

Single-incision laparoscopic sleeve gastrectomy: initial experience in 20 patients and 2-year follow-up

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Received: 9 September 2013 / Accepted: 17 December 2013 / Published online: 5 February 2014
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Summary

Background The transumbilical route began being clinically feasible with or without unique access devices.

Setting The setting for this study was a private practice at Clínica Las Condes, Santiago, Chile.

Objective The objective was to describe our experience performing a laparoscopic sleeve gastrectomy (LSG) via transumbilical route using a single-port access device in addition to standard laparoscopic instruments.

Method A prospective nonrandomized protocol was applied to patients fulfilling the following inclusion criteria: to have been medically indicated for an LSG, to have a body mass index (BMI) of less than or equal to 40 kg/m², and the distance between the xiphoid appendix and umbilicus should be less than 22 cm. All patients were female with a median (p50) age of 34.5 (ranging from 21 to 57) years, a median weight of 92 (ranging from 82.5 to 113) kg, and a median BMI of 35.1 (ranging from 30.5 to 40) kg/m². The device insertion technique, the gastrectomy, and postoperative management are described.

Results LSG via transumbilical route was successfully carried out in 19 of the 20 patients in whom the procedure was performed; one patient had to be converted to a conventional laparoscopic procedure. Mean operating time was 127 (ranging from 90 to 170) min. On the second postoperative day, all patients were assessed through an

upper gastrointestinal barium-contrasted radiological series. There was neither morbidity nor mortality in this group. Excess weight loss at 25 months after surgery was 114%.

Conclusions Single-port LSG can be successfully performed in selected obese patients with a BMI of less than 40 kg/m² using traditional laparoscopic instruments. The technique allows performing a safe and effective vertical gastrectomy.

Keywords Laparoscopic sleeve gastrectomy · Single-incision laparoscopic surgery · Single-site surgery

Introduction

Since the introduction of laparoscopic cholecystectomy, abdominal surgery has been looking to achieve most of its surgical interventions to be performed on solid and hollow viscera through minimally invasive procedures. Because of this reason, laparoscopic surgery has become the standard technique for several abdominal surgical procedures, such as cholecystectomy, appendectomy, antireflux surgery and achalasia, splenectomy, colectomy, and bariatric surgery.

Furthermore and in a parallel manner, over the past 20 years, minimally invasive surgery has progressed from surgery with minimal incisions, which includes laparoscopic surgery, to transorifice surgery, with no skin incisions, using natural orifices such as the mouth, vagina, and rectum as ports of entry. However, this technique is highly demanding from a technical point of view. Besides, the proper technology has to be available in the operating room, and the learning curve is slow. Moreover, this technique has the significant disadvantage of going through healthy organs such as the stomach, vagina, and rectum to access the peritoneal cavity. Because of this disadvantage, transorifice surgery is still in its initial stages, and

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it probably will require a long time before it can become more accepted [1].

Transumbilical surgery has emerged as an intermediate procedure in the evolution of surgery, as it allows abdominal surgery to be performed with only one port at the umbilicus, which is almost invisible, most likely with fewer traumas to the abdominal wall, a faster recovery, and a decrease in the use of analgesics [2–4].

The use of the umbilicus as the port of entry provides an excellent laparoscopic access to the abdominal cavity in general, and it presents a natural scar in which any new incision will not be noticed. This can be achieved by using several trocars or a single transumbilical port. This technique is already available for clinical use [5] using traditional laparoscopic instruments, and there are many single-port devices available in the market. Through a single incision, usually less than 3 cm wide in the skin and umbilical aponeurosis, there is the possibility of installing a device that consists of three or four access channels, using the same amount of laparoscopic instruments.

In recent years, the development of bariatric surgery has allowed continuous and progressive training in laparoscopic techniques, which are applied to severely overweight patients. One of these techniques, laparoscopic sleeve gastrectomy (LSG), is the one that has increased the most as a single procedure per year. This procedure poses a particular challenge in minimally invasive surgery, as given its proved effectiveness for weight loss in the short term and the safety of this method, its medical prescription has recently been extended to moderately obese patients [6]. Because of this group extension, our team has applied this method to patients with a body mass index (BMI) that ranges between 30 and 40 kg/m², and who have problems associated to metabolic, cardiovascular, and osteoarticular comorbidities, which would benefit from weight loss or be corrected once it has occurred. This determines that patients with obesity class I and II are potential candidates for a gastrectomy using this new abdominal minimal access approach.

Objectives

The objectives of this study were as follows: to evaluate the feasibility of performing laparoscopic vertical gastrectomy via transumbilical route, using a single-port abdominal access device in addition to straight traditional laparoscopic instruments; and to replicate the LSG technique and achieve the same magnitude and quality standards of the gastrectomy as those achieved via conventional laparoscopy with four or five access trocars.

Material and methods

The authors started performing transumbilical surgery at the beginning of 2009 [7], initially performing this procedure on selected cases of elective cholecystecto-

Table 1 Inclusion criteria which defined the type of patients candidates to LSG

1. Obese conditions
2. Medically indicated LSG
3. BMI equal or less to 40 kg/m ²
4. Distance less than 22 cm between the xiphoid appendix and the umbilicus
5. Interest in having surgery with less incision
6. Female gender
7. Written informed consent
<i>LSG</i> laparoscopic sleeve gastrectomy, <i>BMI</i> body mass index

mies and emergency appendectomies. After becoming familiar with the use of this device and this new surgical approach, a prospective nonrandomized protocol was designed, which included the criteria that defined which type of obese patients were LSG candidates (Table 1).

A total of 20 patients underwent an LSG using the transumbilical route. All these patients were female with a median (p50) age of 34.5 (ranging from 21 to 57) years, a median weight of 92 (ranging from 82.5 to 113) kg, and a median BMI of 35.1 (ranging from 30.5 to 40) kg/m². All patients were evaluated from a digestive, nutritional, metabolic, cardiovascular, and mental perspective. They were presented to the Multidisciplinary Committee of Obesity, where the prescription of this surgical treatment was approved due to their level of obesity and associated morbidity.

Surgical technique

The patient is positioned with both legs apart in reversed Trendelenburg position with a 15° tilt. The surgeon's position is between the legs of the patient. The procedure begins with a vertical transumbilical incision of approximately 3 cm on the cutaneous and fascia surface. Once the fascia has been opened, the multilumen port (SSL[®], Ethicon Endo-Surgery) is installed with three work channels, two 5 mm and one 12 mm in diameter, and the pneumoperitoneum is created reaching an intra-abdominal pressure of 15 mmHg. The rigid 30°, 5-mm and 50-cm length optic is introduced at a 30° angle. The gastric intervention itself begins with the skeletization of the greater curvature starting at 3 cm from the pylorus. A small opening toward the retrogastric space is created. In some cases, separating the liver required the use of an additional trocar or the installation of a Veres needle in the epigastrium to be used as a hepatic separator. At this time, the anesthesiologist takes out the gastric tube and introduces transorally a 36F calibrating gastric tube, which advances transpyloric until the duodenum, attaching it to the lesser curvature to act as a calibrator and to avoid narrowness of the remnant gastric tube.

After installing the calibrating gastric tube and after the surgeon ensures that there is no other probe in the stomach, the gastric section starts from distal to proximal portions using the linear staplers (Echelon Flex 60[®],

Ethicon Endo Surgery), starting with two sets of 2.0-mm staple cartridge (green), followed by the application of five to six sets of 1.5-mm staple cartridge (blue). Once the stomach has been almost entirely sectioned, the gastric skeletization of the greater curvature starts from the antrum to the His angle by using the ultrasonic energy device (Harmonic Ace[®], *Ethicon Endo-Surgery*). The objective while approaching the gastroesophageal junction is the visualization of the left crus and the left border of the abdominal esophagus, sectioning the short vessels and phrenoesophageal membrane in its left half. The last line of mechanical sutures is located 10 mm away from the His angle, with the purpose of completely dissecting the gastric fundus.

Hemostasis of the gastric edge is carried out by electrocoagulation of the section's edge, applying clips to any bleeding point or installing absorbable hemostats directly on the bloody edge. Once the gastric section is completed, the anesthesiologist introduces 60 to 80 ml of methylene blue to assess the presence of any leakage.

The extraction of the gastrectomy piece is carried out through the umbilical incision. The fascia is sutured using interrupted stitches of 2-0 absorbable material, and intradermic sutures of 4-0 absorbable monofilaments are applied to the skin. None of the patients required intra-abdominal drains.

In addition to analgesics, local infiltration with 10 ml of bupivacaine at 0.5% was used in the umbilical incision once the procedure was finished.

Antibiotic prophylaxis was used as one dose of first-generation cephalosporin, during the induction of anesthesia, followed by two postoperative doses. To prevent thromboembolic disease, antiembolic stockings were used in addition to an intermittent pneumatic compressor for lower extremities during the intraoperative periods, followed by the use of low-molecular-weight heparin 6 h after surgery, which is continued once a day until the patient is discharged. All patients got up and out of bed, assisted by a physical therapist, to walk around within 12–18 h of completing surgical procedure. They all had two sessions of respiratory and general therapy per day during their stay in the hospital.

Postoperative management

Postoperative analgesia was based on the use of a continuous intravenous solution consisting of metamizol (3 g per day) and a nonsteroidal anti-inflammatory drug (ketoprofen, 300 mg daily) for 48 h. Proton pump inhibitors were used at the induction of the anesthesia and were continued for 30 days.

On next day after surgery, all patients were submitted to a barium swallow study to assess the shape of the gastric tube, absence of leakage or strictures, and satisfactory gastric emptying. We prefer barium sulfate instead of water-soluble contrast, as in our experience, the quality and details of images are better with barium [8, 9].

After this radiological examination, patients were given a fractioned hypocaloric liquid diet of 300–400 cal/

day, which was continued for 10 days. On day 11, a hypocaloric soft diet was begun, fractioned until day 30.

Follow-up

Ambulatory clinical control was carried out in postoperative days 10 and 30, and later at 3, 6, and 12 months after surgery. The mean follow-up was 25 (10–38) months.

The percentage of excess weight loss was calculated by knowing the real weight and the theoretical weight of the patient according to the weight and height acceptable for adult Chilean population, adapted from the data of the Metropolitan Life Insurance Company, USA.

Results

In the first two patients of this series, the gastrectomy began with the gastric skeletization of the entire greater curvature from distal to proximal portions in the same way as the authors performed LSG with conventional laparoscopy [7]. After this, gastric section was carried out using mechanical sutures. Both of these patients required the use of an additional 5-mm trocar in the middle line to use retractor forceps or a 5-mm camera. From the third patient onward, the technique was modified to the previously described one, and the need of an additional trocar was avoided.

Mean operating time was 127 min, ranging from 90 to 170 min. The most time-consuming procedures were in patient 1 and 5. The first patient of this series was operated on for 170 min and required the use of an additional trocar in the middle line. The other patient with an extended operation time was the fifth patient. However, this patient did not require the installation of an additional trocar.

In 19 of the 20 patients in whom the transumbilical procedure was attempted, the procedure was successful and exclusively achieved by this route. In one patient (the last one), additional trocars had to be installed due to the impossibility of obtaining proper visualization of the esophagogastric junction as a result of a voluminous fatty liver. This yields a conversion percentage of 5% (1/20 patients).

Also, two patients suffered from a large umbilical hernia, and the device was installed through their hernial defect; once the gastrectomy was finished, a standard umbilical herniorrhaphy was performed.

In these 20 patients, no relationship between their height and the distance between the xiphoid appendix and navel was found as a factor that facilitated the procedure and that could have resulted in a decrease in operating time.

All radiological examinations with diluted barium sulfate were satisfactory, indicating good flow to distal portions and absence of leaks, narrowness, and/or residual gastric fundus.

Table 2 Mean percentage excess weight loss after sleeve gastrectomy in different periods

1 month	46.7
3 months	74.4
6 months	99.5
12 months	111
25 months	114

After the radiological studies, oral ingestion of fractionated liquids was started, and these were well tolerated. Eleven patients were discharged after 48 h and the remaining nine 72 h after surgery.

There was no morbidity at all up to 30 postoperative days in this group of patients. Four patients developed gallstones 1 year after surgery, of whom three were operated by transumbilical approach and the fourth was operated in another institution by classic laparoscopic approach. Of the 20 patients, 19 were checked up and only 1 (5%) was lost for later follow-up (Table 2). The mean excess weight loss at 6, 12, and 24 months after surgery was 99%, 118%, and 114%, respectively.

Discussion

Ever since laparoscopic surgery has been regarded the new “standard” in abdominal surgery, a permanent quest has existed concerning the further reduction in the number of ports for abdominal access routes. The search has been mainly oriented in two directions: surgery through natural orifices and exclusive access using the transumbilical route [4].

While surgery through natural orifices has progressed very slowly, transumbilical surgery has evolved rapidly, and over the past couple of years, there are several reports of cholecystectomies [10, 11], appendectomies [12], colectomies [13], and nephrectomies [14, 15] performed using this route. The introduction of this form of intervention is closely linked to the development of unique access devices by industry. There are already several of these devices with three or more work channels in clinical use [2, 3], all with a reduced diameter of 3–4 cm.

In bariatric surgery, Saber et al. [16] published the first report of an LSG performed using this route in 2008, stating that seven obese patients with a BMI > 50 kg/m² had undergone surgery with a transumbilical device. There was no need to convert to conventional laparoscopic surgery or open surgery, and the mean operating time was 125 min. After this initial experience, it was recommended as a safe procedure that is technically feasible and reproducible.

We started using unique access devices in 2009, when performing cholecystectomies and appendectomies. However, the rest of the optics and instruments that were used were the same as the ones used for laparoscopic surgery in any medical center; that is, 5- and 10-mm-diameter optics and 30° angle in addition to straight forceps of 5-mm diameter and 43-cm length. Afterward,

we introduced rigid optics of 50-cm length and a curved grip forceps, which have optimized close-up vision, and it avoided instruments bumping into each other outside the abdomen.

This new form of surgery poses a special technical challenge, which is triangulation. When three work channels are used, after the optic is placed, there are only two channels available, which usually are for the section, coagulation, and dissection instruments and for the traction forceps. Counter traction must then be done in a “natural” way, anatomically, taking advantage of the support and immobilization structures that the organs naturally have. In obesity surgery, greater difficulty is added because of the enormous size the patients have, which results in greater distance between the instrument-entering point and the operating site, which is mobile. In this case, one has to be capable of covering the entire stomach to its full extension, considering that the typical length of the instruments is insufficient and that the upper gastric third cannot be reached in a precise and fast way.

To keep both of these aspects that are technically relevant in this technique, and due to the difficulties presented at the beginning of this series, we decided to modify the order of the gastrectomy: starting with the gastric section at the beginning of the operation, when the support elements anatomically hold the stomach allowing for much better presentation and vision of the remaining gastric tube. In a prospective randomized study, Dapri et al. [17] compares two LSG techniques, depending on whether the greater curve is first devascularized followed by the gastric section or vice versa. He concludes that it seems to be easier and takes less time to first section the stomach and then devascularize it.

Lakdawala et al. [18] compared in a randomized prospective study conventional LSG versus transumbilical LSG, with 50 patients per group. They found that the operative time and intraoperative bleeding were similar in both groups, although the transumbilical group had considerably less pain from the eighth hour after surgery, resulting in a decrease in the use of analgesics. Therefore, it has been concluded that the technique benefits are an invisible scar as well as a decrease in postoperative pain. Other descriptive reports of patients who have undergone a transumbilical LSG [19–21] using different devices mention a reported operating time of 2 h without the need of converting to open or conventional surgery, and with little need of resorting to additional trocars in selected populations. The technique is recommended as safe, technically feasible, and reproducible.

The surgeries in our series have also lasted, on average, a little more than 2 h, although they were our first patients. When a new technique is introduced, more time is used in the intraoperative phase, just like when the standard laparoscopic LSG technique started being used some years ago. Two patients also had an umbilical hernia through which a single incision was made in the navel, performing two procedures at the same time: a gastrectomy and an umbilical herniorrhaphy. This situation was not initially expected by us, but we believe that

it is an excellent prescription to undergo surgery via the transumbilical route.

Due to the aforementioned facts and given that this technique requires a new learning curve, we believe that it should be initially reserved for surgeons who are dedicated to gastrointestinal laparoscopic surgery and who should optimize the selection criteria of patients with the purpose of offering short and safe surgical actions. We also believe, without a doubt, that as longer and more angled instruments become available, this surgical technique will become much quicker and safer to perform.

One aspect that must be considered when introducing new techniques and technologies is the financial factor. For us, the cost of the device is the same as or perhaps slightly greater than the cost of the four or five trocars used in a conventional laparoscopy. The rest of the equipment and materials that are used are the same as the ones used for a standard laparoscopic LSG. We believe that in the end, this increase in cost has a very limited impact on the overall cost of obesity surgery.

The objective of this study was to describe the experience of performing sleeve gastrectomy through a single port to demonstrate the feasibility of developing the intervention in this way, while maintaining the quality and safety standards of the gastrectomy. First of all, in this innovative technique, the safety of the patients is backed up by the surgical criteria that specifies the introduction of more trocars (convert to conventional laparoscopic surgery), in other words, as many as needed to perform the operation quickly and safely. Second, the quality of the gastrectomy is safe-guarded by the imagenologic evaluation of the residual stomach through contrast X-ray evaluation of the stomach, which allows measuring and comparing with sleeve gastrectomies performed using the conventional laparoscopic way.

The limitations of this report are that it is a descriptive and small series of patients and they were all females. Nonetheless, the objective was to demonstrate the feasibility of performing single-incision LSG using just standard instruments. The next challenge is to assess outcomes in terms of body weight loss and impact in comorbidities and then patient satisfaction concerning cosmetic issues. There are three minor details that need to be addressed:

- a. The average excess weight loss of 100% at 6 months after surgery is due to the fact that patients had a low preoperative BMI, which produces a greater loss of weight compared with patients with higher BMIs. Therefore, it corresponds to a selective group of patients.
- b. Offering surgery to patients with a BMI less than 35 kg/m² may be considered inadequate. However, there is an important group of patients with this lower BMI but with other important comorbidities such as osteoarticular diseases, cardiovascular problems, and diabetes. Each patient was carefully evaluated and discussed in our multidisciplinary meeting, reaching the consensus to be included in this study.
- c. The addition of another trocar may seem to eliminate the transumbilical concept. Although this is true, the most important point to consider in this surgery is patient's safety much more than surgical interest in finishing surgery by a single-port device. We believe that it adds nothing important to use a small 5-mm trocar if it is needed (in 10% of the patients).

The authors believe that this technical innovation should be available to patients even though this requires further training for surgeons as well as the acquisition of new skills. This technique potentially has significant benefits, mainly a decrease in postoperative pain and an improved cosmetic appearance for patients because there is no visible scar. These aspects and other potential benefits must still be proved in time and through randomized future studies.

In contrast, the application of the transumbilical technique in bariatric surgery presents the challenge of identifying within the obese population the appropriate candidate for this procedure, applying the ideal selection criteria to offer this technique safely and effectively.

Conclusions

The results of the present study suggest that LSG can be successfully performed in selected obese patients with a BMI of less than 40 kg/m² using a unique access device with traditional laparoscopic instruments. The technique allows performing a safe and effective vertical gastrectomy. However, a greater number of patients should be evaluated to prove the efficacy of this procedure, and a longer follow-up is still needed to establish it as a standard technique.

Conflict of interest

Dres. Fernando Maluenda, Juan León, Attila Csendes, Patricio Burdiles, José Giordano, and Macarena Molina have no conflicts of interest or financial ties to disclose.

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