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Three-Dimensional Laparoscopic Sleeve Gastrectomy: Improved Patient Safety and Surgeon Convenience

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One of the aims of laparoscopic surgery is to improve upon the results obtained by open surgery. This clearly appears to have been achieved in bariatric surgery. Two-dimensional (2-D) systems have been used to date, though new 3-dimensional (3-D) technologies have been introduced in an attempt to improve surgeon vision and thus increase the safety of the surgical techniques. Sixty obese patients underwent sleeve gastrectomy using a device equipped with 3-D optics allowing surgery to be viewed by the surgeon in 3 dimensions by using a specific monitor and wearing appropriate glasses. The mean patient age was 48.1 years. The mean weight was 114 kg (range, 92–172), with a mean body mass index (BMI) of 44 ± 5.21 kg/m^2. All surgeries were performed using the 3-D system, with a mean surgical time of 71 ± 49.6 minutes and a mean hospital stay of 3.0 ± 1.2 days. Only 1 intraoperative complication was recorded: retroperitoneal bleeding on insertion of the optical trocar. Over a mean follow-up period of 12 months, the mean body weight of the patients was 88 kg (range, 71–121), with a BMI of 30.56 ± 3.98 kg/m^2 and a percentage excess weight loss of 68.14% ± 7.89%. There was clear improvement of both the blood pressure and glucose levels. Three-dimensional sleeve gastrectomy is safe, viable, and fully reproducible compared with 2-D surgery, improving visualization of the surgical field, safety, and surgeon convenience. Randomized studies involving larger patient samples are needed for the comparison of results.

Key words: 3-D laparoscopy – Bariatric surgery – Metabolic surgery

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In recent years, laparoscopic surgery has become clearly indicated in bariatric and metabolic surgery. This surgical technique has made it possible to reduce morbidity and mortality in comparison with conventional open surgery, and to shorten hospital stay. In addition to the usual 5-trocar technique, laparoscopic surgery has also produced satisfactory results with the single-port approach, which is regarded as less invasive and affords equivalent outcomes and improved aesthetic results.

More recently, the possibility of using three-dimensional (3-D) surgery has been considered. The film *Avatar* (James Cameron, 2006) represented a starting point for a number of multinational medical engineering companies who launched projects that now allow us to use 3-D laparoscopic systems. This new technology offers the perception of depth, which was not previously available.

Sleeve gastrectomy is one of the surgical techniques presently used to treat obesity. It was initially regarded as first-step surgery in patients with a high body mass index (BMI), before performing biliopancreatic diversion. Sleeve gastrectomy is currently considered to be a restrictive technique that can be used as a sole option in morbid obesity, even when accompanied by diabetes mellitus, as contemplated by the International Sleeve Gastrectomy Expert Panel Consensus of 2011.

Three-dimensional laparoscopic sleeve gastrectomy requires 5 ports, like the two-dimensional (2-D) laparoscopic technique, and one of them must be enlarged to extract the sectioned stomach. However, 3-D visualization is very useful in all the surgical steps, as it improves spatial orientation and can increase the safety of the surgical technique.

The present study analyzes the results of 3-D laparoscopic sleeve gastrectomy after a short 1-year follow-up period, with a view to evaluating its safety and feasibility in patients with severe or morbid obesity and type 2 diabetes.

Materials and Methods

Between January and September 2013, we performed 3-D laparoscopic sleeve gastrectomy in 60 patients with severe or morbid obesity and comorbidities. The inclusion criteria were based on the National Institutes Consensus Development Panel report (1991). Accordingly, we included patients with BMI $\geq$35 kg/m^2 associated with comorbid conditions or patients with BMI >40 kg/m^2 with or without comorbidities.

Surgical Procedure

Surgery was performed under standard general anesthesia with orotracheal intubation and no central venous catheterization. Rocuronium was used as muscle relaxant. Neuromuscular monitoring was performed with TOF-Watch SX (Organon Ltd, Dublin, Ireland). The time of extubation was defined by a time of flight (TOF) ratio of over 0.9, with the administration of sugammadex (2 mg/kg) if lower than this value at the end of the operation. The patient was placed in supine decubitus and in the anti-Trendelenburg position, with the surgeon between the legs and an assistant on each side.

We used an Olympus 3-D laparoscopic system (Olympus Ltd, Hamburg, Germany) equipped with optics (Endoeye Flex 3D, Olympus) using 2 high-resolution cameras encapsulated at the distal tip of the device and with high-density imaging sensors in the video-endoscope. The tip allows angulations of 100° in 4 directions and offers very useful visualization of the surgical field, particularly in less-accessible zones. At any time, and by simply pressing a button, we can switch from 3-D to 2-D visualization and *vice versa*. No focusing of the endoscope is needed.

The surgical technique involved a conventional 5-port approach, accessing the abdominal cavity through an optical trocar. The pylorus was first identified, and at a distance of 4 cm, we started to mobilize the greater curvature of the stomach, sectioning its vessels with Caiman (Aesculap, Tuttlingen, Germany) to the angle of His, where we visualized the left crus of the diaphragm. Any adherences between the posterior surface of the stomach and the pancreatic capsule were removed, and the anesthetist then advanced a 36-French bougie to the gastric antrum. Resection of the antrum was started with Echelon 60 Endoflex (Ethicon Endo-Surgery, Cincinnati, Ohio) and gold load (3.8 mm), leaving at least twice the width of the bougie at the level of the incisura angularis. This was followed by resection of the gastric corpus and fundus, using the bougie with blue loads (3.5 mm). On grasping with the endostapler and before triggering the device, the anesthetist checked that the tube was mobile, in order to avoid trapping it by accident. We waited at least 15 seconds before each trigger of the endostapler, and usually required a total of 5 to 6 triggers to fully section the stomach. With the last trigger, we kept away from the esophagus, respecting the fat pad in this area, and triggered the device at a distance of at least 1 cm outside the angle of His. We did not use buttress material at all to reinforce the staple line. Oversewing was performed with polypropylene along the entire sectioned gastric margin. A methylene blue–leak test was performed at the end of the operation, introducing the solution through the bougie and previously pressing upon the gastric antrum. An aspiration drain was placed along the section margins for 5 to 7 days. The trocar on the left side at midclavicular level was enlarged to extract the resected stomach.

Results

The study was carried out between January and September 2013 and included 60 patients (34 men and 26 women). The mean body weight of the patients was 114 kg (range, 92–172), with a mean preoperative BMI of 44 ± 5.21 kg/m^2. The mean patient age was 42.6 years.

The main comorbidities were type 2 diabetes (16 patients), arterial hypertension (8 patients), and obstructive sleep apnea (10 patients). A cholecystectomy was also performed in 3 cases owing to the presence of gallstones.

Surgery proved uneventful in all cases, and the conversion rate to open surgery was 0%. The mean duration of the procedure was 71 ± 49.6 minutes. The 3-D system was used in all cases, and switching to 2-D was only performed on an isolated basis to compare vision between the 2 systems.

As intraoperative complications, we recorded a single case of retroperitoneal bleeding on inserting the optical trocar. Compression was applied for several minutes, without the need for surgery or transfusions. Hemostasis at the end of surgery was satisfactory.

The mean hospital stay was 3.0 ± 1.2 days. There was no morbidity–mortality in our series, and the patients remained on a liquid diet for 20 days, followed by a mashed diet until 1 month after surgery, when food of normal consistency was allowed. Vomiting was recorded during the first month in 12 patients, gradually decreasing in quantity until full resolution 1 month after the operation, without the need for complementary treatment measures. We only insisted on the frequent ingestion of food in small amounts, without mixing solids and liquids. The patients received omeprazole 40 mg via the oral route throughout the follow-up period.

Over the 12 months of follow-up, the mean body weight of the patients was 88 kg (range, 71–121), with a percentage excess weight loss of 68.14% ± 7.89%. The BMI 1 year after surgery was 30.56 ± 3.98 kg/m^2. In our unit, sleeve gastrectomy is the most used technique for bariatric surgery, and it is used as the primary procedure, including super-obese patients in our protocol. None of our patients was subjected to further procedures.

Twelve of the diabetic patients required no medication, and 4 achieved diabetes control with oral antidiabetic drugs alone, without the need for insulin as before surgery. Of importance, in those patients who had had more than 10 years diabetes progression and who had needed treatment with insulin (4 patients), improvement was achieved; they no longer needed insulin and continued treatment with only oral antidiabetic medication. In those patients with less than 10 years diabetes progression and who had not been treated with insulin, control of their diabetes was achieved with diet and without need for medication.

Of the patients with arterial hypertension, 4 were able to suspend medication, and 4 required a lower drug dosage. Furthermore, obstructive sleep apnea was resolved in all cases.

Discussion

The new 3-D laparoscopic systems allow improved visualization, with the sensation of depth, and therefore better spatial orientation. The aim of this new technology is to make surgery more convenient and faster, with increased safety and consequently less morbidity and mortality. Improved vision, founded upon 3-D visualization, is the goal of both these modern devices and of robotic surgery—though the latter is more expensive and involves a longer learning curve. The 3-D systems are a little more expensive than the conventional 2-D systems, though handling is similar in both.

In our experience, and from the start of 3-D surgery, the learning curve was very short, as we quickly became used to the new form of visualization. In the first cases, the duration of surgery was similar to that of previous operations using 2-D systems and was seen to shorten as our experience with 3-D laparoscopy increased. This improvement in laparoscopic skills is also evidenced when expert and novel surgeons perform a series of pelvitrainer tasks—better results are obtained with the 3-D systems than with the traditional 2-D systems.[1–5] In this respect, the 3-D techniques may shorten the learning curve, thereby allowing surgeons to gain expertise in a brief period of time.[1,2]

Mention must also be made of the possible negative effects of these new 3-D systems. The first reports described surgeon dizziness and nausea, though this is no longer a problem with the new systems. A pending issue is possible eye fatigue with this new technology. As evidenced by our own experience, a number of rules should be followed when performing surgery of this kind:

1. The modern 3-D systems use 2 high-resolution cameras at the distal tip of the device. We must establish an adequate distance between our eyes and the monitor, seeking stereopsis comfort zones for optimum visualization, and avoiding the limitations of the human eye.[6] In our system, the distance between the eyes of the surgeon and the monitor should be 2.5 times the diagonal length of the monitor.
2. The current 3-D monitors are less bright than the 2-D monitors; it therefore may be useful to darken the operating room.[6]
3. Brusque movements of the optics are to be avoided as the resulting discomfort is greater than in the case of brusque movements with 2-D systems.
4. It is advisable to occasionally and alternately close one eye and then the other in order to discern whether the optics are dirty, as this is harder to determine than with the 2-D systems.
5. The optical trocar must have generous space with respect to the other trocars in order to avoid contact that can move the lens or instruments located very close to the camera, thereby altering the view.

Our results indicate that these systems may become very useful in the near future. For a few seconds, we compared 2-D versus 3-D visioning in performing common tasks such as suturing or examining the angle of His, switching between the 2 modes by simply pressing a button on the optics. All team members agreed that visualization was better in 3-D, and that consequently the surgical steps were safer—this being the fundamental advantage sought by 3-D laparoscopic surgery.

In conclusion, further prospective studies are needed comparing 2-D and 3-D laparoscopic surgery, with the evaluation of surgery times, safety, and morbidity and mortality. Perhaps, in the near future, improvement in the 2-D systems should be switched to 3-D.

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