LSG and Roux-en-Y Gastric Bypass (RYGB) have similar safety profiles in both short- and long-term follow-ups [2, 3]. However, LSG has demonstrated a lower long-term risk of mortality and complications in patients with severe clinical conditions [4]. Consequently, LSG has been proposed as the preferred procedure for elderly patients, solid organ transplantation recipients, those with end-stage kidney disease, and other challenging conditions [5–7].

The association between obesity and abdominal wall hernia is very prevalent. Data from 106,968 patients undergoing open and laparoscopic ventral hernia repair has demonstrated that 60% had obesity, with Body Mass Index (BMI) >40 kg/m^2, which is significantly associated with surgical site infection and reoperation [8]. More recently, an increasing BMI was linked to a stepwise rise in operative time and postoperative length of stay [9]. In this context, complex abdominal wall hernias (CAWH) in patients with severe obesity present as a challenging condition for surgeons, requiring a multidisciplinary team and technically demanding procedures [10, 11].

Current practice favors leaving large hernia sacs or those containing a significant amount of omentum unrepaired during MBS due to the reduced risk of incarceration or strangulation associated with postoperative weight loss and the subsequent decrease in abdominal wall tension [8, 9]. As concurrent ventral hernia repair to Metabolic and Bariatric Surgery (MBS) leads to higher 30-day readmission and reoperation rates [12], it has predominantly been performed for small hernias in favorable locations [13] or symptomatic patients [14]. A systematic review involving 499 patients noted that all studies reported a mean defect size <18 cm^2, which represents (for a circular defect) a mean width of 4.8 cm [14]. However, for patients with CAWH, experts recommend a staged treatment with LSG first and a subsequent hernia repair after weight loss [15, 16]. This strategy aligns with the 2022 joint statement of the American Society for Metabolic and Bariatric Surgery (ASMBS) and the International Federation for the Surgery of Obesity and Metabolic Disorders (IFSO) on current indications for MBS [17]. Nevertheless, progressively complex situations with larger hernia sacs containing multiple organs and configuring loss of domain (LOD) remain to be evaluated. This study aims to describe the intraoperative and postoperative complications of LSG in patients with severe obesity and CAWL with LOD.

Methods

We described a retrospective cohort of unselected consecutive patients with large incisional complex abdominal wall hernias (CAWH) with loss of domain (LOD) and severe obesity (BMI ≥ 35 kg/m^2) with associated medical conditions who underwent Laparoscopic Sleeve Gastrectomy (LSG) from 2016 to 2023 at an academic referral hospital. We included patients with incisional hernias (IH) with large volume and loss of domain (LOD). Patients with large hernias were classified as having >10 cm in width or length [18]. Hernia classification regarding location, width, and recurrence was performed according to the European Hernia Society (EHS) classification for incisional abdominal wall hernias [19]. An experienced radiologist calculated the hernia sac volume (HSV), abdominal cavity volume (ACV), and volume ratio (VR) using abdominal computed tomography (CT) images according to Tanaka's and Sabbagh's methods [20, 21], considering LOD if the Tanaka criteria were $>25\%$ and Sabbagh $>20\%$ of the volume ratio [22]. Patients were excluded if they were aged <18 years old, had a primary hernia, or did not fit the LOD criteria for both above-mentioned scores.

Preoperative weight loss of at least 5% was recommended for all patients as a routine practice of our service. Those with a BMI >60 kg/m^2 or >50 kg/m^2 accompanied by significant visceral obesity, which could pose greater technical challenges to the procedure, participated in a supervised in-hospital weight loss program aiming for a mean preoperative Total Weight Loss (%TWL) of 20%. This program utilized a very low-calorie diet (VLCD) of 6–8 kcal/kg/day, a standard practice at our center for this specific population with higher BMI [23]. After achieving the expected %TWL, these patients were transferred from the secondary hospital to our bariatric unit for surgery.

An experienced team of bariatric surgeons performed all procedures. Laparoscopic access was achieved using a Veress needle in patients without upper abdominal wall hernias. In cases of supraumbilical midline hernias, an open (Hasson) technique was used to create the pneumoperitoneum. Trocar placement was customized based on the location and extent of the hernia. Sleeve gastrectomy involved reducing 70% to 80% of the gastric volume, calibrated with a 32-Fr bougie beginning 5 cm from the pylorus and ending at the angle of His. Given the higher risk of morbidity in this population and the restricted access to our emergency department—which only admits referred patients—in the event of postoperative complications, we routinely placed an abdominal drain at the end of the procedure.

The primary outcome of this study was 90-day morbidity after LSG, according to the Clavien-Dindo

classification [24]. The research team defined major complications as Clavien-Dindo ≥ 3. The secondary outcomes were readmission, reoperation, and 90-day mortality. We collected patient demographics, weight, BMI, obesity-related comorbidities, hernia characteristics, and postoperative complications.

LSG was the initial step of a more extensive research protocol for the staged management of CAWH associated with obesity. The data and clinical findings from CAWH repair will be published in a future manuscript. This research was approved by the Institutional Ethics Research Committee and the written informed consent was obtained from all participants. We presented all data with descriptive statistics, as no comparative group exists. Data that followed a normal distribution were summarized using the mean and standard deviation (SD). For data that were not normally distributed, we used the median and interquartile range (IQR) to represent central tendency and variability better, minimizing outliers'influence. The decision to use median and IQR was based on the distribution characteristics identified during the initial data analysis.

Results

Sixteen patients met the inclusion criteria, as summarized in Table 1. With a mean BMI of 41.75 ± 4.75 kg/m^2 after a mean preoperative %TWL of 7.89 ± 7.33, more than half of them had type 2 diabetes, hypertension, and hyperlipidemia. The median hernia sac volume (HSV) was 3331.0 ml (IQR 2647.25—3616.25), and the median ACV was 7330.50 ml (IQR 5341.75—8204.75), achieving a median volume ratio of 44.69% (IQR 33.58—55.69) and 30.88% (IQR 25.14—34.70) according to Tanaka's and Sabbagh's criteria respectively, as seen in Table 1.

All cases were incisional hernias, with 37.5% being recurrent IH. As detailed in Table 1, eight patients had M4 W3R, three had L1 W3R, two M2 W3R, two L2 W3R, and one L4 W3R according to EHS classification. Herniated organs included the small and large bowel in all patients, the stomach in 3, the appendix in 2, the pancreas and liver in 2, and the right kidney in one. Figure 1 illustrates how physical examination and abdominal CT contribute to the evaluation of hernia contents and planned trocar placement for LSG.

All patients underwent LSG without intraoperative complications or conversion to an open procedure. The surgical strategy for trocar placement was planned and tailored according to the hernia volume and location. When the hernia was located on the right upper quadrant or M1-3 position, the patient was positioned in a right lateral position, and trocars were placed in the left upper quadrant, as shown in Fig. 2. In the three patients with the stomach located in the hernia sac, one with significant volume achieved complete reduction following preoperative weight loss, while the other two with minor herniation experienced spontaneous reduction of herniated contents during the creation of pneumoperitoneum. No intraoperative injury to other organs contained in the hernia sac was observed, and no enterotomy was required.

Table 1 Patient demographic and clinical characteristics

	N = 16
Sex, female (%)	14 (87.5%)
Age, years (± SD)	55 (± 10.6)
Baseline weight, kg (± SD)	116.8 ± 21.6
Baseline BMI, kg/m^2 (± SD)	45.67 ± 6.69
Pre-operative weight, kg (± SD)	106.7 ± 16.8
Pre-operative BMI (± SD)	41.75 ± 4.75
Pre-operative weight loss, % (± SD)	7.89 ± 7.33
Clinical associated conditions (%)	
T2DM	9 (56.2%)
Hypertension	11 (68.7%)
Hyperlipidemia	9 (56.2%)
MASH	6 (37.5%)
GERD	4 (25.0%)
Hernia sac volume, mL (IQR)	3331.00 (2647.25—3616.25)
Abdominal cavity volume, mL (IQR)	7330.50 (5341.75—8204.75)
Volume ratio, % (IQR)	
Tanaka	44.69 (33.58—55.69)
Sabbagh	30.88 (25.14—34.70)
EHS classification, n	
M2 W3R	2
M4 W3R	8
L1 W3R	3
L2 W3R	2
L4 W3R	1

SD Standard Deviation, *BMI* Body Mass Index, *T2DM* Type 2 Diabetes Mellitus, *MASH* Metabolic dysfunction-associated steatohepatitis, *GERD* Gastroesophageal Reflux Disease, *IQR* Interquartile Range, *EHS* European Hernia Society

Three patients (18.75%) experienced major 90-day complications: bleeding, angle of His fistula, and small bowel perforation, classified as Clavien-Dindo 4B, 4 A, and 4 A, respectively, as shown in Table 2. The patient with the bleeding lost 700 mL, as documented by the intrabdominal drain routinely placed at the end of the procedure, but showed no symptoms of hemorrhagic shock. Despite presenting with acute kidney injury, which was reversed with intravenous fluid therapy, bleeding was managed conservatively, with no need for intervention or blood transfusion, as the hemoglobin level was 8.5 g/dL. Another patient, with an angle of His fistula, was readmitted to the emergency department with septic shock and required emergency laparoscopy for cleaning and drainage of the abdominal cavity. The fistula was treated endoscopically with a stent and nasoenteral

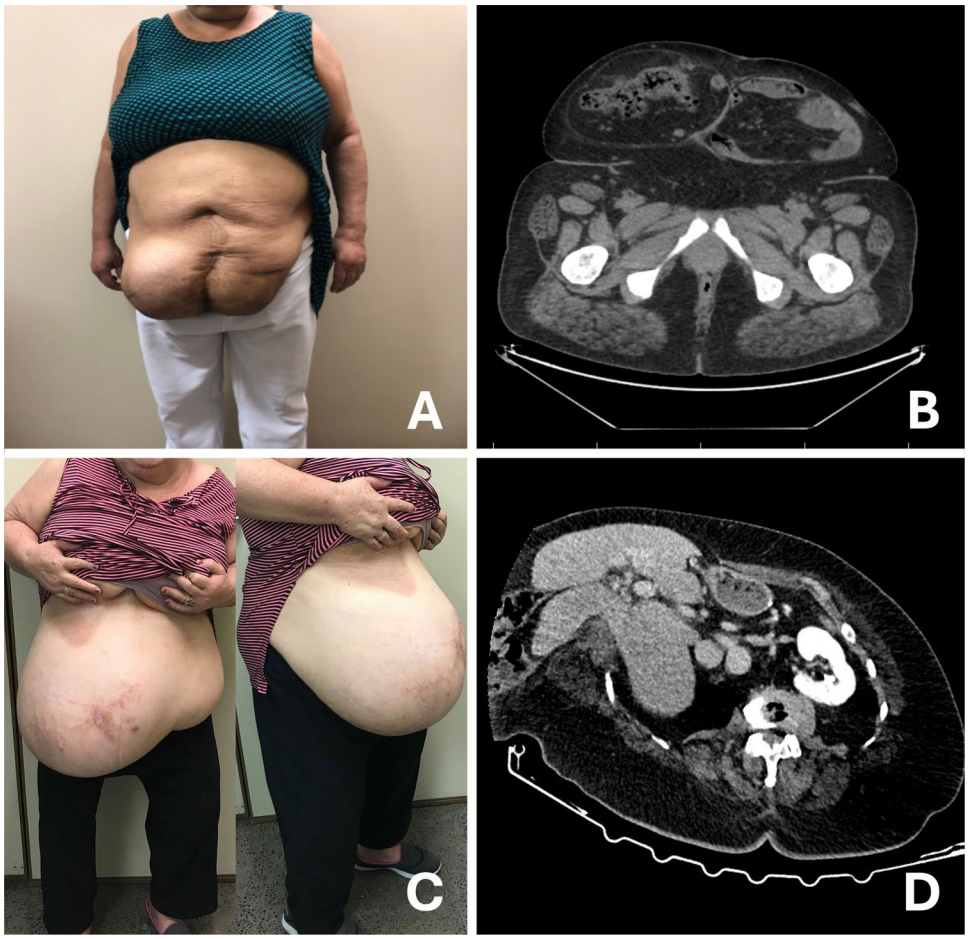

Fig. 1 Physical examination (**A** and **C**) and abdominal CT (**B** and **D**) for surgical planning

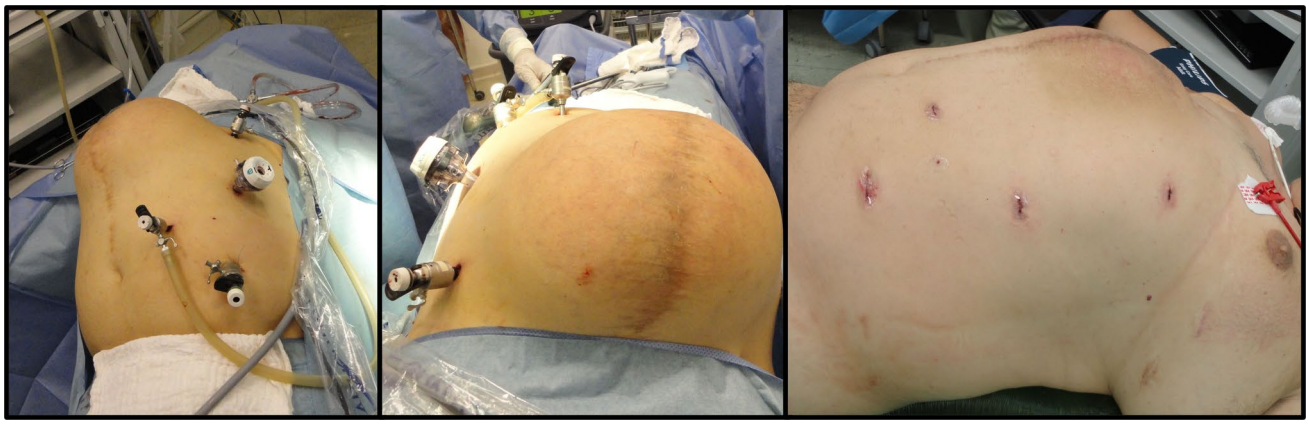

Fig. 2 Trocar placement tailored according to previous incision and hernia volume

feeding. Lastly, the patient with small bowel perforation, probably due to an inadvertent bowel injury during dissection or trocar placement, developed septic shock two days after surgery and underwent exploratory laparoscopy with a suture repair of the perforation. All three patients required admission to intensive care.

In addition to these cases, one patient experienced a minor complication, presenting with abdominal pain and requiring readmission. This was diagnosed as a deep wound infection, which was treated with antibiotics. As detailed in Table 2, there were two readmissions, two reoperations, and no mortality.

Table 2 Postoperative complications

	N = 16
Overall complications, *n* (%)	4 (25.0%)
Minor complication, *n* (%)	1 (6.25%)
Major complication, *n* (%)	3 (18.7%)
Intraoperative complication, *n* (%)	0
Conversion, *n* (%)	0
Readmission, *n* (%)	2 (12.5%)
Reoperation, *n* (%)	2 (12.5%)
Mortality, *n* (%)	0

Discussion

Patients with severe obesity and CAWH with LOD present a significant challenge for both the surgical team and the healthcare system, as they combine two intricate conditions. Our study demonstrates that LSG is safe and feasible in this high-risk population. However, the procedure involves specific technical considerations and a higher risk of complications, with our cohort reporting two patients requiring procedural interventions due to major complications. These findings highlight the importance of performing LSG in this setting within experienced surgical teams at specialized referral centers. To our knowledge, this case series represents the largest cohort of LSG in patients with CAWH and LOD.

Our patients had a mean hernia sac volume > 3,000 cm^3 with a mean VR > 50% according to Tanaka' and > 30% according to Sabbagh's criteria. This reflects the severity of our case series based on standardized criteria, in contrast to heterogeneous data on CAWH metrics in patients undergoing MBS reported in the literature. Borbély et al. [15] published a case series of 15 patients with LOD, defined in their study as extra-abdominal volume > 20%, but they did not report HSV and VR values. Morrell et al. [25] considered CAWH if the hernia surgeon determined that a component separation would be necessary for the hernia repair. They did not report on HSV or VR, only a mean hernia area of 394.9 cm^2. Schroeder et al. [16] included patients based on Current Procedural Terminology (CPT) codes related to ventral hernia, reporting a mean hernia width of 14 cm and 58% with LOD despite having no specified criteria.

Previous literature recognizes Tanaka and Sabbagh's criteria for complex hernias [26]. Although Sabbagh's method was chosen as the preferred method by a recent international Delphi consensus with expert hernia surgeons [22], we prefer Tanaka's method, as it was developed by the referral team of hernia surgeons from our institution [20]. We employed both criteria for inclusion in this study to avoid selection bias. While primarily used for academic characterization, both classification criteria are based on preoperative abdominal CT, which is mandatory for patients with CAWH and LOD. Beyond estimating hernia volume and proportions, imaging allows the surgical team to assess abdominal wall configuration and identify herniated organs. These factors are essential in tailoring intraoperative decisions according to the hernia's size and location, which includes patient positioning, trocar placement, and surgical approach. This individualized strategy may assist other centers in optimizing outcomes when treating similarly complex cases.

Three out of 16 patients had severe complications within 90 days, according to the Clavien-Dindo classification. While this is a high complication rate for LSG, considering the procedure's overall safety, it can be justified by the complexity of the hernia and the technical challenges for MBS in this specific population. In contrast, Morrell et al. [25] reported only one severe complication requiring reoperation due to bleeding, and Borbély et al. [15] reported no major complication. However, our case series involved more severe CAWH with a more significant loss of domain than these studies. Although there is no evidence to support this assumption, our two cases of staple line bleeding and the angle of His fistula may be related to the severity of our cases regarding hernia sac volume and volume ratio, which could have contributed to increased intra-abdominal pressure over the gastric sleeve.

Although there is no consensus on the optimal approach for ventral hernia repair in patients who are candidates for MBS, the 2022 ASMBS/IFSO consensus guidelines on indications for MBS recommend that patients with severe obesity and large, chronic abdominal wall hernias undergo MBS as a staged procedure to definitive hernia repair [17]. Recently, the European Hernia Society Prehabilitation Project demonstrated in a systematic review that weight loss for patients with obesity reduces the risks of complications following abdominal wall reconstruction, supporting obesity treatment as a prehabilitation strategy prior to ventral hernia repair [27]. Additionally, it has been shown that patients who underwent a staged approach with MBS experienced no hernia recurrence at mid-term follow-up, although postoperative morbidity related to surgical site infection was still observed [16].

Furthermore, there is no agreement on the best bariatric procedure for patients with ventral hernia. A nationwide French register has demonstrated that the type of bariatric procedure did not impact the surgical outcomes. Still, they used data from administrative claims, with no information on hernia sac volume or its relation to abdominal cavity volume [28]. Nonetheless, our strategy of preferring LSG in this patient population aligns with the current literature for CAWH with loss of domain, as the hernia size and the herniated organs may affect the technical difficulty of derivative bariatric procedures.

This study is limited by its retrospective nature, lack of a control group, small sample size, and single-center design. These limitations underscore the challenges of performing MBS in patients with severe obesity complicated by CAWH with loss of domain. While our center is not currently accredited by the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP), it functions within the framework of a high-volume academic institution that routinely manages complex cases. However, previous data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) demonstrated that centers outside of the MBSAQIP accreditation system tend to report higher postoperative morbidity rates, even after risk adjustment when compared to MBSAQIP-accredited centers [29]. This suggests that institutional structure, standardized protocols, and multidisciplinary care pathways in accredited centers may contribute to improved outcomes, particularly when managing high-risk patients.

Although this study contributes to the growing body of literature on MBS in patients with CAWH and LOD, future prospective studies are necessary to evaluate a preoperative program that can better prepare these patients to diminish the risk for severe complications. With recent advances in obesity treatment using glucagon-like peptide-1 receptor agonists (GLP-1 RAs), neoadjuvant GLP-1 RA therapy may enhance the safety of MBS in high-risk patients, or even serve as a stand-alone treatment. These approaches hold promise for the future management of complex abdominal wall hernias in individuals with obesity [30].

Conclusion

Laparoscopic sleeve gastrectomy in patients with severe obesity and CAWH with loss of domain is safe and feasible, but it is associated with a higher-than-expected rate of serious morbidity, reflecting the complexity of this patient population. Given the technical challenges involved, the procedure should be reserved for surgical teams with expertise in MBS and complex hernia repair. Future prospective studies are needed to evaluate long-term outcomes and complications in this high-risk group.

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Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval All procedures performed in studies involving human participants followed the ethical standards of the institutional and/or national research committee, along with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no conflict of interest.

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