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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 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, $P < .001$, 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,[1,2] 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.[3–5] Laparoscopic treatment for incisional hernias was initially described by Leblanc and Booth in 1993,[6] 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[7–10] with a similar incidence of recurrence.[5] Widely recognized key factors in obtaining good results and decreasing compli-

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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.[11,12] A large number of articles involving numerous series of patients undergoing laparoscopic repair of incisional hernia have been published.[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), nonclosure 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; 3.11%). 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 nadroparin calcium (0.4 mL in cases of BMI $\geq$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, adhesiolysis 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 χ^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
	n (%)
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 adbominal 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.

Table 2.
Surgery and Intraoperative Results

Population: 1,029	n (%)
EHS classification of abdominal wall hernia	
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%)
Incisional + primary abdominal hernia	8 (0.78%)
Reccurent hernia	147 (14.29%)
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%)
Securstrap	71 (6.90%)
Multiple devices	55 (5.34%)
Glue	15 (1.46%)
Transcutaneous sutures	
0	5 (0.49%)
2	130 (12.63%)
4/6	894 (86.88%)
Operative time	
≥60 minutes	841 (81.73%)
>60 to ≤120 minutes	166 (16.13%)
>120 minutes	22 (2.14%)
Median (IQR), range (minutes)	40 (30; 55), 10–175
Associated surgery	674 (65.50%)
Adhesiolysis	492 (73.00%)
Inguinal hernia repair	21 (3.12%)
Cholecystectomy	13 (1.93%)
Other	148 (21.96%)
Intraoperative 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.

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. Early postoperative surgical complications (within 30 d) occurred in 50 patients (4.86%); more specifically, wound seroma occurred in 34 of 1,029 patients (3.30%), wound hematoma in 17 of 1,029 patients (1.65%), mesh infection in four of 1,029 patients (0.39%), postoperative bowel

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, 111.53, $P < .001$, 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, 111.53, $P < .001$, 95% CI, 21.53–577.67). Finally, mesh bulging was a significant risk factor for hernia recurrence (OR, 12.06, $P = .005$, 95% CI, 2.11–69.03), (**Table 6**).

Table 3.
Postoperative Course

Variables	n (%)
Postoperative course (days)	
0/1	150 (14.58%)
2/3	648 (62.97%)
4/5	160 (15.55%)
≥6	71 (6.90%)
Median (IQR), range (days)	2 (2; 3), 0–15
VRS	
Absent	64 (6.22%)
Mild	731 (71.04%)
Moderate	212 (20.60%)
Severe	6 (0.58%)
Early postoperative complications	50 (4.86%)
Hematoma	17 (1.65%)
Peritonitis	2 (0.19%)
Seroma	34 (3.30%)
Prothesis infection	4 (0.39%)
Hemoperitoneum	0 (0.00%)
Bowel obstruction	0 (0.00%)
Pain	0 (0.00%)
Reoperation	
Laparoscopy	5 (0.49%)
Open	1 (0.10%)
Clavien-Dindo classification	
Grade I	34 (3.30%)
Grade II	10 (0.97%)
Grade III	6 (0.58%)
Grade IIIA	0 (0.00%)
Grade IIIB	6 (0.58%)
Grade IV	0 (0.00%)
Grade V	0 (0.00%)

VRS, Verbal Rating Scale; IQR, interquartile range.

DISCUSSION

Abdominal wall hernias are a common occurrence.[1,2] In 1993, Le Blanc was the first to describe the laparoscopic approach for surgical repair using an intraperitoneal mesh.[6] The advantages of a minimally invasive surgery in

Table 4.
Postoperative Early Complication (within 30 days)

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, mediana (IQR) (kg/m^2)	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/m^2)	19/40 (47.5%)	306/741 (41.3%)	.245
Obesity (BMI ≥30 kg/m^2)	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
Reccurent abdominal hernia	0	147/933 (15.8%)	**<.001**
EHS classification of abdominal wall hernia			
M1 subxiphoidal	0	58/979 (5.9%)	.107
M2 epigastric	23/50 (46.0%)	429/979 (43.8%)	.762
M3 umbelical	26/50 (52.0%)	551/979 (56.3%)	.552
M4 infraumbelical	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%)	

Table 4.
Continued

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).

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 Conference[14] 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 Chalabi[16] described a rate of wound infections five times lower for the laparoscopic technique compared with open surgery. Although different

Table 5.
Recurrent Abdominal Hernia vs. Nonrecurrent Abdominal Hernia

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%)	
Agek, median (IQR)	62.5 (54.5; 71)	61 (48; 70)	.260
BMI (kg/m^2), mediana (IQR)	26.4 (23.6; 28.9)	27 (24; 30.4)	.490
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%)	1.000
Radiotherapy	5/40 (12.5%)	35/963 (3.6%)	**.005**
Smoke	8/40 (20.0%)	262/967 (27.1%)	.321
Overweight (BMI ≥25 kg/m^2)	15/34 (44.1%)	310/747 (41.5%)	.732
Obesity (BMI ≥30 kg/m^2)	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
Reccurent 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 umbelical	17/40 (42.5%)	560/989 (56.6%)	.078
M4 infraumbelical	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%)	

Table 5.
Continued

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).

authors[14–22] have reported good clinical results for the minimally invasive approach in the short term, long-term results are less well defined,[23] with studies including a small number of patients or being dated or inconclusive.[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

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		**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		**0.22**	**<.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.

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.[15,25] Despite this, literature data are conflicting about recurrence rates following the use of absorbable or nonabsorbable staples,[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.[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

between absorbable and nonabsorbable devices. The use of resorbable fixing devices was a significant risk factor for hernia recurrence (OR,111.53, $P < .001$, 95% CI, 21.53–577.67). According to other authors,[14,27] nonabsorbable 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[12] recommend a minimum size of 3 cm, whereas other authors[20,27,29] 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.[18] and the 13% rate reported by Heniford et al..[23] Postoperative complications according to Clavien-Dindo classification: 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). Also, our repeat surgery rate was very low, and most cases were undertaken laparoscopically, as reported by others.[14,29] 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.[25] and 5% or less in other studies.[2,30,31] 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,[28,32–35] we did not see obesity as a risk factor, unlike other authors.[11] 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.

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