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MODERN SURGERY: TECHNICAL INNOVATION

Single Incision Laparoscopic Sleeve Gastrectomy (SILS): A Novel Technique

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Abstract
Background Laparoscopic sleeve gastrectomy is an emerging bariatric procedure that typically necessitates five to seven small skin incisions to place five to seven trocars. The senior author (Saber) has developed a single umbilical incision approach to laparoscopic sleeve gastrectomy.
Methods Seven patients underwent single access transumbilical laparoscopic sleeve gastrectomy between March 2008 and July 2008. The same surgeon performed all surgical interventions. The umbilicus was the sole point of entry for all patients, and the same operative technique and perioperative protocol were used in all patients.
Results A total of seven single-incision laparoscopic sleeve gastrectomies were performed. The procedure was successfully performed in all patients. Mean operating time was 125 min. None of the patients required conversion to an open procedure. There were no mortalities or postoperative complications noted during the mean follow-up period of 3.4 months.
Conclusion Single-incision transumbilical laparoscopic sleeve gastrectomy is safe, technically feasible, and reproducible.

Keywords Minimally invasive surgery · Single-access surgery · Single-port laparoscopy · Single-incision laparoscopic surgery · Sleeve gastrectomy · Morbid obesity · Bariatric surgery

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Introduction

Laparoscopic sleeve gastrectomy is an emerging new bariatric procedure [1–4]. Typically, the procedure necessitates five to seven small skin incisions to place five to seven laparoscopic trocars [3, 4]. Recently, single-port surgery has been used successfully for numerous laparoscopic urologic procedures [5–9]. The senior author (Saber) has developed a single-incision approach for laparoscopic sleeve gastrectomy using the umbilicus as the sole portal of entry. The rationale of this manuscript is to evaluate the safety and feasibility of single-access transumbilical laparoscopic sleeve gastrectomy for morbid obesity with a report of our initial experience with this novel approach that we have developed. To the best of our knowledge, this is the first report of single-incision laparoscopic sleeve gastrectomy.

Materials and Methods

Seven consecutive patients underwent single-access transumbilical laparoscopic sleeve gastrectomy between March 2008 and July 2008. All surgical interventions were performed by the same surgeon (Saber). The same operative technique and perioperative protocol was used in all patients as described herein.

The procedure was offered to all the patients that were eligible for the standard sleeve gastrectomy without any specific exclusion criteria.

Operative Technique

The patient is placed in the supine position with the arms extended laterally. The surgeon stands on the right side of

the patient with the assistant on the left side. The main idea behind our technique involves the use of three ports through the same umbilical incision to provide visualization as well as two working channels through a single umbilical incision (Fig. 1).

Using an open Hasson technique, a 2.5-cm semicircular umbilical incision is made at the upper half of the umbilicus and deepened to the linea alba, where a 1-cm fascial incision is made; the peritoneum is incised, and the 15-mm blunt trocar is deployed. It should be noted that the fascial incision must be smaller than the blunt trocar size to create an effective seal, preventing gas leakage. Carbon dioxide insufflation with a pneumoperitoneum pressure of 15 mm/Hg is achieved. A long, 5-mm, rigid, 45° video laparoscope is inserted. Under direct visualization, two 5-mm DEXIDE™ threaded laparoscopic trocars (Covidien, Norwalk, CT, USA) are placed through the same umbilical skin incision. All ports are inserted under direct vision and aimed toward the stomach. The patient is placed in reverse Trendelenburg position and rotated toward the right for optimal exposure of the esophagogastric junction.

A Nathanson liver retractor (Mediflex, Islandia, NY, USA) is inserted through a 5-mm subxiphoid skin puncture with no port placement. The various operative steps are similar to standard laparoscopic sleeve gastrectomy [2, 3].

Using a 5-mm LigaSure (Covidien), the greater curvature of the stomach is mobilized at a point 6 cm proximal to the pylorus. The lesser sac is entered, and staying close to the wall of the stomach, the greater curvature ligaments (gastrosplenic and gastrocolic) are divided all the way up to the angle of His. It is important to identify and mobilize the angle of His with exposure of the left crus of the diaphragm to delineate the gastroesophageal junction and to facilitate complete resection of the gastric fundus. Retrogastric adhesions are taken down with the LigaSure to allow complete mobilization of the stomach, to eliminate any redundant posterior wall of the sleeve, and to exclude the fundus from the gastric sleeve. Once the stomach has been completely mobilized, a 34-Fr orogastric tube is inserted transorally into the pylorus and placed against the lesser curvature. This will calibrate the size of the gastric sleeve, prevent constriction at the gastroesophageal junction, and provide a uniform shape to the entire stomach.

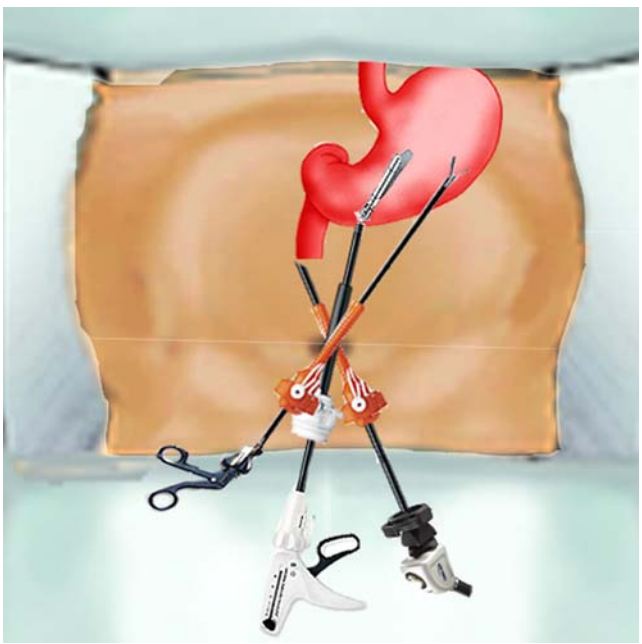

Fig. 1 Ports placement through the umbilical incision

Gastric transection is started at a point 6 cm proximal to the pylorus, leaving the antrum and preserving gastric emptying. A long laparoscopic reticulating 60-mm XL endo GIA stapler with green cartridge 4.8 mm (Covidien) and bioabsorbable glycolide copolymer buttressing material reinforcements (Seamguard; W.L. Gore & Associates, Flagstaff, AZ, USA) are inserted through the 15-mm trocar in a cephalad direction and used for the entire transection. The stapler is fired consecutively along the length of the orogastric tube until the angle of His is reached. Care must be taken not to narrow the stomach at the angularis. It is important to inspect the stomach anteriorly and posteriorly to ensure no redundant posterior stomach. At this point, approximately 80% of the stomach has been separated.

The entire staple line is inspected for bleeding and tested for leak. The patient is placed flat, and an atraumatic clamp is placed near the pylorus. The integrity of the staple line is tested by insufflating air under saline and infusing 30–60 cm^3 of methylene blue into the remaining stomach.

The resected stomach is placed in a 15-mm specimen endobag and extracted through the umbilical incision with no extension of the umbilical skin incision. A 19-Fr Blake drain is placed along the staple line and exteriorized through the umbilical incision. The fascial defect of the 15-mm trocar site is closed with a figure of eight 2/0 nonabsorbable sutures to prevent port site hernia.

Some modifications of conventional laparoscopic approach are required for the single-incision laparoscopic procedure. Long instruments and equipment (dissectors, staplers, scope, clip appliers) are required, as in the morbidly obese patient the umbilicus is usually far from the gastroesophageal junction. In the single-access procedure, triangulation can be challenging. Frequent realignment of the instruments and scope relative to each other is crucial to provide optimal visualization and to minimize clinching of the instruments and the laparoscope.

All patients have a routine gastrograph swallow study on postoperative day 1 and are commenced on oral foods if

Fig. 2 The resulting scars 1 month postoperatively

normal. On average, most patients are discharged home by postoperative day 2, and the drain is removed prior to the patient's discharge. Fig. 2 depicts one of the patients 1 month after the surgery.

Results

A total of seven single-access laparoscopic sleeve gastrectomies were performed by the same surgeon (Saber). The patients were four females and three males. The mean age was 45.6 years (range 29 to 62 years); mean weight was 341 lbs, and the mean preoperative body mass index (BMI) was 53.5 (range 42 to 68). Comorbidities included arthritis (seven patients), gastroesophageal reflux disease (six patients), back pain (five patients), sleep apnea (four patients), diabetes (two patients), hypertension (two patients), and stress incontinence (two patients).

The procedure was successfully performed in all patients. Mean operating time was 125 min (range 90 to 177 min). Mean operative blood loss was 60 cm^3. None of the patients required conversion to an open procedure. One patient required insertion of one additional port to facilitate hemostasis at the gastroesophageal junction after the completion of the stomach resection. Mean hospital stay was 2.4 days (range 1 to 3 days) after the procedure. There were no intraoperative or postoperative morbidity or mortality. Mean postoperative BMI was 45.8 with a mean follow-up period of 3.4 months. Table 1 demonstrates individual patients' variables.

Discussion

The numerous advantages of laparoscopic procedures compared to the open counterparts have inspired an interest in even more minimally invasive surgical approaches. This interest facilitated the birth of needlescopic instruments [10–12], natural orifice transluminal endoscopic surgery [13–15], and single-access laparoscopy [5–9].

Single-access laparoscopy involves the introduction of special multichannel access devices that allow laparoscopic surgery to be performed through one incision, preferably the umbilicus. The potential advantages of this approach are related to limiting the port incisions to one site, in addition to the advantages of traditional minimally invasive surgery. Positioning the single access within the umbilicus results in better cosmesis and avoids muscle penetration, which minimizes incision pain. The substantial reduction in abdominal wall trauma translates into less postoperative pain, a more rapid recovery, fewer wound complications, and improved cosmetic outcomes. Avoiding lateral placement of ports eliminates the risk of epigastric vessel injury [16]. The umbilicus is the thinnest part of abdominal wall; therefore, access through the umbilicus minimizes the torching effect of trocars, facilitating the mobility of the instruments/trocars in different directions. When necessary, the surgeon can convert a single-access transumbilical

Table 1 Patient's characteristics

Patient number	Age (years)	Sex	Height (in.)	Preop weight (lbs)	Preop BMI	Blood loss (cm^3)	OR time (min)
1	46	F	68	364	68.0	60	177
2	54	M	72	373	50.6	100	128
3	37	F	65	372	58.9	20	156
4	52	F	63	280	48.4	100	125
5	29	M	72	423	56.7	20	110
6	62	M	67	334	50.1	20	90
7	38	F	63	241	42.0	100	92

procedure into a conventional laparoscopic procedure by adding one or more conventional laparoscopic ports, thus preserving the existing standards of care.

However, the applicability of this technique has not resulted in widespread use due to the associated technical challenges. The instruments and laparoscope are introduced adjacent and parallel to each other through a single access. This tends to restrict the range of motion and result in "crowding" of the laparoscope and instruments, making surgical dissection through a single port more difficult than in conventional multiport laparoscopy. Loss of the triangulation between the two hand instruments and the laparoscope renders intracorporeal suturing a challenge as well.

The use of a specially designed single port with multichannel access through which prototype instruments having varying curvatures or bends in the shaft and a flexible 5-mm laparoscope is recommended to improve maneuverability and overcome these obstacles. In addition, the instrument shafts are frequently crossed at the point of entry into the valve, such that the external right-hand instrument becomes the left instrument internally and vice versa. As a result, dissection might sometimes be done with the nondominant hand, requiring ambidexterity on the part of the surgeon.

At our institution, we offer a sleeve procedure to high-risk morbidly obese patients, including those with a high BMI, central obesity, multiple abdominal surgeries, or those who also have significant comorbid conditions. While we use nonflexible instruments to perform our single-access surgery on morbidly obese patients, Kaouk et al. excluded obese patients (BMI more than 30 kg/m^2) when performing single-port laparoscopic surgery in urology utilizing specially designed instruments [8].

The current laparoscopic sleeve gastrectomy techniques involve the use of five to seven laparoscopic ports/small skin incisions [1–4]. We have developed a surgical technique of laparoscopic sleeve gastrectomy performed entirely through an umbilical incision. This entails simultaneous passage of three laparoscopic ports through the same 2.5-cm semicircular intraumbilical access incision. Unlike the previous single-port access reports that used specially designed articulating instruments, ports, and equipment, our technique utilizes conventional rigid laparoscopic instruments, laparoscope, and ports that are already available in the operating room. To our knowledge, this is the first report describing a single-incision laparoscopic sleeve gastrectomy procedure.

Coordination between the surgeon and the camera person and switching the 5-mm instrument between the laparoscopic ports are essential to optimize the instruments' range of motion for better ergonomics and to avoid clashing of the instruments and the laparoscope during the procedure. Confident, multiport laparoscopic skills are critical to safely introduce this new technique without added complications. This approach has a unique learning curve, principally to overcome the technical challenges of navigating instruments within a limited range of motion.

Using the single-access approach, we are able to combine all of the standard laparoscopic entry points into one port of entry, i.e., the umbilicus, thus decreasing the number of incisions required for laparoscopic sleeve gastrectomy from six or seven incisions to two incisions. Fewer incisions are ultimately translated to minimal discomfort, fast recovery time, and a hidden scar. This single-port access technique we have developed allows us to do the same procedure we have been doing for the past few years but through fewer incisions and with no additional new equipment, instruments, or new complications. Overall, intraoperative and postoperative results obtained in this initial series are comparable to previously reported laparoscopic series [1–4]. We believe this approach has potential application for common laparoscopic procedures to be performed entirely through the patient's umbilicus.

Additional work must be done before these techniques achieve the level of standardization. The development of more flexible articulating instruments, high-illumination, high-magnification, flexible endoscopes, and freestanding insertable retractors will need to be developed. Introducing robotically controlled flexible instruments inserted through the single port might be the ultimate solution to facilitate technical performance.

In conclusion, single access transumbilical laparoscopic sleeve gastrectomy is safe, technically feasible, and reproducible. Prospective randomized studies comparing single-access versus conventional multiports laparoscopic sleeve gastrectomy, with large numbers and long-term follow-up, are needed to confirm our initial experience.

References

1. Regan JP, Inabnet WB, Gagner M, et al. Early experience with two-stage laparoscopic Roux-en-Y gastric bypass as an alternative in the super-super obese patient. Obes Surg. 2003;13:861–4.
2. Deitel M, Crosby RD, Gagner M. The first international consensus summit for sleeve gastrectomy (SG), New York City, October 25–27, 2007. Obes Surg. 2008;18:487–96.
3. Mognol P, Chosidow D, Marmuse JP. Laparoscopic sleeve gastrectomy as an initial bariatric operation for high-risk patients: initial results in 10 patients. Obes Surg. 2005;15:1030–3.
4. Roa PE, Kaidar-Person O, Pinto D, et al. Laparoscopic sleeve gastrectomy as treatment for morbid obesity: technique and short-term outcome. Obes Surg. 2006;16:1323–6.
5. Rané A, Rao P, Rao P. Single-port-access nephrectomy and other laparoscopic urologic procedures using a novel laparoscopic port (R-Port). Urology. 2008 (in press).
6. Goel RK, Kaouk JH. Single port access renal cryoablation (SPARC): a new approach. Eur Urol. 2008;53:1204–9.

7. Kaouk JH, Palmer JS. Single-port laparoscopic surgery: initial experience in children for varicocelectomy. BJU Int. 2008; 102:97–9.
8. Kaouk JH, Haber GP, Goel RK, et al. Single-port laparoscopic surgery in urology: initial experience. Urology 2008;71:3–6.
9. Ponsky LE, Cherullo EE, Sawyer M, et al. Single access site laparoscopic radical nephrectomy: initial clinical experience. J Endourol. 2008;22:663–6.
10. Tagaya N, Rokkaku K, Kubota K. Needlescopic cholecystectomy versus needlescope-assisted laparoscopic cholecystectomy. Surg Laparosc Endosc Percutan Technol. 2007;17:375–9.
11. Shalaby R, Shams AM, Mohamed S, et al. Two-trocar needlescopic approach to incarcerated inguinal hernia in children. J Pediatr Surg. 2007;42:1259–62.
12. Liao CH, Chueh SC, Wu KD, et al. Laparoscopic partial adrenalectomy for aldosterone-producing adenomas with needlescopic instruments. Urology 2006;68:663–7.
13. Marks JM, Ponsky JL, Pearl JP, et al. PEG "Rescue": a practical NOTES technique. Surg Endosc. 2007;21:816–9.
14. Zorrón R, Filgueiras M, Maggioni LC, et al. NOTES. Transvaginal cholecystectomy: report of the first case. Surg Innov. 2007;14:279–83.
15. Zorron R, Maggioni LC, Pombo L, et al. NOTES transvaginal cholecystectomy: preliminary clinical application. Surg Endosc. 2008;22:542–7.
16. Saber AA, Meslemani AM, Davis R, et al. Safety zones for anterior abdominal wall entry during laparoscopy: a CT scan mapping of epigastric vessels. Ann Surg. 2004;239:182–5.