Laparoscopic Abdominal Wall Hernia Repair

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ABSTRACT

Background and Objectives: The aim of this retrospective monocentric study was to evaluate results and recurrence rate with long-term follow-up after laparoscopic incisional/ventral abdominal hernia repair.

Methods: This was a retrospective, single-center, observational trial, collecting data from patients who underwent laparoscopic incisional/ventral abdominal hernia repair using the open intraperitoneal onlay mesh technique and a single mesh type. All patients signed an informed consent form before surgery.

Results: A total of 1,029 patients were included. The median surgery time was 40 min (range 30–55) and the median length of hospital stay was 2 d (range 2–3). Intraoperative complications occurred in two of 1,029 patients (0.19%), whereas early postoperative surgical complications (within 30 d) occurred in 50 patients (4.86%). Postoperative complications according to Clavien-Dindo classification were as follows: I, 3.30% (34 of 1,029); II, 0.97% (10 of 1,029); IIIb, 0.58% (six of 1,029); IV, 0.00% (none of 1,029); and V, 0.00% (none of 1,029). During follow-up, bulging mesh was diagnosed in 58 of 1,029 patients (5.6%), and hernia recurred in 40 of 1,029 patients (3.9%). A mesh overlap equal to or greater than 4 cm appeared to be a significant protective factor for hernia recurrence (P < .001); a mesh overlap equal or greater than 5 cm appeared to be a significant protective factor for bulging (P < .001), whereas the use of resorbable fixing devices was a significant risk factor for hernia recurrence (odds ratio, 111.53, 95% confidence interval, 21.53–577.67).

Conclusion: This study demonstrates that laparoscopic repair of ventral/incisional abdominal wall hernias is a safe, effective, and reproducible procedure. Identified risk factors for recurrence are an overlap of less than 4 cm and the use of resorbable fixation means.

Key Words: incisional hernia, ventral hernia, laparoscopic repair, intraperitoneal onlay mesh.

INTRODUCTION

Laparoscopic incisional and ventral hernia repair is a safe and worldwide accepted surgical procedure performed. In various studies there are compared different mesh types, or with follow-up periods that are too short to analyze the long-term complication and recurrence rates. Primary and incisional abdominal wall hernias are common issue in adult population, whereas incisional hernias represent a common complication in the long-term follow-up in patients who have undergone open abdominal surgery, with a reported incidence of up to 30% in laparotomies. Laparoscopic treatment for incisional hernias was initially described by Leblanc and Booth in 1993, and currently represents the surgical strategy of choice because of its well-recognized advantages. During the last 20 years, the use of laparoscopic ventral hernia repair has rapidly increased because of its benefits compared with open surgery. Laparoscopic repair is superior to open repair in terms of less blood loss, fewer abdominal wall complications, and shorter hospital stay with a similar incidence of recurrence. Widely recognized key factors in obtaining good results and decreasing complicat-
cation and recurrence rates include the following: careful patient selection, taking into account age, gender, comorbidities, site and size of the abdominal wall defect; mesh, i.e., type, size and shape of the mesh; mesh fixing devices, which can be nonabsorbable staples, absorbable staples, fibrin glue, or transfascial sutures, either used on their own or in varying combinations.\textsuperscript{11,12} A large number of articles involving numerous series of patients undergoing laparoscopic repair of incisional hernia have been published.\textsuperscript{13} To overcome the limitations of the available literature data, this monocentric study analyzed patients who underwent laparoscopic repair of an abdominal wall hernia or incisional hernia using only the open intraperitoneal onlay mesh technique and using a single mesh type, i.e., a composite polyester mesh with a hydrophilic film (Parietex Composite mesh; Medtronic, Minneapolis, MN). The aims of this monocentric retrospective study is to analyze the results (medical and surgical complications, bulging, recurrences) in the short, medium, and long term. Any risk factors identifiable in the population will be analyzed statistically, both with regard to the clinical features and the surgical technique. The main aim of this study was to analyze risk factors for long-term recurrence after laparoscopic repair.

**MATERIALS AND METHODS**

We present short-, medium-, and long-term results of our work, after more than 1,000 operations for incisional/ventral hernia repair with a minimally invasive approach, from January 2001 to June 2017 at the San Marco Hospital–GSD (Bergamo, Italy) (before at the San Giuseppe Hospital (Milan, Italy) since 2008 to 2010; at San Gerardo Hospital (Monza, Italy) since 2001 to 2008); during this period the surgical team worked in these three centers; therefore, all cases are considered. Follow-up was performed by the team throughout the period. For all patients included, the following data were collected from the hospital records: age, gender, body mass index (BMI), comorbidities, American Society of Anaesthesiologists score, size and site of the abdominal wall defect, previous abdominal surgery, preoperative assessment, surgical timing (elective or emergency), surgery time, intraoperative complications, fixing devices, mesh overlap, conversion rate, postoperative complications, early repeated surgery, and length of hospital stay. All patients who underwent laparoscopic repair of an abdominal wall defect and/or an incisional hernia during the study period were eligible for inclusion in the study. Inclusion criteria were a symptomatic hernia of the abdominal wall and/or an incisional abdominal hernia, laparoscopic repair with intraperitoneal mesh (intraperitoneal onlay mesh technique), non-closure of the wall defect, and use of the composite polyester mesh (Parietex Composite mesh; Medtronic). Prior to surgery, patients underwent a clinical assessment, during which an ultrasound (US) or computed tomography (CT) scan was performed, depending on the surgeon’s choice, but it was uncommon (32 of 1,029 patients; 3.1%). All patients received short-term prophylactic antibiotic treatment with 2 g of intravenous cefotaxime or 2.2 g of intravenous amoxicillin-clavulanic acid 1 h before surgery, plus deep-vein thrombosis prophylaxis with compression stockings and 0.3 mL of subcutaneous n-dropanin calcium (0.4 mL in cases of BMI ≥30 kg/m\(^2\)) 12 h before surgery. All patients signed an informed consent form before surgery.

**Surgical technique**

The procedures were performed laparoscopically under general anesthesia. In most cases, three ports were used, placed on the left side of the abdomen, whereas for large defects (diameter larger than 10 cm), one or two additional ports were positioned on the right side of the abdomen. Pneumoperitoneum was created using a Veress needle to achieve an intraabdominal pressure of 14 mm Hg. In all cases, a 30° laparoscope was used. First, adhesiolyis is performed to recognize the size of the hernia, separating each anterior abdominal wall adhesion and visualizing the whole laparotomic wound to assess the presence of small defects. Wall defects were measured, both in the longitudinal and transverse direction, and in all cases the Parietex Composite mesh (Medtronic) was used, selecting the right size to achieve a circumferential overlap of at least 4–5 cm. Identification of the defect was made on the skin, and the overlap was determined using a skin marker pencil on the external abdominal wall. Before placing the mesh, careful inspection of any potential bowel tears and bleeding to the wall was performed. Mesh was then moistened, rolled with hydrophilic gel inside, and finally introduced through a 12-mm port, unfolded, orientated, and centered on the defect, with hydrophilic gel placed toward the bowel and the polyester side toward the abdominal wall. Then the mesh was suspended using transcutaneous sutures and fixed in place with the circumferential application of either absorbable or nonabsorbable staples, depending on the surgeon’s choice, according to the double-crown technique. Hemostasis was achieved before removal of the trocars, and no abdominal or subcutaneous drains were placed. All 10- and 12-mm port fascial openings were closed, and an elastic bandage was placed before the patients were woken.
Once discharged from hospital, patients were invited for follow-up visits, including a clinical evaluation at 1 mo, then for just a clinical examination at 3, 6, and 12 mo, and then annually. Follow-up US or CT scan evaluations were performed if the clinical visit alone was not sufficient to rule out complications.

Statistical analysis

Categorical variables are reported as frequencies and percentages, whereas continuous variables are reported as a median and interquartile range (IQR) because of nonnormal distributions. Univariate analysis of the differences between groups was performed using the \( \chi^2 \) test for categorical data (with Fisher correction when needed) and using the nonparametric Mann-Whitney test for continuous variables. To identify potential predictors of clinical outcome (recurrence and early postoperative surgical complications), a multivariate analysis using logistic regression models was then performed. The covariates included in the final model were those with a univariate value of \( P < .05 \). Results are expressed as odds ratios (OR) with 95% confidence intervals (CI). Furthermore, a Spearman's correlation was run to assess the relationship between surgery time and the overlap measurement. For all the tests used, the statistical significance level was set at the conventional \( P < .05 \). The results were analyzed using StataSE 15 statistical software (Stata Corp., College Station, TX).

RESULTS

A total of 1,029 patients were recruited, including 568 males (55.20%) and 461 females (44.80%). The median age was 61 y (range 25–90) and the median BMI was 27 kg/m\(^2\) (range 16.6–74.0). These data and comorbidities are presented in Table 1 along with demographic and preoperative data. Regarding preoperative assessment, 96.1% of patients underwent a clinical diagnosis, whereas the rest underwent a radiological examination: a CT scan of the abdomen in 3.66% of cases and US of the abdominal wall in 0.24%.

Regarding the surgical procedure, 95.43% of patients underwent an elective operation (982 of 1,029 patients), whereas 4.57% had emergency surgery (47 of 1,029). For 7.29% of patients, the overlap was measured as 1–3 cm, in 17.88% it was 4 cm, in 39.16% it was 5 cm, in 33.92% it was between 6 and 9 cm, and for 1.36% of cases, it was more than 10 cm. Several devices were used to fix the mesh to the abdominal wall, which were characterized as resorbable in 92 of 1,029 patients (8.4%), nonresorbable in 867 of 1,029 (84.26%), sutures or fibrin glue in 15 of 1,029 (1.46%), and multiple devices in 55 of 1,029 patients (5.34%). Only glue was used in 29 of 1,029 cases (2.84%). The median surgery time was 40 min (IQR, 30–55, range 10–175 min); more specifically, for 81.73% of patients, the surgical procedure lasted less than 60 min, and for 16.13% it lasted between 60 and 120 min, whereas it lasted more than 2 hours for only 2.14% of cases. For 65.50% of patients (674 of 1,029), a second procedure was combined with the hernia repair (e.g., adhesiolysis, 492 of 674 patients, 73.0%, inguinal hernia repair, cholecystectomy, or others). Intraoperative complications occurred in two of 1,029 patients (0.19%, bowel perforation). Laparotomic conversion occurred in six of 1,029 cases (0.58%). These data are summarized in Table 2.

| Table 1. Characteristics of the Population and Comorbidities |
|-------------------------------------------------------------|
| Population: 1,029                                           |
| Median (IQR), Range                                         |
| Age (years)                                                | 61 (48; 70), 25–90 |
| BMI (kg/m\(^2\))                                           | 27 (24; 30.2), 16.6–74.0 |
| Sex (M/F)                                                  | 568 (55.20%)/461 (44.80%) |
| ASA score 1                                                | 155 (15.06%) |
| ASA score 2                                                | 640 (62.20%) |
| ASA score 3                                                | 229 (22.25%) |
| ASA score 4                                                | 5 (0.49%) |
| Comorbidities                                              |                |
| COPD                                                       | 145 (14.09%) |
| Diabetes mellitus                                          | 167 (16.23%) |
| Cardiovascular diseases                                    | 97 (9.43%) |
| Hypertension                                               | 518 (50.34%) |
| OAT                                                       | 27 (2.62%) |
| Steroid therapy                                            | 13 (1.26%) |
| Radiotherapy                                               | 40 (3.89%) |
| Smoke                                                      | 270 (26.24%) |
| Overweight (BMI ≥25 kg/m\(^2\))                            | 325 (31.58%) |
| Obesity (BMI ≥30 kg/m\(^2\))                               | 206 (20.02%) |
| CRF                                                       | 7 (0.68%) |
| HCV-related liver disease/ cirrhosis                      | 10 (0.97%) |
| Prior abdominal surgery                                    | 714 (69.39%) |
| Recurrent abdominal hernia                                 | 147 (14.29%) |

BMI, body mass index; ASA, American Society of Anaesthesiology; COPD, chronic obstructive pulmonary disease; OAT, oral anticoagulant therapy; CRF, chronic renal failure; HCV, hepatitis C virus.
Postoperative pain was measured through both a verbal rating scale (VRS) and a numeric rating scale, with similar results. With the VRS score, postoperative pain was absent in 6.22% of patients, mild in 72.04%, moderate in 20.60%, and severe in 0.58%. Postoperative pain was compared between patients in whom the mesh was fixed with resorbable and nonresorbable devices, resulting no differences being seen using the VRS score ($P > .05$). The median length of hospital stay was 2 d (IQR, 2–3; range, 0–15 d). Specifically, 14.58% of patients spent 1 day in the hospital, 62.97% stayed for 2 or 3 d, 15.55% stayed for 4 or 5 d, and only 6.90% of patients stayed for 6 d or more.

Table 2.
Surgery and Intraoperative Results

| EHS classification of abdominal wall hernia | n (%)         |
|-------------------------------------------|--------------|
| M1 subxiphoidal                           | 58 (5.64%)   |
| M2 epigastric                             | 452 (43.93%) |
| M3 umbelical                              | 577 (56.07%) |
| M4 infraumbelical                         | 154 (14.97%) |
| M5 suprapubic                             | 75 (7.29%)   |
| L1 subcostal                              | 41 (3.98%)   |
| L2 flank                                  | 70 (6.80%)   |
| L3 iliac                                  | 32 (3.11%)   |
| L4 lumbar                                 | 0 (0.00%)    |
| W1 (<4 cm)                                | 304 (29.54%) |
| W2 (4–10 cm)                              | 343 (33.33%) |
| W3 (>10 cm)                               | 382 (37.12%) |
| Type of hernia                            |              |
| Incisional abdominal hernia               | 752 (73.08%) |
| Primary abdominal hernia                  | 269 (26.14%) |
| Recurrent + primary abdominal hernia       | 8 (0.78%)    |
| Swiss-cheese incisional hernia            | 93 (9.04%)   |
| Type of surgery                           |              |
| Elective                                  | 982 (95.43%) |
| Emergency                                 | 47 (4.57%)   |
| Overlap                                   |              |
| 1 cm                                      | 6 (0.58%)    |
| 2 cm                                      | 15 (1.46%)   |
| 3 cm                                      | 54 (5.25%)   |
| 4 cm                                      | 184 (17.88%) |
| 5 cm                                      | 403 (39.16%) |
| 6 cm                                      | 177 (17.20%) |
| 7 cm                                      | 79 (7.68%)   |
| 8 cm                                      | 57 (5.54%)   |
| 9 cm                                      | 36 (3.50%)   |
| >10 cm                                    | 14 (1.36%)   |
| Fixing devices                            |              |
| Protack                                   | 367 (35.67%) |
| Absorbatack                               | 21 (2.04%)   |
| EMS                                       | 471 (45.77%) |
| Endoanchor                                | 29 (2.82%)   |

Postoperative complications

- Nothing: 1,027 (99.81%)
- Bowel perforations: 2 (0.19%)
- Conversion: 6 (0.58%)

EHS, European Hernia Society; IQR, interquartile range. Total number of hernia by type exceeds total number of patients because in some cases more than one type of hernia was present in the same patient.
occlusion in none of 1,029 patients (0.00%), postoperative peritonitis in two of 1,029 patients (0.19%), hemoperitoneum in none of 1,029 patients (0.00%). Early surgical reintervention occurred in six of 1,029 cases (0.58%), five of which were laparoscopic and one by open surgery. Postoperative complications according to Clavien-Dindo classification were as follows: I, 3.30% (34 of 1,029); II, 0.97% (10 of 1,029); IIIB, 0.58% (six of 1,029); IV, 0.00% (none of 1,029); and V, 0.00% (none of 1,029). Postoperative data are summarized in Table 3. Regarding early postoperative complications, age and recurrence abdominal hernia showed a statistically significant difference ($P < .001$) (Table 4).

The median follow-up duration was 83.1 ± 47.8 mo (IQR, 44.3–116.0 mo). We have a 99% complete 5-y follow-up. Of all the case histories of the population in question, we recorded an overall loss at follow-up of less than 3%. During the follow-up evaluations, mesh bulging was diagnosed in 58 of 1,029 patients (5.6%), whereas hernia recurrence was diagnosed in 40 of 1,029 cases (3.89%). More than 90% of cases of recurrences/bulging occurred in the first year and a half. Less than 5% of relapses occurred after 3 y. Surgery for bulging/recurrence incisional hernia was performed in 50 of 1,029 cases (4.86%). Among these 50 patients, surgical procedure was performed in 44 (88.00%) by the laparoscopic approach and by open surgery in six cases (12.00%). We proceeded to remove the prosthesis in 14 of 1,029 patients (1.36%). A recurrence risk factor analysis showed that the recurrence rate was higher in cases of overlap <4 cm, for M1 (i.e., midline, subxiphoid) European Hernia Society (EHS) hernia types, and in patients with absorbable fixation devices. Univariate analysis of patients with relapse (40) compared with patients without recurrence (989) has identified as risk factors: radiotherapy, M1 localization, overlap size, and use of resorbable fixation means. These data are summarized in Table 5.

In the logistic regression analysis, hernia recurrence was a close presence of liver disease and/or hepatitis C virus (HCV) infection (OR, 16.71, $P = .016$, 95% CI, 1.69–165.02), radiotherapy (OR, 11.87, $P = .008$, 95% CI, 1.93–73.19), L2 European Hernia Society (EHS) classification type (OR, 4.98, $P = .029$, 95% CI, 1.17–21.13), and absorbable fixation devices (OR, 111.3, $P < .001$, 95% CI, 21.53–577.67). Mesh overlap greater than 3 cm appeared to be a significant protective factor ($P < .001$), whereas the use of resorbable mesh staples appeared to be a significant risk factor for recurrence (OR, 111.3, $P < .001$, 95% CI, 21.53–577.67). Finally, mesh bulging was a significant risk factor for hernia recurrence (OR, 12.06, $P = .005$, 95% CI, 2.11–69.05), (Table 6).

### DISCUSSION

Abdominal wall hernias are a common occurrence. In 1993, Le Blanc was the first to describe the laparoscopic approach for surgical repair using an intraperitoneal mesh. The advantages of a minimally invasive surgery in
| Variables                          | Complicated (n = 50) | Regular (n = 979) | P Value |
|-----------------------------------|----------------------|-------------------|---------|
| Male                              | 26/50 (52.0%)        | 542/979 (55.4%)   | .641    |
| Female                            | 24/50 (48.0%)        | 437/979 (44.6%)   |         |
| Age (years), median (IQR)         | 70 (57; 73)          | 61 (47; 70)       | <.001   |
| BMI, median (IQR) (kg/m²)         | 26.2 (23.4; 28.2)    | 27 (24.1; 30.4)   | .113    |
| ASA Score 1                        | 6/49 (12.2%)         | 139/961 (14.5%)   | .340    |
| ASA Score 2                        | 27/49 (55.1%)        | 612/961 (63.7%)   |         |
| ASA Score 3                        | 16/49 (32.7%)        | 206/961 (21.4%)   |         |
| ASA Score 4                        | 0                    | 4/961 (0.4%)      |         |
| Comorbidities                     |                      |                   |         |
| COPD                              | 13/49 (26.5%)        | 132/954 (13.8%)   | .014    |
| Diabetes mellitus                 | 9/49 (18.4%)         | 158/954 (16.6%)   | .741    |
| Cardiovascular diseases           | 10/50 (20.0%)        | 87/956 (9.1%)     | .011    |
| Hypertension                      | 33/50 (66.0%)        | 485/958 (50.6%)   | .034    |
| OAT                               | 3/49 (6.1%)          | 24/954 (2.5%)     | .141    |
| Steroid therapy                   | 0                    | 13/954 (1.4%)     | 1.000   |
| Radiotherapy                      | 2/49 (4.1%)          | 38/954 (4.0%)     | 1.000   |
| Smoke                             | 16/49 (32.7%)        | 254/958 (26.5%)   | .344    |
| Overweight (BMI ≥25 kg/m²)        | 19/40 (47.5%)        | 306/741 (41.3%)   | .245    |
| Obesity (BMI ≥30 kg/m²)           | 6/40 (15.0%)         | 200/741 (27.0%)   |         |
| CFR                               | 0                    | 7/979 (0.7%)      | 1.000   |
| HCV-related liver disease/cirrhosis | 0                 | 10/979 (1.0%)   |         |
| Other                             | 0                    | 1/979 (0.10%)     |         |
| Prior abdominal surgery           | 38/50 (76.0%)        | 676/933 (72.5%)   | .584    |
| Recurrent abdominal hernia        | 0                    | 147/933 (15.8%)   | <.001   |
| EHS classification of abdominal wall hernia | | | |
| M1 subxiphoidal                   | 0                    | 58/979 (5.9%)     | .107    |
| M2 epigastic                      | 23/50 (46.0%)        | 429/979 (43.8%)   | .762    |
| M3 umbilical                      | 26/50 (52.0%)        | 551/979 (56.3%)   | .552    |
| M4 infraumbilical                 | 7/50 (14.0%)         | 147/979 (15.0%)   | .844    |
| M5 suprapubic                     | 4/50 (8.0%)          | 71/979 (7.3%)     | .780    |
| L1 subcostal                      | 2/50 (4.0%)          | 39/979 (4.0%)     | 1.000   |
| L2 flank                          | 4/50 (8.0%)          | 66/979 (6.7%)     | .770    |
| L3 iliac                          | 2/50 (4.0%)          | 30/979 (3.1%)     | .666    |
| L4 lumbar                         | 0                    | 0                 | —       |
| W1 (<4 cm)                        | 19/50 (38.0%)        | 285/979 (29.1%)   | .028    |
| W2 (4–10 cm)                      | 16/50 (32.0%)        | 327/979 (33.4%)   |         |
| W3 (>10 cm)                       | 14/50 (28.0%)        | 367/979 (37.5%)   |         |
terms of less postoperative pain, fewer postoperative complications, and a shorter hospital stay are well described and also in abdominal wall surgery. Because of its advantages, the laparoscopic approach to primary and incisional hernia repair allows the use of a larger mesh with a lower abdominal wall dissection, becoming the approach of choice for many surgeons.2 The 2015 Consensus Conference14 stated that the laparoscopic approach is safe and effective and superior to the open technique in terms of length of hospital stay, postoperative pain, and complication rate. In 2016, Ecker,15 comparing laparoscopic and open ventral hernia repair, reported a lower incidence of perioperative complications, postoperative readmissions and revisional surgery for the laparoscopic approach. Moreover, in his meta-analysis, Al Chalabi16 described a rate of wound infections five times lower for the laparoscopic technique compared with open surgery. Although different

| Variables | Complicated (n = 50) | Regular (n = 979) | P Value |
|-----------|---------------------|------------------|---------|
| Type of surgery | | | |
| Elective | 47/50 (94.0%) | 935/979 (95.5%) | .494 |
| Emergency | 3/50 (6.0%) | 44/979 (4.5%) | |
| Overlap | | | |
| 1 cm | 0 | 6/975 (0.6%) | .648 |
| 2 cm | 1/50 (2.0%) | 14/975 (1.4%) | |
| 3 cm | 3/50 (6.0%) | 51/975 (5.2%) | |
| 4 cm | 14/50 (28.0%) | 170/975 (17.4%) | |
| 5 cm | 17/50 (34.0%) | 386/975 (39.6%) | |
| 6 cm | 6/50 (12.0%) | 171/975 (17.5%) | |
| 7 cm | 4/50 (8.0%) | 75/975 (7.7%) | |
| 8 cm | 2/50 (4.0%) | 55/975 (5.6%) | |
| 9 cm | 3/50 (6.0%) | 33/975 (3.4%) | |
| >10 cm | 0 | 14/975 (1.4%) | |
| Fixing devices | | | |
| Protack | 17/50 (34.0%) | 350/979 (35.8%) | .079 |
| Absorbatack | 0 | 21/979 (2.2%) | |
| EMS | 26/50 (52.0%) | 445/979 (45.5%) | |
| Endoanchor | 2/50 (4.0%) | 27/979 (2.8%) | |
| Securstrap | 2/50 (4.0%) | 69/979 (7.1%) | |
| Multiple devices | 0 | 55/979 (5.6%) | |
| Glue | 3/50 (6.0%) | 12/979 (1.2%) | |
| Type of fixing devices | | | |
| Nonresorbable | 45/50 (90.0%) | 822/979 (84.0%) | .015 |
| Resorbable | 2/50 (4.0%) | 90/979 (9.2%) | |
| Glue | 3/50 (6.0%) | 12/979 (1.2%) | |
| Multiple devices | 0 | 55/979 (5.6%) | |
| Conversion | 1/50 (2.0%) | 5/979 (0.5%) | .259 |

P < .05 (bold values). BMI, body mass index; ASA, American Society of Anaesthesiology; COPD, chronic obstructive pulmonary disease; OAT, oral anticoagulant therapy; CRF, chronic renal failure; HCV, hepatitis C virus; EHS, European Hernia Society; IQR, interquartile range; EMS, Endoscopic Multifeed Stapler (Ethicon, Inc., Cincinnati, OH, USA).
| Variables                          | Recurrent (n = 40) | Nonrecurrent (n = 989) | P Value |
|-----------------------------------|-------------------|-----------------------|---------|
| Male                              | 20/40 (50%)       | 548/989 (55.4%)       | .500    |
| Female                            | 20/40 (50%)       | 441/989 (44.6%)       | .260    |
| Age, median (IQR)                 | 62.5 (54.5; 71)   | 61 (48; 70)           | .490    |
| BMI (kg/m²), median (IQR)         | 26.4 (23.6; 28.9) | 27 (24; 30.4)         |         |
| ASA Score 1                       | 4/40 (10.0%)      | 141/970 (14.5%)       | .769    |
| ASA Score 2                       | 26/40 (65.0%)     | 613/970 (63.2%)       |         |
| ASA Score 3                       | 10/40 (25.0%)     | 212/970 (21.9%)       |         |
| ASA Score 4                       | 0                 | 4/970 (0.4%)          |         |
| Comorbidities                     |                   |                       |         |
| COPD                              | 7/40 (17.5%)      | 138/963 (14.3%)       | .576    |
| Diabetes mellitus                 | 4/40 (10.0%)      | 163/963 (16.9%)       | .384    |
| Cardiovascular diseases           | 4/40 (10.0%)      | 93/966 (9.6%)         | .790    |
| Hypertension                      | 16/40 (40.0%)     | 502/968 (51.9%)       | .141    |
| OAT                               | 3/40 (7.5%)       | 24/963 (2.5%)         | .089    |
| Steroid therapy                   | 0                 | 13/963 (1.4%)         |         |
| Radiotherapy                      | 5/40 (12.5%)      | 35/963 (3.6%)         |         |
| Smoke                             | 8/40 (20.0%)      | 262/967 (27.1%)       | .321    |
| Overweight (BMI ≥25 kg/m²)        | 15/34 (44.1%)     | 310/747 (41.5%)       | .732    |
| Obesity (BMI ≥30 kg/m²)           | 7/34 (20.6%)      | 199/747 (26.6%)       |         |
| CFR                               | 0                 | 7/989 (0.7%)          | .013    |
| HCV-related liver disease/cirrhosis | 3/40 (7.5%)     | 7/989 (0.7%)          |         |
| Other                             | 0                 | 1/989 (0.1%)          |         |
| Prior abdominal surgery           | 28/36 (77.8%)     | 686/947 (72.4%)       | .481    |
| Recurrent abdominal hernia         | 3/36 (8.3%)       | 144/947 (15.2%)       | .343    |
| EHS classification of abdominal wall hernia |               |                       |         |
| M1 subxiphoidal                   | 11/40 (27.5%)     | 47/989 (4.8%)         | <.001   |
| M2 epigastric                     | 19/40 (47.5%)     | 433/989 (43.8%)       | .642    |
| M3 umbilical                      | 17/40 (42.5%)     | 560/989 (56.6%)       | .078    |
| M4 infraumbilical                 | 9/40 (22.5%)      | 145/989 (14.7%)       | .173    |
| M5 suprapubic                     | 6/40 (15.0%)      | 69/989 (7.0%)         | .056    |
| L1 subcostal                      | 0                 | 41/989 (4.2%)         | .401    |
| L2 flank                          | 6/40 (15.0%)      | 64/989 (6.5%)         | .036    |
| L3 iliac                          | 0                 | 32/989 (3.2%)         | .632    |
| W1 (<4 cm)                        | 6/40 (15.0%)      | 298/989 (30.1%)       | .008    |
| W2 (4–10 cm)                      | 9/40 (22.5%)      | 334/989 (33.8%)       |         |
| W3 (>10 cm)                       | 25/40 (62.5%)     | 356/989 (36.0%)       |         |
| Type of surgery                    |                   |                       |         |
| Elective                          | 39/40 (97.5%)     | 943/989 (95.4%)       | 1.000   |
| Emergency                         | 1/40 (2.5%)       | 46/989 (4.7%)         |         |
authors\textsuperscript{14–22} have reported good clinical results for the minimally invasive approach in the short term, long-term results are less well defined,\textsuperscript{23} with studies including a small number of patients or being dated or inconclusive.\textsuperscript{17,23,24} This monocentric retrospective study, which analyzed long-term follow-up of more than 1,000 cases, reports one of the largest series of patients who have undergone laparoscopic surgery for abdominal hernia repair, using a standardized technique and a single mesh type. Our series reports only patients in whom a single type of intraperitoneal mesh was used, Parietex Composite mesh (Medtronic). In our opinion, composite meshes offer the advantage of combining both the strength of a permanent intraperitoneal mesh

| Variables          | Recurrent (n = 40) | Nonrecurrent (n = 989) | \(P\) Value |
|--------------------|-------------------|------------------------|-------------|
| Overlap            |                   |                        |             |
| 1 cm               | 2/40 (5.0%)       | 4/985 (0.4%)           | \(<.001\)   |
| 2 cm               | 4/40 (10.0%)      | 11/985 (1.1%)          |             |
| 3 cm               | 13/40 (32.5%)     | 41/985 (4.2%)          |             |
| 4 cm               | 5/40 (12.5%)      | 179/985 (18.2%)        |             |
| 5 cm               | 7/40 (17.5%)      | 396/985 (40.2%)        |             |
| 6 cm               | 7/40 (17.5%)      | 170/985 (17.3%)        |             |
| 7 cm               | 2/40 (5.0%)       | 77/985 (7.8%)          |             |
| 8 cm               | 0                 | 57/985 (5.8%)          |             |
| 9 cm               | 0                 | 36/985 (3.7%)          |             |
| >10 cm             | 0                 | 14/985 (1.4%)          |             |
| Fixing devices     |                   |                        |             |
| Protack            | 9/40 (22.5%)      | 358/989 (36.2%)        | \(<.001\)   |
| Absorbatack        | 0                 | 21/989 (2.1%)          |             |
| EMS                | 7/40 (17.5%)      | 464/989 (46.9%)        |             |
| Endoanchor         | 5/40 (12.5%)      | 24/989 (2.4%)          |             |
| Securstrap         | 19/40 (47.5%)     | 52/989 (5.3%)          |             |
| Multiple devices   | 0                 | 55/989 (5.6%)          |             |
| Glue               | 0                 | 15/989 (1.5%)          |             |
| Type of fixing devices |               |                        |             |
| Nonresorbable      | 21/40 (52.5%)     | 846/989 (85.5%)        | \(<.001\)   |
| Resorbable         | 19/40 (47.5%)     | 73/989 (7.4%)          |             |
| Glue               | 0                 | 15/989 (1.5%)          |             |
| Multiple devices   | 0                 | 55/989 (5.6%)          |             |
| Bulging            | 8/40 (20.0%)      | 50/989 (5.1%)          | \(<.001\)   |
| Conversion         | 0                 | 6/989 (0.6%)           | 1.000       |
| Early postoperative complication | 3/40 (7.5%) | 47/989 (4.8%) | .438 |
| Hematoma           | 0                 | 17/989 (1.7%)          | 1.000       |
| Seroma             | 1/40 (2.5%)       | 33/989 (3.3%)          | 1.000       |
| Prothesis infection| 2/40 (5.0%)       | 2/989 (0.2%)           | \(.008\)    |

\(P<.05\) (bold values). BMI, body mass index; ASA, American Society of Anaesthesiology; COPD, chronic obstructive pulmonary disease; OAT, oral anticoagulant therapy; CRF, chronic renal failure; HCV, hepatitis C virus; EHS, European Hernia Society; IQR, interquartile range; EMS Endoscopic Multifeed Stapler (Ethicon, Inc., Cincinnati, OH, USA).
and an antiadhesion barrier to protect the visceral layer. Clinical experience and literature data suggest that the correct fixation of the mesh is a vital aspect of the surgical procedure, affecting both postoperative pain and early and late recurrence rates.\textsuperscript{15,25} Despite this, literature data are conflicting about recurrence rates following the use of absorbable or nonabsorbable staples,\textsuperscript{11,14,16,26,27} whereas some studies suggest that the use of fibrin glue enables a vast reduction in postoperative pain with very low recurrence rates.\textsuperscript{28} In our series, different staples were used, depending on the surgeon’s choice, and this enabled us to compare the results for different device categories. Specifically, we observed a small increase in early postoperative pain in patients treated with nonabsorbable staples, whereas a significant difference in recurrences rates was noted.

### Table 6.
Recurrent Abdominal Hernia: Univariate and Multivariate Analysis

| Variables                                      | Univariate | Multivariate |
|------------------------------------------------|------------|--------------|
|                                                | $P$ Value  | OR           | $P$ Value | 95% CI       |
| Radiotherapy                                   | .005       | 11.87        | .008      | 1.93–73.19   |
| CFR                                            | .013       | 1            | —         | —            |
| HCV-related liver disease/cirrhosis            | .016       | 16.71        | .016      | 1.69–165.02  |
| Other                                          | 1          | —            | —         | —            |
| M1 subxiphoidal                                | <.001      | 2.54         | .166      | 0.68–9.51    |
| L2 flank                                        | .036       | 4.98         | .029      | 1.17–21.13   |
| EHS classification of abdominal wall hernia    |            |              |           |              |
| W1 (<4 cm)                                     | .008       | 1            | —         | —            |
| W2 (4–10 cm)                                   | 0.93       | .925         | 0.19–4.55 |
| W3 (>10 cm)                                    | 3.92       | .085         | 0.83–18.51|
| Overlap                                        |            |              |           |              |
| 1 cm                                           | <.001      | 1            | —         | —            |
| 2 cm                                           | 0.36       | —            | —         | —            |
| 3 cm                                           | .22        | <.001        | 0.22–0.25 |
| 4 cm                                           | 0.19       | <.001        | 0.16–0.25 |
| 5 cm                                           | 0.12       | <.001        | 0.13–0.39 |
| 6 cm                                           | 0.16       | <.001        | 0.17–0.51 |
| 7 cm                                           | 0.46       | <.001        | 0.36–0.59 |
| 8 cm                                           | 1          | —            | —         | —            |
| 9 cm                                           | 1          | —            | —         | —            |
| >10 cm                                         | 1          | —            | —         | —            |
| Type of fixing devices                         |            |              |           |              |
| Nonresorbable                                  | <.001      | 1            | —         | —            |
| Resorbable                                     | 111.53     | <.001        | 21.53–577.67|
| Glue                                           | 1          | —            | —         | —            |
| Multiple devices                               | 1          | —            | —         | —            |
| Bulging                                        | <.001      | 12.06        | .005      | 2.11–69.03   |
| Prothesis infection                            | .008       | 1            | —         | —            |

$P<.05$ (bold values). OR, odds ratio; CI, confidence interval; CRF, chronic renal failure; HCV, hepatitis C Virus; EHS, European Hernia Society.
between absorbable and nonabsorbable devices. The use of resorbable fixing devices was a significant risk factor for hernia recurrence (OR, 11.53, P < 0.001, 95% CI, 21.53–577.67). According to other authors, non-absorbable fixing devices should be considered as the standard method of fixation in laparoscopic hernia repair. Another essential surgical consideration is mesh overlap. The Italian Laparoscopic Ventral Incisional Hernia Guidelines recommend a minimum size of 3 cm, whereas other authors suggest the overlap is increased to 5 cm, especially for larger defects. In our series, only 7.29% of patients had an overlap smaller than 4 cm; in these cases, the recurrence rate was higher than 24%, whereas the rate dropped to 0–4.0% for an overlap equal to or greater than 4 cm, thus confirming that the mesh overlap should routinely be at least 4 cm. In our results, laparoscopic ventral hernia repair resulted in a very short hospital stay, with 75% of patients staying for less than 3 d. Postoperative pain was absent or mild in more than 75% of patients. This confirms the great tolerability of the laparoscopic technique, even in larger defects. Concerning early postoperative surgical complications, an overall complication rate of 5.43% was noted, which is much lower than the 20% rate recently reported by Sanchez et al. and the 13% rate reported by Heniford et al. Postoperative complications according to Clavien-Dindo classification: I, 3.30% (34 of 1,029); II, 0.97% (10 of 1,029); IIIa, 0.58% (six of 1,029); IIIb, 0.00% (none of 1,029); and V, 0.00% (none of 1,029). Also, our repeat surgery rate was very low, and most cases were undertaken laparoscopically, as reported by others. In the long term, a bulging rate and recurrence rate of less than 6% was noted. In particular, bulging was diagnosed in 58 of 1,029 patients (5.6%) and hernia recurred in 40 of 1,029 patients (3.9%). Literature data reports heterogeneous recurrence rates, ranging from 23% by Lund et al. and 5% or less in other studies. Logistic regression analyses enabled us to identify clear independent surgical risk factors for hernia recurrence as a mesh overlap smaller than 4 cm, the use of absorbable fixation devices and M1 (subxiphoidal) type. Whereas localization, an inadequate overlap and an inadequate mesh fixation are risk factors for recurrence already reported in the literature, we did not see obesity as a risk factor, unlike other authors. Multivariate analysis also confirmed the aforementioned risk factors. In addition, however, past radiotherapy and hepatitis C virus (HCV) are also identified as risk factors for relapse. The main limitations of this study are represented by being a single-center retrospective study without a control group.

CONCLUSION

This study demonstrates that laparoscopic repair of primary and postincisional abdominal wall hernias is a safe, effective, and reproducible procedure. Closely following surgical recommendations is a crucial factor in obtaining good results, especially the use of a mesh overlap equal to or greater than 4 cm and the use of nonabsorbable fixation staples in addition to a strict postoperative care and follow-up regimen to prevent or treat mesh infections and bulging.

References:

1. Dabbas N, Adams K, Pearson K, Royle G. Frequency of abdominal wall hernias: is classical teaching out of date? J R Soc Med. 2011;2:5.
2. Sauerland S, Walgenbach M, Habermalz B, Seiler CM, Miserez M. Laparoscopic versus open surgical techniques for ventral or incisional hernia repair. Cochrane Database Syst Rev. 2011:CD007781.
3. Van’t Riet M, Steyerberg EW, Nellensteyn J, Bonjer HJ, Jeekel J. Meta-analysis of techniques for closure of midline abdominal incisions. Br J Surg. 2002;89:1350–1356.
4. Bloemen A, van Dooren P, Huizinga BF, Hoofwijk AG. Randomized clinical trial comparing polypropylene or polydioxanone for midline abdominal wall closure. Br J Surg. 2011;98:633–639.
5. Eker HH, Hansson BM, Buunen M, et al. Laparoscopic vs open incisional hernia repair: a randomized clinical trial. JAMA Surg. 2013;148:259–263.
6. LeBlanc KA, Booth WV. Laparoscopic repair of incisional hernias using expanded polytetrafluoroethylene: preliminary findings. Surg Laparosc Endosc. 1993;3:39–41.
7. Zhang V, Zhou H, Chai Y, Cao C, Jin K, Hu Z. Laparoscopic versus open incisional and ventral hernia repair: a systematic review and meta-analysis. World J Surg. 2014;38:2233–2240.
8. Olmi S, Scaini A, Cesana GC, Erba L, Croce E. Laparoscopic versus open incisional hernia repair: an open randomized controlled study. Surg Endosc. 2007;21:555–559.
9. Misra MC, Bansal VK, Kulkarni MP, Pawar DK. Comparison of laparoscopic and open repair of incisional and primary ventral hernia: results of a prospective randomized study. Surg Endosc. 2006;20:1839–1845.
10. Carbajo MA, Martin Olmo JC, Blanco JL, Toledano M, de la Cuesta C, Ferreras C. Laparoscopic approach to incisional hernia. Surg Endosc. 2003;17:118–122.
11. Nardi M Jr., Millo P, Brachet Contul R, et al. Laparoscopic ventral hernia repair with composite mesh: analysis of risk factors for recurrence in 185 patients with 5 years follow-up. *Int J Surg.* 2017;40:38–44.

12. Cuccurullo D, Piccoli M, Agresta F, et al. Laparoscopic ventral incisional hernia repair: evidence-based guidelines of the first Italian Consensus Conference. *Hernia.* 2013;17:557–566.

13. Misiakos EP, Patapis P, Zavras N, Tzanetis P, Machairas A. Current trends in laparoscopic ventral hernia repair. *JSLS.* 2015 Jul–Sep;19(3).

14. Silecchia G, Campanile FC, Sanchez L, et al. Laparoscopic ventral/incisional hernia repair: updated Consensus development Conference based guidelines. *Surg Endosc.* 2015;29:2463–2484.

15. Ecker BL, Kuo LE, Simmons KD, Fischer JP, Morris JB, Kelz RR. Laparoscopic versus open ventral hernia repair: longitudinal outcomes and cost analysis using statewide claims data. *Surg Endosc.* 2016;30:906–915.

16. Al Chalabi H, Larkin J, Mehigan B, McCormick P. A systematic review of laparoscopic versus open abdominal incisional hernia repair, with meta-analysis of randomized controlled trials. *Int J Surg.* 2015;20:65–74.

17. Olmi S, Scaini A, Cesana GC, Erba L, Croce E. Laparoscopic versus open incisional hernia repair: an open randomized controlled study. *Surg Endosc.* 2007;21:555–559.

18. Sánchez LJ, Piccoli M, Ferrari CG, et al. Laparoscopic ventral hernia repair: results of a two thousand patients prospective multicentric database. *Int J Surg.* 2018;51:31–38.

19. Olmi S, Erba L, Magnone S, Bertolini A, Croce E. Prospective clinical study of laparoscopic treatment of incisional and ventral hernia using a composite mesh: indications, complications and results. *Hernia.* 2006;10:243–247.

20. Caruso F, Ciccarese F, Cesana G, Uccelli M, Castello G, Olmi S. Massive incisional hernia repair with parietax: monocentric analysis on 500 cases treated with a laparoscopic approach. *J Laparoendosc Adv Surg Tech A.* 2017;27:388–392.

21. Wassenaar E, Schoenmaekers EJ, Raymakers JT, Rakic S. Recurrences after laparoscopic repair of ventral and incisional hernia: lessons learned from 505 repairs. *Surg Endosc.* 2009;23:825–832.

22. Olmi S, Scaini A, Cesana GC, Erba L, Croce E. Use of fibrin glue (Tissucol) in laparoscopic repair of abdominal wall defects: preliminary experience. *Surg Endosc.* 2007;21:409–413.

23. Heniford BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic repair of ventral hernias. Nine years’ experience with 850 consecutive hernias. *Ann Surg.* 2003;238:391–400.

24. Carbajo MA, Mart del Olmo JC, Blanco JL, et al. Laparoscopic approach to incisional hernia. *Surg Endosc.* 2003;17:118–122.

25. Lund S, Farley D. A decade of experience with laparoscopic ventral hernia repairs. *Am J Surg.* 2019 Mar;217(3):546–549.

26. Pham CT, Perera CL, Watkin DS, Maddern GJ. Laparoscopic ventral hernia repair: a systematic review. *Surg Endosc.* 2009;23:4–15.

27. Reynvoet E, Deshepper E, Rogiers X, et al. Laparoscopic ventral hernia repair: is there an optimal mesh fixation technique? A systematic review. *Langenbecks Arch Surg.* 2014;399:55–63.

28. Olmi S, Scaini A, Erba L, Croce E. Laparoscopic ventral/incisional hernia repair: updated consensus development Conference based guidelines. *Surg Endosc.* 2015;29:2463–2484.