# Effectiveness of Elective Laparoscopic Treatment for Colonic Diverticulitis

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## ABSTRACT

**Background and Objectives:** To analyze the short- and long-term outcomes of laparoscopic sigmoid colectomy for the elective treatment of diverticular disease.

**Methods:** A consecutive unselected series of 94 patients undergoing elective laparoscopic sigmoid colectomy for diverticular disease from 2008 to 2012 was analyzed. We collected patients-, surgery- and hospital stay–related data, as well as the short- and long-term outcomes. Operative steps, instrumentation, and postoperative cares were standardized. Comorbidity was assessed by Charlson comorbidity index. Complications were classified using the Clavien-Dindo classification system. The qualitative long-term assessment was carried out by subjecting patients to the validated gastrointestinal quality of life index questionnaire before and after surgery.

**Results:** The mean age of our cohort was 61.3 ± 11.0 years with a Charlson comorbidity index of 1.2 ± 1.5.

Mean operative time was 213.5 ± 60.8 minutes and estimated blood loss was 67.2 ± 94.3 mL. We had 3 cases (3.2%) of conversion to open laparotomy. The rates of postoperative complications were 35.1%, 6.3%, 2.1%, and 1.06%, respectively, for grades 1, 2, 3b, and 5 according to the Clavien-Dindo system. Length of hospital stay was 8.1 ± 1.9 days, and we have not recorded readmissions in patients discharged within 60 days after surgery. Median follow-up was of 9.6 ± 2.7 months. We observed no recurrence of diverticular disease, but there was evidence of 3 cases of incisional hernia (3.19%). The difference between preoperative and late gastrointestinal quality of life index score was statistically significant (97.1 ± 5.8 vs 129.6 ± 8.0).

**Conclusions:** Elective laparoscopic treatment of colonic diverticular disease represents an effective option that produces adequate postoperative results and ensures a satisfactory functional outcome.

**Key Words:** Laparoscopic surgery, Sigmoid colectomy, Diverticular disease, Elective surgery.

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## INTRODUCTION

The hospitalization rates and the social impact of diverticular disease in Western countries have drastically increased.[1] It is estimated that >1 of 4 European citizens is affected by diverticula of the colon and therefore could potentially develop advanced clinical disorders associated with this condition. Acute diverticulitis affects between 10% and 25% of people with diverticulosis, although these epidemiological data are very dated. The prevalence of diverticular disease is age-related, affecting about 60% of people over 80 years of age regardless of sex.[2] In this sense, and in consideration of the progressive increase of the mean age of the population, diverticula-related diseases are a common cause of hospitalization. In addition to patients with acute complicated and uncomplicated diverticulitis, there are others who are affected daily by functional disorders associated with diverticular disease, with significant social costs and loss in productivity. The therapeutic request of the latter is to restore an acceptable quality of life. Over the past 20 years, laparoscopic surgery has revolutionized the treatment of both malignant and benign colorectal diseases. The minimally invasive techniques allow us to obtain excellent results in the short term, in full compliance with the standard of care. The aim of this study is to analyze the effectiveness of laparoscopic sigmoid colectomy for the elective treatment of diverticular disease. This analysis was carried out through the evaluation of short- and long-term surgical outcomes and through the responses of patients by an appropriate validated questionnaire for calculating the perceived quality of life before and after the surgical procedure. Our hypothesis is that the laparoscopic treatment can ensure both adequate postoperative results in full compliance with the standards of care and an increase in quality of life.

## METHODS

A consecutive unselected series of 94 patients undergoing laparoscopic sigmoid colectomy at our division from January 1, 2008 to December 31, 2012 was analyzed. The indications for elective surgery were both multiple episodes of uncomplicated acute diverticulitis and single episodes of complicated acute diverticulitis with primary resolution by conservative treatment or laparoscopic drainage of abdominal abscess. All patients eligible for surgery were candidates for laparoscopic treatment. Only those unsuitable from an anesthesiologic point of view or who had not given their consent to laparoscopy were treated by traditional surgery. Preoperative contrast-enhanced computed tomography of the abdomen, colonoscopy, and barium enema were used in all cases. All data were recorded in a prospectively maintained database and were retrospectively processed. We collected patients-, surgery- and hospital stay–related data, as well as the short- and long-term outcomes, as summarized in **Table 1**. Comorbidity of each patient was assessed by Charlson comorbidity in-

dex.[3] From 2008 to 2011, patients were subjected to mechanical bowel preparation using polyethylene glycol 70 + 70 g/2 L the day before surgery, whereas from 2011, no patients underwent any bowel preparation. All patients were treated with both short-term broad-spectrum intravenous antibiotics (ceftizoxime plus metronidazole) and antithrombotic prophylaxis by low molecular weight heparin according to body weight. A nasogastric tube and a urinary catheter were placed after induction of general anesthesia in all cases. In selected cases we placed a left ureteral stent before starting the surgical procedure. All the operations were performed or supervised by the same team; the team was fully trained in both colorectal and minimally invasive surgery. We used a 4-port medial-to-lateral standardized laparoscopic technique, as summarized in the following steps. Surgical instrumentation was standardized, and dissection was performed by harmonic scalpel (Harmonic ACE, Ethicon Endo-Surgery, LLC, Guaynabo, Puerto Rico).

### Surgical Technique

The patient was placed in a classical Lloyd-Davis position with the left arm abducted and the right one along the body. The surgeon and the camera-holder stood on the right side of the patient and the assistant surgeon on the left. During the procedure, the operating table was tilted toward the right and ranged between Trendelenburg and reverse Trendelenburg positions depending on the operative steps. Pneumoperitoneum was inducted to a pressure of 12 mm Hg by the insertion of a 10-mm disposable Hasson trocar about 5 cm cranially to the umbilicus at the midline. An accurate peritoneal inspection was carried out through a 30° camera to evaluate whether the case was suitable for laparoscopic surgery. Then 3 trocars were placed: one 10/12-mm trocar in the right flank (T2) and 2 10-mm trocars in the right lower quadrant (T3) and in the left flank (T4), respectively. If we needed to mobilize the colonic splenic flexure, we started by opening the gastrocolic ligament with access to the lesser sac. The transverse mesocolon was dissected from right to left, exposing and preserving the capsule of the pancreatic tail. The left colonic angle was thus freed from splenic adhesions by the section of the splenocolic ligament. A lateral dissection completed the liberation of the splenic flexure. We continued then by an upward traction of the left colon sigma, which enabled a medial to lateral approach. The sacral promontory was identified and the peritoneum was opened at that level. We dissected the peritoneum in a caudal to cranial direction, and, after identifying both the inferior mesenteric artery (AMI) and vein, we separated

**Table 1.**
Prospective Study Data Analyzed

| Data | Item |
|---|---|
| Demographics/pathology | Age, y |
| | Sex |
| | BMI, kg/m$^2$ |
| | ASA score |
| | Charlson comorbidity index |
| | Previous acute episodes |
| Surgery-related | Procedure |
| | Conversion rate |
| | Operative time, min |
| | Estimated blood loss, mL |
| | Length of skin incision, mm |
| | Use of abdominal drainage |
| Short-term outcomes | Time of first stool, d |
| | Early postoperative complications[a] |
| | Length of hospital stay, d |
| Long-term outcomes | Late postoperative complications |
| | Functional outcomes[b] |

Abbreviations: ASA, American Society of Anesthesiology; BMI, body mass index.

[a]Clavien-Dindo classification system.

[b]Determined by the gastro intestinal quality of life Index.

the white line of Toldt from the Gerota fascia under the arch of Treitz, with right identification of the left ureter and gonadal vessels. AMI and inferior mesenteric vein were isolated and dissected by 10-mm clips (Ligaclip, Ethicon Endo-Surgery), respecting both the inferior mesenteric and the hypogastric plexus. The left sigmoid colon was laterally freed through the dissection of the left parietocolic ligament along the line of Monk. The intestine was distally resected at the level of the upper rectus by an endoscopic linear stapler (Echelon Flex 60, Ethicon Endo-Surgery) with blue-load (3.5-mm × 6 rows, Ethicon Endo-Surgery). We performed a minilaparotomy in the lower left quadrant, enlarging the T4 incision. From that site, adequately protected (Steri-drape, 3M Healthcare, St. Paul, Minnesota), the left colon sigma was exteriorized with subsequent sigmoidectomy and insertion of the anastomotic anvil inside the proximal left colon. So the bowel was replaced into the abdominal cavity and the pneumoperitoneum restored. An end-to-end colorectal anastomosis using the Knight-Griffen technique was made by a transanal circular stapler (Endoscopic Curved Intraluminal Stapler—ILS 29 mm, Ethicon Endo-Surgery). The omentum was then relocated whenever possible to cover the anastomosis and finally both the port sites and minilaparotomy were synthesized for layers.

We did not use drains routinely. Postoperative medical and nursing care was standardized. The clinical course was documented for each patient. All patients were mobilized early with removal of the urinary catheter, with the exception of those preoperatively suffering from colovesical fistula, in which the catheter was maintained for 7 days. The nasogastric tube was removed after the first flatus. Criteria for the discharge included absence of symptoms, tolerance of a minimum of 3 meals without restrictions, and passage of stool. All adverse events that occurred within 30 days after surgery were considered complications. Complications were classified using the Clavien-Dindo classification system.[4] Anastomosis was routinely checked by water-soluble contrast enema on postoperative days 6 or 7. The term *anastomotic leakage* defines all conditions with clinical or radiological anastomotic dehiscence, with or without the need for surgical revision. The short- and long-term follow-up were conducted at 5 and 30 days after discharge and at 6 and 12 months after surgery, respectively. The qualitative long-term assessment was carried out by subjecting patients to the validated questionnaire gastrointestinal quality of life index (GIQLI),[5] via telephone or direct interview between 6 and 12 months after surgery, after obtaining proper consent.

## Statistical Analysis

Continuous and categorical variables were expressed as mean ± SD and as percentage value, respectively. The long-term qualitative assessment has been graphically represented with box-and-whiskers plot and compared using Student *t* test. A *p* value of < 0.05 was considered statistically significant. Statistical analysis was performed using R (version 2.15.1; The R Foundation for Statistical Computing).

## Ethics

Institutional review committee approval was not required because the data of the present study were collected in the course of routine clinical practice and, therefore, are considered valid according to the informed consent signed by each patient for any surgery or other procedure. The study protocol conforms to the ethical guidelines contained in the "World Medical Association Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects" adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964, then revised in Tokyo 2004.[6]

## RESULTS

Patient- and disease-related data are listed in **Table 2**, and intraoperative and short-term results are summarized in **Table 3**. In all cases, the definitive histological examination of the specimen demonstrated the presence of diverticula in association with diverticulitis and peridiverticulitis, conditioning sometimes an inflammatory pseudotumor. We did not record incidental findings of malignancy. We had 3 cases (3.2%) of conversion to open laparotomy due to prolonged anatomical difficulties that did not allow us to safely continue the laparoscopic procedure. Postoperative complications, classified according to the Clavien-Dindo system, are summarized in **Table 4**. We recorded 2 cases of reoperation (2.1%), one for a postoperative bleeding and the other for a fecal peritonitis from a nearly complete early anastomotic dehiscence. This latter case was fatal, hence the mortality rate of 1.06%. In the remaining discharged patients, we did not record readmissions within 60 days after surgery. The mean length of hospital stay was 8.1 ± 1.9 days. We observed no recurrence of diverticular disease during the clinical follow-up, although there was evidence of 3 cases (3.19%) of incisional hernia. **Figure 1** shows the results carried out by the GIQLI validated questionnaire before the procedure and at follow-up of 9.6 ± 2.7 months. The percentage of participation was 82.9% (78 patients). The preoperative (97.1 ±

**Table 2.**
Patient- and Disease-related Data

|  |  | N = 94 |
|---|---|---|
| Age, y |  | 61.3 ± 11.0 |
| Male/female |  | 58/36 |
| BMI |  | 26.2 ± 3.7 |
| ASA score |  |  |
|  | I | 24 (25.5) |
|  | II | 57 (607) |
|  | III | 13 (13.8) |
|  | IV | 0 (0.0) |
| Charlson comorbidity index |  | 1.2 ± 1.5 |
| Previous acute episodes |  |  |
| Uncomplicated acute diverticulitis |  |  |
| 1 |  | 30 (31.9) |
| 2 |  | 34 (36.1) |
| 3 or more |  | 15 (16.0) |
| Complicated acute diverticulitis |  |  |
| 1 |  | 15 (100.0) |
| 2 or more |  | 0 (0.0) |

Abbreviations as in Table 1.
Values are mean ± SD or n (%).

**Table 3.**
Short-term Outcomes

|  | N = 94 |
|---|---|
| Conversion rate | 3/94 (3.2) |
| Operative time, min | 213.5 ± 60.8 |
| Estimated blood loss, mL | 67.2 ± 94.3 |
| Length of skin incision, mm | 55.1 ± 6.4 |
| Use of drainage | 28/94 (29.7) |
| Time of first stool, d | 4.4 ± 1.7 |
| Length of hospital stay, d | 8.1 ± 1.9 |

Values are mean ± SD or n/N (%).

**Table 4.**
Complications According to Clavien-Dindo Classification System

| Grade |  | N = 94 |
|---|---|---|
| I | Antiemetic | 15 (15.9) |
|  | Diuretic | 10 (10.6) |
|  | Wound infection | 8 (8.5) |
|  | Total | 33 (35.1) |
| II | Blood transfusion | 6 (6.3) |
|  | Total | 6 (6.3) |
| IIIa | Total | 0 (0.0) |
| IIIb | Reoperation | 2 (2.1) |
|  | Total | 2 (2.1) |
| IVa | Total | 0 (0.0) |
| IVb | Total | 0 (0.0) |
| V | Mortality | 1 (1.06) |
|  | Total | 1 (1.06) |

Values are n (%).

5.8) and late (129.6 ± 8.0) feedback data were statistically significant.

## DISCUSSION

Given the increased prevalence of colonic diverticular disease in the last decades, the surgical treatment of pa-tients with diverticulitis in both elective and emergency situations has become an important topic of discussion.

However, despite a considerable number of papers, the indications, choice of technique, and timing for surgery are still subject to debate, lacking level 1A evidence. Laparoscopic surgery has revolutionized the treatment of many diseases of surgical interest. In 1991, Jacobs et al[7] published the world's first series of laparoscopic-assisted colorectal procedures wherein of 20 reported cases, 5 were laparoscopic sigmoidectomies for diverticular disease. Since then, the minimally invasive treatment of diverticular disease has proved feasible and effective. Laparoscopy minimizes postoperative pain and respiratory distress, reducing the length of hospital stay and improving the return to an active life. The largest published series of laparoscopic sigmoid colectomies for diverticular disease, > 500, has shown excellent results in terms of conversion rate (2.8%), anastomotic leakage (1.4%), and overall mortality (0.2%).[8] Furthermore, the only meta-analysis available today, by Siddiqui et al[9], showed a
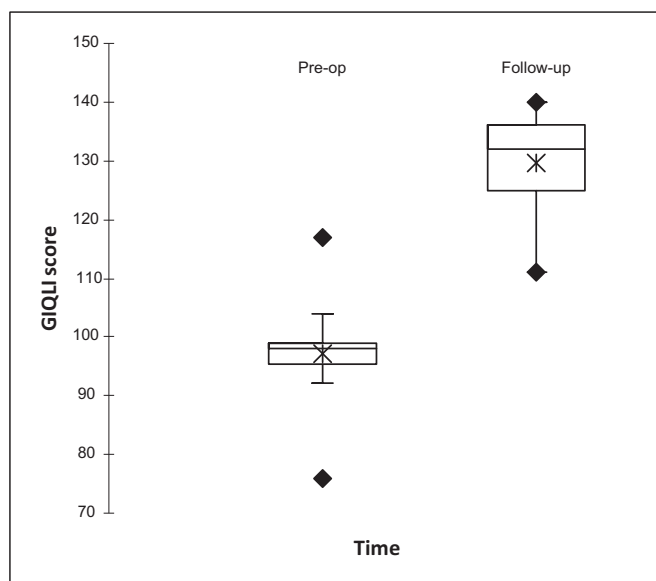
**Figure 1.** Box-whiskers plots show GIQLI scores before surgery and at follow-up. GIQLI, gastrointestinal quality of life index.

statistically better outcome for laparoscopic surgery compared with open surgery in terms of time of canalization, hospital stay, and morbidity rate.

Our results are consistent with those of other investigators in the literature, some of which are summarized in **Table 5**. The mean length of hospital stay is higher than that shown in some series, but not in all, as we routinely submit patients to a water-soluble contrast enema in postoperative days 6 or 7. We use the enema to check for proper anastomotic transit and the absence of subclinical leakage. We considered the preoperative comorbidity using the Charlson comorbidity index. This assessment produces values well-correlated to the morbimortality, allowing us to objectively stratify the risk through the analysis of 19 tracer diseases, each of which contributes to the total score on a scale from 1 to 6. Although the mean value obtained (1.2 ± 1.5) may seem rather low, it indicates a mild-to-moderate risk case group. In fact, a Charlson score > 5 usually indicates a severe comorbidity, noting that in the original work by Charlson et al[16] a score > 3 was associated with a 10-year survival of 45%. Body mass index is excluded from this assessment of comorbidity; however, in our cohort, it was 26.2 kg/m$^2$, which is perfectly in line with the European population's mean of 26.5 kg/m$^2$. [17] However, according to the guidelines of the World Health Organization, these body mass indexes connote a condition of preobesity. In our experience, a body mass index > 25 is not a contraindication to laparoscopic surgery; in fact, we firmly believe that obese people can benefit

from minimally invasive colorectal surgery versus conventional procedures.[18]

Due to the inflammatory nature of the disease to be treated, the operative time is relatively higher compared with the time for the same surgery for cancer. Moreover, the primary surgical goals are to completely remove the colonic segment affected by diverticula and to perform a totally tension-free anastomosis; to do this it was necessary perform full mobilization of the colonic splenic flexure in > 50% of cases. Mobilization of the left angle of the colon is a challenging laparoscopic step that results in a substantial increase in operating time. In order to identify a proper training pathway in laparoscopic colorectal surgery, Jamali et al[19] have collected the opinions of 35 experts in the field and then published a ranking of difficulty for 12 minimally invasive procedures of the lower digestive tract. Their results showed a significant increase in difficulty between the simple sigmoidectomy and the sigmoidectomy with mobilization of the splenic flexure. The learning curve in laparoscopic colorectal surgery aims not only to achieve a technical proficiency but also to ensure adequate functional or oncological results. The breakpoint is estimated at around 50 to 60 procedures, as indicated by Tekkis et al.[20] Although in our view, a proper attitude resulting from a progressive training in minimally invasive surgery could lower these numbers.

Complications were classified according to the Clavien-Dindo system. This choice comes from the need to standardize the assessment of surgical outcomes. To date, there is no consensus on how to define and classify the severity of complications following surgery. Often, the dichotomy between "major" and "minor" complications, without further explanations, is proposed. This raises the risk of assessing differently the results of surgery, with highly variable outcomes for similar procedures. To overcome these potential biases, in 2004, Dindo and Clavien proposed a classification system that estimates the severity of complications depending on the resources used to solve them, and they tested it on a prospective cohort of 6336 patients undergoing elective surgery between 1988 and 1997.[5] After a single episode of acute uncomplicated conservatively treated diverticulitis, the probability of developing a second episode within 5 years is between 25% and 30%, with a proportional increase in the risk of diverticulitis complicated by free perforation and peritonitis. In addition, the rate of patients who remain symptomatic despite having no further hospitalizations after a first acute episode varies between 40% and 80%, resulting in an increase of the health and social costs.[21] For some years, the guidelines from the American Society of Colon and Rectal Surgeons[22] and the European Society for Endoscopic

**Table 5.**
Elective Laparoscopic Treatment—Reports in the Literature

| Authors | Type | Year | N | Morbidity, % | Anastomotic Leakage, % | Conversion Rate, % | Hospital Stay, d | Mortality, % |
|---------|------|------|---|-------------|------------------------|--------------------|-----------------|--------------|
| Schwandner et al[10] | MNC | 2004 | 396 | 18.4 | 1.6 | 6.8 | 11.8 | 0.5 |
| Alves et al[11] | MTC[c] | 2005 | 163 | 5.5 | 1.2 | 15.3 | 10 | 0 |
| Jones et al[9] | MNC | 2008 | 500 | 11.0 | 1.4 | 2.8 | 4 | 0.2 |
| Forgione et al[12] | MNC | 2009 | 46 | 6.5 | 0 | 2.0 | 5 | 0 |
| Klarenbeek et al[13] | RCT | 2009 | 52 | 9.6 | 5.3 | 19.2 | 5 | |
| Gervaz et al[14] | RCT | 2010 | 59 | 5.0 | 0 | 8.5 | 5 | 0 |
| Raue[15] | RCT | 2011 | 75 | 37.0 | 5 | 9.0 | 9 | 0 |

Abbreviations: MNC, monocentric; MTC, multicentric; RCT, randomized clinical trial.

Surgery[23] have recommended an elective surgical treatment after 2 episodes of uncomplicated diverticulitis and after a single episode of complicated diverticulitis But these recommendations have been criticized by some investigators and are not currently included in the latest version of American Society of Colon and Rectal Surgeons guidelines.[24] The current trend seems to prefer a tailored approach to each patient individually, assessing the medical history, the answer to the first acute episode, and the chronic symptoms. Indeed, in 2010, Mäkelä et al[25] published the review of a large 20-year series of patients hospitalized for acute diverticulitis, and they concluded that ≥2 acute episodes would not justify an elective surgical treatment. But the epidemiological considerations by Peppas et al[21] on > 30,000 cases have estimated a hospital readmission rate of 18.6% in patients treated conservatively compared with 6.1% in patients undergoing surgery. Patients in our series underwent laparoscopic surgical treatment after 1 or 2 episodes of uncomplicated diverticulitis in 78% of cases, as well as after a single episode in all cases of complicated diverticulitis. This confirms our current view, which is to undergo surgery after the first acute episode in patients under age 60 years and after 2 episodes in the remaining patients unless contraindicated otherwise. The indications for surgery are inspired by the observation that a growing number of acute episodes is directly proportional to both the conversion rate and the incidence of postoperative complications, whereas patients with < 3 acute episodes can effectively benefit from a minimally invasive surgical treatment.[26] Moreover, we believe that some factors such as lower comorbidity and the search for improvements in quality of life can motivate an earlier treatment in patients < 60 years.

Most of the literature that aimed to study the surgical treatment of diverticular disease almost exclusively analyzed the short-term outcomes, leaving for consideration the functional ones. The long-term outcomes are reported only by a few investigators and are contradictory. Egger et al[27] have reported that 25% of the 124 patients had "bad" functional outcomes—symptoms such as painful constipation, abdominal distension, and diarrhea—although the severity was not quantified. Ambrosetti et al[28] analyzed a series of 43 patients who underwent elective laparoscopic sigmoidectomy and concluded that minimally invasive surgery had given excellent functional outcomes, despite the 9.3% of patients who reported the occurrence of new symptoms of abdominal pain that the investigators then explained as a concomitant irritable bowel syndrome. Raue et al[15] reported that the quality of life evaluated by the European Organization for Research and Treatment of Cancer – Quality of Life Questionnaire (EORTC-QLQ-C30) did not differ between open and laparoscopic technique, neither at 30 days nor at 12 months after surgery. The SIGMA trial interim results showed, after 6 weeks from the operation, a significantly better quality of life for the laparoscopic group, assessed by the SF-36 questionnaire; this outcome decreased at the 6-month follow-up.[29] A prospective assessment through the validated GIQLI questionnaire was made by Forgione et al[12] who analyzed both the pre- and postoperative results of 46 patients who underwent minimally invasive treatment for diverticular disease and concluded that laparoscopic sigmoidectomy produced statistically significant results in terms of short- and long-term quality of life. Our experience confirms these latest results, with postoperative GIQLI mean values higher by > 20% compared with preoperative values, indicate a significant improvement of the quality of life of patients.

The use of the GIQLI questionnaire was partially discussed and criticized because it evaluates not only the typical symptoms of the lower digestive tract but also more general

symptoms.[30] On the contrary, we believe that this feature defines the real indication for an overall assessment of performance status, psychological well-being, and quality of life after colorectal surgery. After surgical resection of the sigmoid colon and rectum, some patients report symptoms such as fecal incontinence, soiling, urgency, and difficulty to discriminate between liquids and gases. This condition is called postoperative defecatory disorder (PDD). The etiology of PDD is not clear, but it could have multiple causes: an iatrogenic denervation of the left and sigmoid colon, a hypogastric plexus injury in the course of rectal mobilization, or a sphincter lesion caused by the insertion of the stapler. During laparoscopic sigmoidectomy, the incomplete mobilization of the rectum minimizes the hypogastric plexus injuries. However, some investigators suggest as a possible cause of PDD the potential injury of both the ascending fibers from the pelvic plexus and the descending fibers from the inferior mesenteric plexus.[31] These lesions may be caused by a "high" ligation of the AMI. So, some investigators proposed AMI preservation with contextual section of the arterial branches proximal to the sigmoid colon.[32] Although this topic requires further research leading to higher levels of evidence, our experience does not confirm the need for a distal arterial ligation. The results in terms of quality of life and bowel comfort stressed the effectiveness of a technique that involves AMI ligation at this origin from the aorta, with careful identification of perivascular nerve plexus thanks to the magnification of the image given by laparoscopy. In addition, the high ligation allows precise identification and compliance with the anatomical fascial planes, minimizing any technical difficulties due to distorsion by previous flogistic episodes, and thus reducing drastically the conversion to laparotomy rate.

## CONCLUSIONS

The elective laparoscopic treatment of colonic diverticular disease is an effective and safe option that produces adequate postoperative results and ensures a satisfactory functional outcome for the patient. The obtained results confirm the appropriateness of both the choice of technique and the timing for surgery.

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