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Management of non-midline incisional hernia by the laparoscopic approach: results of a long-term follow-up prospective study

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Abstract
Background The role of the laparoscopic approach in the repair of non-midline incisional hernias is controversial due to the absence of adequate scientific studies. This study aimed to determine the safety and efficacy of laparoscopic repair for non-midline incisional hernias.
Methods This prospective clinical study was conducted in an abdominal wall unit of a teaching hospital. Patients underwent surgery for non-midline incisional hernias using the laparoscopic approach ($n = 73$) and were classified into three groups: subcostal, iliac, and lumbar. The primary end point was recurrence. The secondary end points were intraoperative parameters, comorbidity, and patient outcomes. The median follow-up period was 62 months (range, 36–170 months).
Results No hospital stay was needed for 34% of the patients. The remaining patients needed an average hospital stay of 2.7 days. The most frequent morbidity was hematoma. The overall recurrence rate was 8.2% and was higher for the subcostal hernias (25%). The three groups differed in size, local morbidity, and recurrence ($P < 0.05$). The independent risk factors for recurrence were size (hazard ratio [HR], 2.16; 95% confidence interval [CI], 1.08–4.33) and local morbidity (HR 30.62; 95% CI 1.22–768-82). The best predictor of recurrence was a hernia diameter greater than 15 cm. The only predictive factor of local morbidity was obesity ($P < 0.007$).
Conclusions The laparoscopic approach is a safe and effective treatment for non-midline incisional hernias. Caution should be taken with subcostal hernias, obese patients, and a defect size greater than 15 cm. An algorithm is suggested to guide the "rational" treatment of non-midline incisional hernias.

Keywords Laparoscopy · Morbidity · Nonmidline incisional hernia · Recurrence · Size defect · Subcostal hernia

What surgical treatment is optimal for incisional hernias remains an unanswered question. The choice of surgical technique is based mainly on the individual surgeon's preference. The classic approach is an aggressive technique, with a major dissection of the abdominal wall that results in considerable morbidity, a hospital stay, and frequently poor sociooccupational prognosis for the patient.

Laparoscopic repair of incisional hernias is a relatively new procedure based on two technical principles: a hernia gate that is not closed and a mesh placed intraperitoneally [1–3]. After nearly two decades, this new approach has been established as an alternative for repair of moderate-sized midline hernias. The laparoscopic approach has several documented advantages including smaller incisions, a lower risk of complications, shorter hospital stays, and patient preference [4–7].

In non-midline hernias, the involvement of different muscle groups makes anatomic reconstruction of the individual fascia layers difficult. For these defects, the meshes are placed intraperitoneally and anchored transparietally. Even more controversial is the application of laparoscopy to these non-midline hernias. The literature contains no specific studies on these defects because they are most commonly either presented in a comprehensive series with other types of primary hernias (e.g., umbilical, inguinal,

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Spiegel) or published as isolated cases descriptively without statistical support. In short, to date, insufficient research has been published with adequate follow-up focusing on non-midline hernias.

This study aimed to determine the safety and efficacy of laparoscopic repair as a treatment option in non-midline incisional hernias over the past 15 years.

Materials and methods

Study design

This prospective clinical study was carried out between January 1994 and January 2008 for 73 consecutive patients with a diagnosis of non-midline incisional hernia who underwent laparoscopic incisional hernia repair (LIHR) at our University Hospital. All the patients were assessed in an abdominal wall unit. Specific informed consent was obtained in all cases. During this period, only two patients underwent surgery for large transverse incisional hernias (L2, Chevrel's classification) [8].

Inclusion and exclusion criteria

The inclusion criteria for LIHR specified age older than 20 years, specific informed consent for laparoscopic treatment of an incisional hernia, and a total parietal defect measuring more than 5 cm in any dimension. Incisional hernia was defined as any abdominal wall gap with or without a bulge in the area of a postoperative scar perceptible or palpable by clinical examination or imaging.

The exclusion criteria ruled out patients with midline hernias (defined as all incisional hernias between the lateral margins of both rectus muscle sheaths, the xyphoid, and the pubic bone), primary hernias (nonincisional hernias), parastomal hernias (because these are a distinct group with specific properties and treatment options), hernias with a maximum diameter less than 5 cm (<5 cm: ambulatory open surgery), transverse incisional hernias (to avoid errors in data interpretation), concurrent neoplasms, psychiatric illness, or other circumstances that might compromise the patient's cooperation, as well as patients who refused to give informed consent.

All the clinical and follow-up parameters were tabulated prospectively and divided into three groups: subcostal (S), iliac (I), and lumbar incisional (L) hernias. The investigation plan was submitted and approved by the Ethics Committee. A database (Microsoft Excel; Microsoft Corporation, Seattle, WA, USA) was used to follow up all the patients enrolled, and data were analyzed by an independent data manager (A.C.-A.).

Surgical technique

A standardized surgical technique was used by a single senior surgeon specialized in laparoscopic hernia repair (A.M.-E). The patient was prepped from xiphoid to pubis and as far laterally as possible. The skin was covered with a protective skin drape to avoid any contact between skin flora and the prosthetic mesh. Repair was performed with the patient under general anesthesia. Using a Veress needle, pneumoperitoneum usually was placed in the left subcostal area. The position of the three trocars depended on the size, site, and number of existing wall defects (two 5-mm trocars and one 10-mm trocar). After complete lysis of adhesions, the hernia contents were reduced. The fascial edges were marked with spinal needles, and the true defect size was determined with the abdomen desufflated using a metric ruler to measure the defect internally.

Subcostal group

The technique for the subcostal hernias was the same as for other ventral and incisional hernias (intraabdominal technique). The patient was placed in a supine position, and three trocars were introduced in the left flank, although the lowest trocar was farther forward than the others, closer to the midline. First, the defect was mobilized at the right parietocolic level. The right triangular ligament of the liver then was divided, thereby allowing for a better view of the operative field. The dissection was extended until it reached from the iliac crest to the costal hepatic dome, and a mesh was placed intraperitoneally.

Iliac group

The technique for iliac hernias was similar to the approach used for the transabdominal preperitoneal repair of inguinal hernias. The patient was placed in a lateral decubitus position. Any adhesions between bowel loops and the hernia sac were sectioned before the start of the dissection with a peritoneal incision, usually superior and lateral to the wall defect. The hernia sac was reduced out of the fascial defect, and the surrounding fascia was exposed, keeping the peritoneal flap distally out of the defect. The entire preperitoneal space was dissected to identify the pubis bone, the Cooper ligament bilaterally, and the inferior epigastric vessels. This allowed the mesh to be placed with good overlap and avoidance of neurovascular injuries. The mesh was fixed to the Cooper ligament and the pubis bone with tacks. The preperitoneal flap was not closed.

Lumbar group

For lumbar hernia, the patient was placed in a lateral decubitus position with the table flexed, opening the space between the rib cage and the iliac crest. This position is crucial for expansion of the operative area. The colon was mobilized by opening the peritoneal reflection along the white line of Toldt, which usually remains intact. Gravity allows retraction of the colon to the midline, and mobilization should continue dorsally to the psoas major muscle. The retroperitoneal fat was reduced, and the borders of the defect were cleared. At that point, the fascial defect was measured, and a mesh was selected to ensure a 5-cm overlap onto the normal fascia. The dissection was extended to the iliac crest caudally and over the diaphragm cranially. The mesh was fixed with spiral tacks, cranially over the tenth rib, caudally over the iliac crest periosteum, and dorsally over the psoas major muscle. To avoid entrapment, it is necessary to identify the iliohypogastric, ilioinguinal, and genitofemoral nerves.

In all cases, a bilaminar mesh large enough to overlap 5 cm onto the normal fascia was inserted via the 10-mm trocar and extended close to the defect (Parietex composite; Sofradim, Villefranche sur Saone, France; or Timesh; PFM, Germany). The mesh was referenced with two guide sutures on the medial side or closer to the trocars (p1 and p2) and another suture near the center of the lower shaft (C point). A Gore suture passer instrument (Gore-Tex; Flagstaff, Arizona, USA) was used to puncture the abdominal wall at the two predetermined sites, to grasp the threads, and to pull them out through the abdominal wall.

Once the mesh was placed over the defect, it was fixed with helical staples no more than 1 cm apart (Protack; Tyco, USA). The setting started at the bottom (C point) before alternating sides and finishing at the top (p1 and p2). The trocars were removed under direct visual guidance, and the threads were cut, ensuring they remained under the skin. The pneumoperitoneum was emptied, and the operation was completed.

Follow-up evaluation

Outpatient follow-up evaluation was done in a specific consulting room at 1, 3, 6, and 12 months, then yearly thereafter by means of physical exploration. The primary end point was recurrence, identified by physical examination and confirmed by computed axial tomography (CAT). The secondary end points were demographics (age, sex, associated diseases, obesity defined as body mass index [BMI] >30 kg/m^2, previous surgery, and hernia type according to Chevrel's classification), intraoperative parameters, and clinical data (e.g., local and general complications including hematomas, seromas, pain on a visual analog scale of zero [no pain] to five [unbearable pain], consumption of analgesics). The borders of the non-midline area were defined, with cranial considered as the costal margin, caudal as the inguinal region, medial as the lateral margin of the rectal sheath, and lateral as the lumbar region. In this area, four zones were defined: (1) subcostal (between the costal margin and a horizontal line 3 cm above the umbilicus), (2) flank (lateral to the rectal sheath in the area 3 cm above and below the umbilicus, (3) iliac (between a horizontal line 3 cm below the umbilicus and the inguinal region), and (4) lumbar (laterodorsal of the anterior axillary line).

The size of the hernia was defined as the intraoperative size of the fascial defect in cm and cm^2 as follows. Diameter or length was defined as the greatest vertical distance between the most cranial and the most caudal margin of the hernia defect. Area was measured by combining length and width in a formula for an oval (area $= \pi \times a \times b$, cm^2), and width was defined as the greatest horizontal distance between the lateral margins of the hernia defect on both sides.

Patients who expressed any concerns about their repair or had any reported abdominal discomfort during physical examination were reevaluated. The examination included palpation while the patient was in the supine position with the legs extended and raised. Computed tomography (CT) examinations were performed when physical examination was not definitive. Patients were followed up postoperatively for a median of 62 months (range 36–170 months). All the data were collected prospectively on computer by an independent observer. No patients were lost to follow-up evaluation.

Statistical analysis

The analysis was based on a modified intention-to-treat population. The quantitative variables were expressed as means ± standard deviations and the qualitative variables as percentages. Categorical variables were compared by the Pearson chi-square test or Fisher's exact test when indicated. For those cases in which we compared means of continuous variables for two groups and in which the variances for the two groups did not differ significantly, we used the Student's *t*-test to determine whether means were significantly different. When comparing the means of three or more groups, we used the analysis of variance to determine whether the means differed significantly. For the cases in which non-normal distributions existed when two or more groups were compared, we used the Kruskal–Wallis nonparametric test.

The relationship between defect size and recurrence over 3 years was analyzed by the receiver operating characteristic curve (ROC), and values of 95% confidence interval, sensitivity, specificity, and predictive values (+PV or −PV) were analyzed using two different categories for defect size (10 and 15 cm). The moment of long-term recurrence was related to the type of hernia and the presence of obesity using the Kaplan–Meier survival curves and the log-rank test. Multivariate analysis using Cox proportional hazards models was used to identify independent risk factors for the long-term follow-up evaluation. Only variables with a P value less than 0.2 in univariate analysis were included in the multivariate analysis.

Statistical significance was defined as a P value less than 0.05, whereas results were described with a hazard ratio (HR) and a 95% confidence interval (CI). All P values given were two-tailed. All data were processed and analyzed using the Statistical Package for the Social Sciences (SPSS) software package for Windows (SPSS Inc, v15.0, Chicago, USA) and MedCalR 11.3.0.0 (MedCalc Software bvba, Mariakerke, Belgium).

Results

Patient characteristics and long-term outcomes of surgery

We analyzed 73 patients, predominantly female (54.8%), with a mean age of 59.8 ± 11.8 years. Obesity, the most common comorbidity factor, was associated in 44 cases (60.3%). The most common site of the non-midline hernia was the lumbar (45%) followed by the iliac hernia. The average size of the defects was 11.1 cm (range 7–20 cm), the subcostal and the lower iliac being larger (Table 1). All cases were completed laparoscopically with no

Table 1 Characteristics and classification of patients undergoing surgery with laparoscopic non-midline incisional hernia repair including types of non-midline incisional hernia and overall morbidity of the laparoscopic technique after a long-term follow-up evaluation[a]

Variable	Iliac ($n = 28$)	Lumbar ($n = 33$)	Subcostal ($n = 12$)	P value[b]
Age	57.1 ± 11.1	61.9 ± 11.8	60.2 ± 13.2	0.174
Gender				0.875
Male	12 (42.9)	16 (48.5)	5 (41.7)	
Female	16 (57.1)	17 (51.5)	7 (58.3)	
Obesity (BMI: kg/m^2)	31.1 ± 5.1	31.3 ± 4.4	32.1 ± 6.6	0.962
Defect size				
Diameter (cm)	9.2 ± 3.7	11.7 ± 4.6	13.1 ± 3.8	0.005
Area (cm^2)	59.5 ± 49.2	93.9 ± 71.9	108.7 ± 64.2	0.013
Operative morbidity				0.558
Bleeding	1	3	0	
I ntestinal injury	1	0	0	
Spleen injury	0	1	0	
Local morbidity				0.041
Hematoma	7 (87.5)	3 (25)	2 (40)	
Seroma	0	7 (58.3)	1 (20)	
Transitory pain	0	2 (16.6)	0	
Bulging	1 (12.5)	0	2 (20)	
Operating time (min)	59.8 ± 25.3	70.6 ± 33.3	65.4 ± 28.9	0.501
Outpatient surgery	12 (42.9)	7 (21.2)	6 (50)	0.094
Hospital stay (days)	2.9 ± 1.1	2.5 ± 0.9	3 ± 1.8	0.477
Pain (VAS)				
1 month: 0/1	18 (72)/6 (24)	22 (73)/4 (13)	6 (54)/3 (27)	0.280
6 months: 0/1	22 (79)/5 (18)	29 (88)/1 (3)	11 (92)/1 (8)	0.413
Recurrence	2 (7.1)	1 (3)	3 (25)	0.058
Median follow-up: months (range)	58 (36–157)	66 (38–170)	62 (40–166)	

BMI body mass index; *VAS* a visual analgesic scale (0–5)

[a] Comparative study of different types of non-midline incisional hernias for laparoscopic repair after a long-term follow-up evaluation. Values are expressed as mean ± standard deviation for continuous variables. The distributions of dichotomous data are given in absolute values (%)

[b] Differences are nonsignificant at $P > 0.05$, with 95% confidence interval

conversions. Of the 73 patients, 25 (34.2%) did not require hospitalization, and those who were hospitalized had an average stay of 2.7 ± 1.1 days (range 1–16 days). There was no perioperative mortality.

Complications were exclusively local. The most common complication was subcutaneous hematoma, which predominated in iliac hernias (25%). Seromas occurred mostly in lumbar hernias. Only two cases of lumbar hernias had prolonged pain, and that disappeared after the third month. The feeling of parietal bulge was mentioned with the subcostal (2 cases) and iliac (1 case) hernias.

After a median follow-up period of 72 months (range 24–170 months), six recurrences were diagnosed (8.2%), three of them in subcostal hernias (25%). All were suspected and confirmed by CT before 12 months. The relationship between the submission time of recurrence and the type of subcostal hernia showed that these recurred earlier, whereas the lumbar hernia recurred less frequently and later ($P = 0.047$) (Fig. 1). Six patients underwent reoperation by open surgery without further complications.

Clinical characteristics and outcome according to non-midline hernia group

Statistical analysis based on the non-medial hernia group (iliac, lumbar, and subcostal) showed no differences in age, gender, or BMI. However, this test showed significant differences in defect size, local morbidity, and recurrences ($P < 0.05$) (Table 1).

Risk factors for recurrence

The analysis of recurrence showed that the risk factors associated with its development were BMI ($P = 0.040$), defect size (diameter and area: $P < 0.001$), surgical time ($P = 0.007$), and local morbidity ($P = 0.022$) (Table 2). The type of hernia failed to demonstrate statistical significance ($P = 0.058$). When multivariate analysis was performed, the independent risk factors for recurrence were size of hernia defect (HR 2.16; 95% CI 1.0–4.3, $P = 0.029$) and postoperative local morbidity (HR 30.62; 95% CI 1.2–768.8; $P = 0.037$).

The relationship between defect size (area: cm^2) and recurrences was analyzed with the creation of ROC curves (Fig. 2), showing an area under the curve of 0.934 (95% CI 0.8–0.9). The prediction of recurrence using a diameter of 10 cm as a cutoff point showed a sensitivity of 100% (95% CI, 91.6–100), with a specificity of 49.25% (95% CI, 36.5–61.9), a +PV of 15% (95% CI, 2.7–27.3), and a −PV of 100% (95% CI, 94.5–100). The 15-cm cutoff point showed a sensitivity of 100% (95% CI, 91.7–100), with a specificity of 79.1% (95% CI, 68.6–89.6), a +PV of 30% (95% CI, 7.4–52.6), and a −PV of 100% (95% CI, 99.1–100).

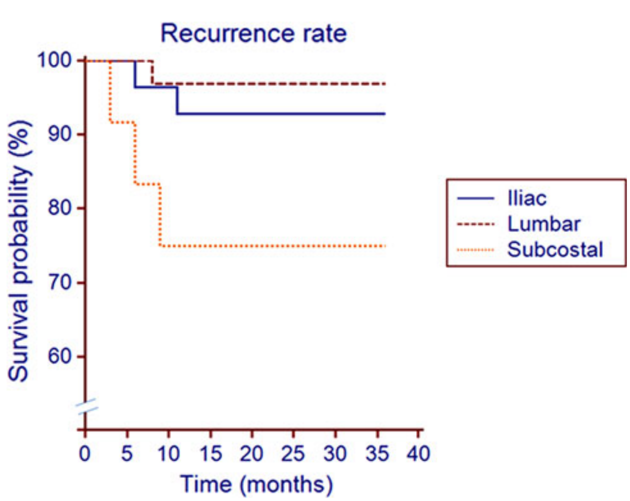

Fig. 1 Kaplan–Meier survival curves for hernia recurrence/non-midline incisional hernia

Risk factors for local morbidity

Local morbidity was statistically significant when associated with obesity, BMI ($P = 0.027$) (Fig. 3), size of hernia defect ($P = 0.010$), and surgical time ($p = 0.017$). When a multivariate analysis was performed, only obesity was confirmed as an independent predictive factor for local morbidity (HR 1.19; 95% CI 1.0–1.3; $P = 0.007$).

Discussion

The laparoscopic approach has been imposed as the treatment of choice for many abdominal processes (e.g., cholecistectomy, colorectal surgery, bariatric surgery). However, its prescription for abdominal wall surgery is disputed. The limitations of laparoscopic repair include inability both to restore functional abdominal wall anatomy and to manage skin redundancy. However, sufficient evidence exists to state that this approach can play an important role in midline hernias of moderate size, improving short-term results, morbidity, and hospital stay [4–10]. However, many of the studies should be interpreted with caution because most include many different types of hernias, vague end points, differing definitions of complications, and short follow-up periods [11–14]. In this context, the role of laparoscopy in the treatment of non-midline incisional hernias still is unknown because of its low prevalence. Furthermore, the experience of surgeons may be limited, and the possibility of having an adequate number of patients is uncommon.

The prevalence of non-midline incisional hernias ranges between 6 and 17%. In our study, specialization in the

Table 2 Overall recurrences: univariate analysis of demographic, clinical, and perioperative variables[a]

Patients	Recurrence ($n = 6$)	No recurrence ($n = 67$)	P value[b]
Age	59.5 ± 6.9	59.8 ± 12.2	0.952
Gender			1.000
Male	3 (50)	30 (44.8)	
Female	3 (50)	37 (55.2)	
Obesity (BMI)	35.4 ± 5.3	30.9 ± 4.8	0.040
COPD	2 (33.3)	10 (14.9)	0.254
Previous open repair	6 (100)	64 (95.5)	1.000
Defect size (cm)	17.8 ± 1.8	10.4 ± 3.9	<0.001
Non-midline site			0.058
Iliac	2 (33.3)	26 (38.8)	
Lumbar	1 (16.7)	32 (47.8)	
Subcostal	3 (50)	9 (13.4)	
Hospital stay (days)	2.8 ± 1.7	2.6 ± 1	0.911
Operating time (min)	99.2 ± 30.4	62.6 ± 27.9	0.007
Intraoperative morbidity	2 (33.3)	7 (10.4)	0.156
Local morbidity	5 (83.3)	20 (29.8)	0.024
Analgesia (days)	15 ± 10	7.1 ± 6	0.029
Prolonged pain			0.005
No	2 (33.3)	49 (73.3)	
Yes	4 (66.6)	18 (26.8)	

BMI, body mass index; COPD, chronic obstructive pulmonary disease

[a] Values were expressed as mean ± standard deviation for continuous variables. The distributions of dichotomous data are given in absolute values (%)

[b] Differences are nonsignificant at $p > 0.05$, 95% confidence interval

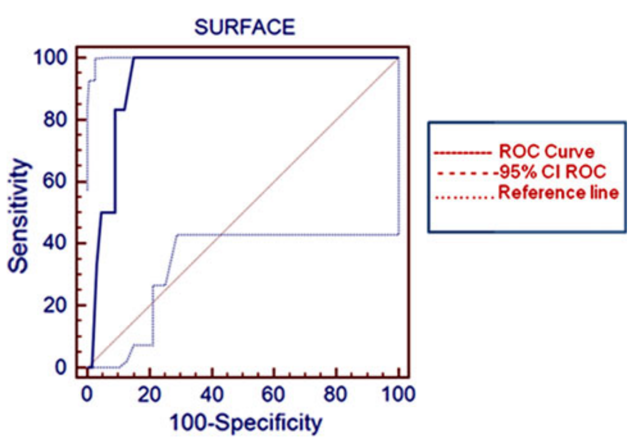

Fig. 2 Receiver operator characteristic curve of defect size (area: cm^2) as a predictor of recurrence development to 3 years. *CI* confidence interval curve roc

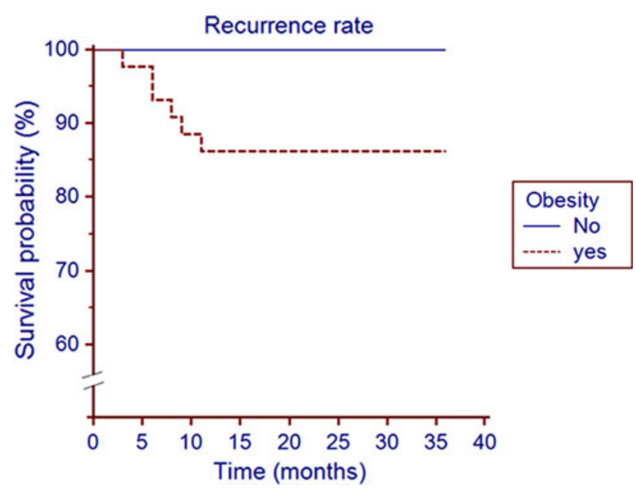

Fig. 3 Kaplan–Meier survival curves for hernia recurrence/obesity in non-midline incisional hernia

treatment of abdominal wall hernias and the multidisciplinary approach helps to explain the size of the study [15]. To our knowledge, this study is the first to look specifically at non-midline hernias with a large series of patients and a long-term follow-up period.

In 2000, Chevrel and Rath [8] proposed a simple classification of incisional hernias based on three parameters: site, width (size), and number of previous recurrences. They coded lateral hernias in four subgroups, namely, L1 subcostal, L2 transverse, L3 iliac, and L4 lumbar hernias. In 2001, Korenkov et al. [3] included a new variable, symptoms of the hernia, with hernias categorized as 1 (asymptomatic) and 2 (symptomatic).

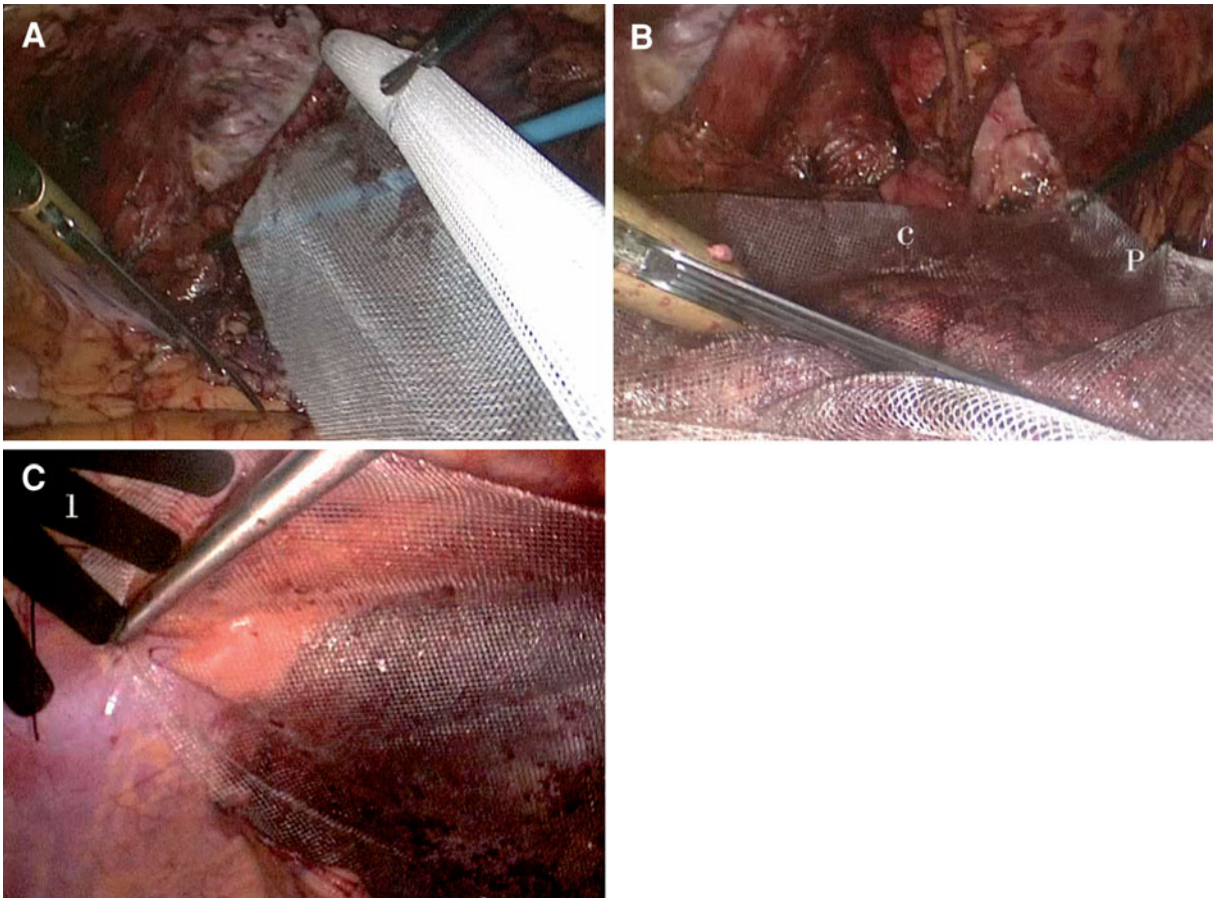

Fig. 4 Maneuver by Moreno-Egea for complex lumbar and iliac hernias. Add or change a 5-mm trocar for a 10-mm trocar and introduce a hepatic retractor (**A**, **B**, **C**). The advantages of this maneuver are that it keeps all the retroperitoneum back; maintains correct vision of the dorsal pararenal and the iliofemoral space; accurately identifies the ureter and renal vessels as well as the iliohypogastric, ilioinguinal, and genitofemoral nerves; performs hemostasis, if necessary, on any bleeding from the lumbar or retroperitoneal vessels; increases by 2–3 cm the caudal overlap of the mesh; performs continuous and safe attachment of the caudal edge; accomplishes fast lateral and cranial extension of the mesh; reduces the surgical time. *P* pubis; *C* Cooper ligament; *1* hepatic retractor

In 2006, Chowbey et al. [16] proposed another classification system based on the expected level of intraoperative difficulty for endoscopic repair (grades 1–6, with higher grades signifying more difficulty). In this classification, the iliac and subcostal groups comprised grades 3 and 4 lumbar hernias but evolved to grade 5 when all the borders of a defect could not be clearly felt, or grade 6 when there was a previous hernia repair (recurrent incisional hernia). In 2007, these authors suggested replacing the term "lateral" with "non-midline" and "groin" with "iliac" to avoid misinterpretation [17].

In 2007, Dietz et al. [18] presented another classification that incorporates body type, hernia morphology, and risk factors to allow tailoring of the repair procedure to the exigencies of the individual case. In 2009, Muysoms et al. [19] returned to warn of the urgent need for a classification system that allows us to make a more scientific registry and that may be used to compare studies on treatment and outcome of incisional hernia repair. Theoretically, without any statistical basis, some authors have suggested that laparoscopic repair of incisional hernias could be a possible alternative to conventional repair for small lateral and lumbar hernias [3, 18–21].

Our study shows that technical difficulty (Choubey's classification) is not a prognostic factor in non-midline incisional hernias. Lumbar hernias (grade 4) have the lowest recurrence rate, whereas the subcostal group (grade 3) has a recurrence rate of 25%. Subcostal hernias are repaired by an intraabdominal laparoscopic procedure, and from a technical point of view are similar to the midline hernias, usually with few visceral adhesions and a good working area. But the defects are larger and poorly defined, with diffuse muscle involvement subject to high intraabdominal pressure, and have the highest rate of recurrence. In the the iliac and lumbar groups, laparoscopy is preperitoneal, with more technical difficulty and morbidity due to

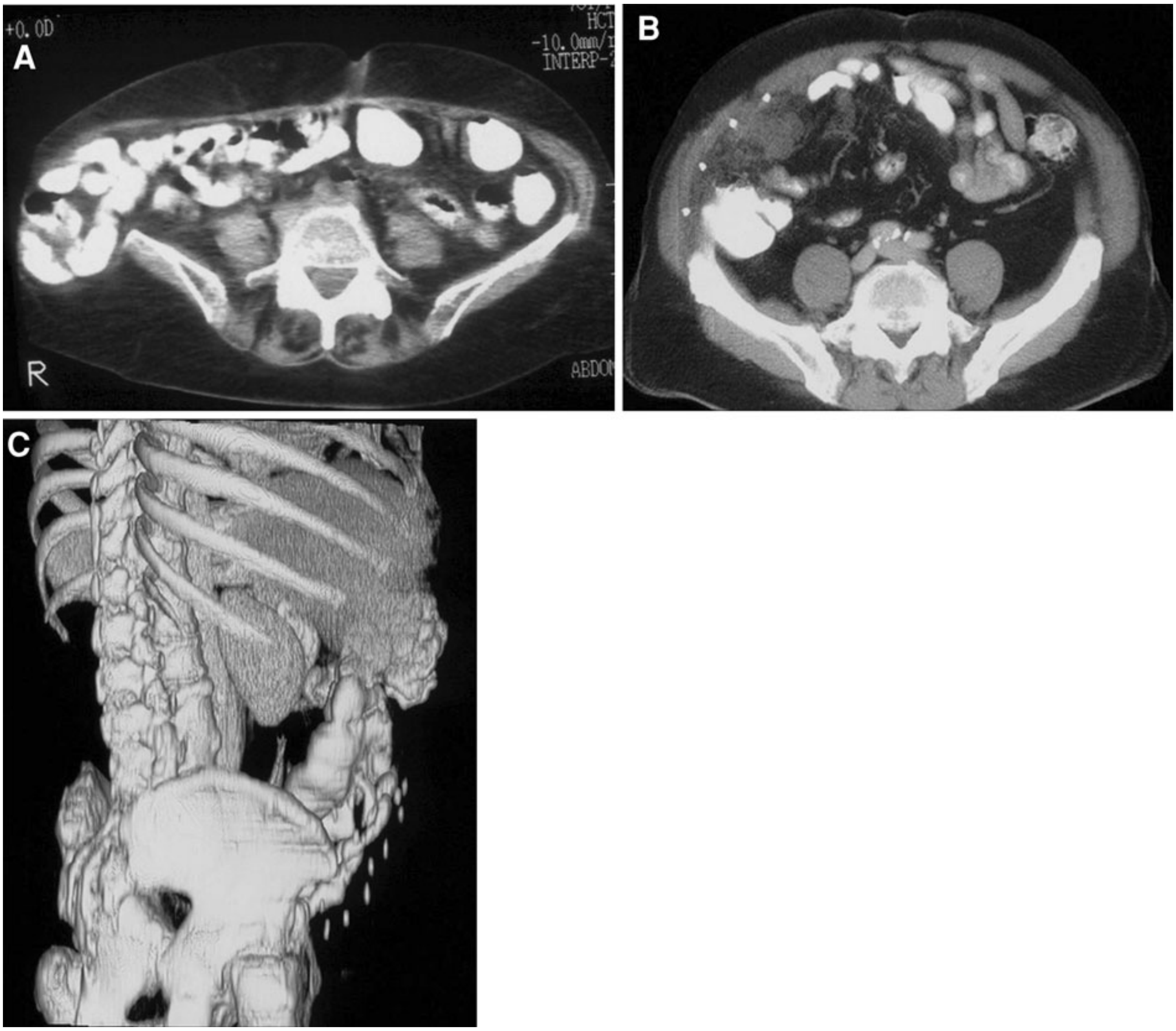

Fig. 5 Computed tomography (CT) study of the iliac hernia (**A**) before and (**B**, **C**) after laparoscopic treatment

the local parietal dissection (hematoma and seroma), but recurrences are less frequent and later, with better cosmetic results, especially if the muscular defect is well defined and there is no associated muscle atrophy (Fig. 4).

All recurrences were confirmed during the first year despite the long follow-up period (Fig. 5). This fact indicates that the cause of failure with the laparoscopic approach is a technical error, a fact that we confirmed during reoperations. The technical error is inadequate fixation of a giant mesh that does not achieve “adequate tension” when fixed on a nonphysiologic (pneumoperitoneum), damaged, or lax wall. At the beginning of this discussion, we stated that laparoscopy has two limitations: anatomy and appearance. We now add a third limitation: inability to achieve adequate tension in a damaged wall. For this reason, in our protocol currently, we have incorporated the use of transmural sutures as a routine procedure for all subcostal hernia groups, obese patients (BMI, >30 kg/m^2), and patients with a defect size larger than 15 cm to improve our results. Alternatively, the author suggests for this patient group a double prosthetic repair in an attempt to cause more fibrosis and appropriate tension to help prevent the development of laxity [22–24] (Fig. 6).

One of the variables independently associated with long-term recurrences is the size of the defect. The laparoscopic approach achieves the best results for defects with diameters less than 15 cm. Defects with a larger diameter are associated with high recurrence rates, as is borne out by the fact that in our series, all recurrences were observed in patients with hernias larger than 15 cm.

The choice of surgical technique probably needs to take into account not only hernia size but also other local and systemic factors [3, 18, 21]. At this point, our study has

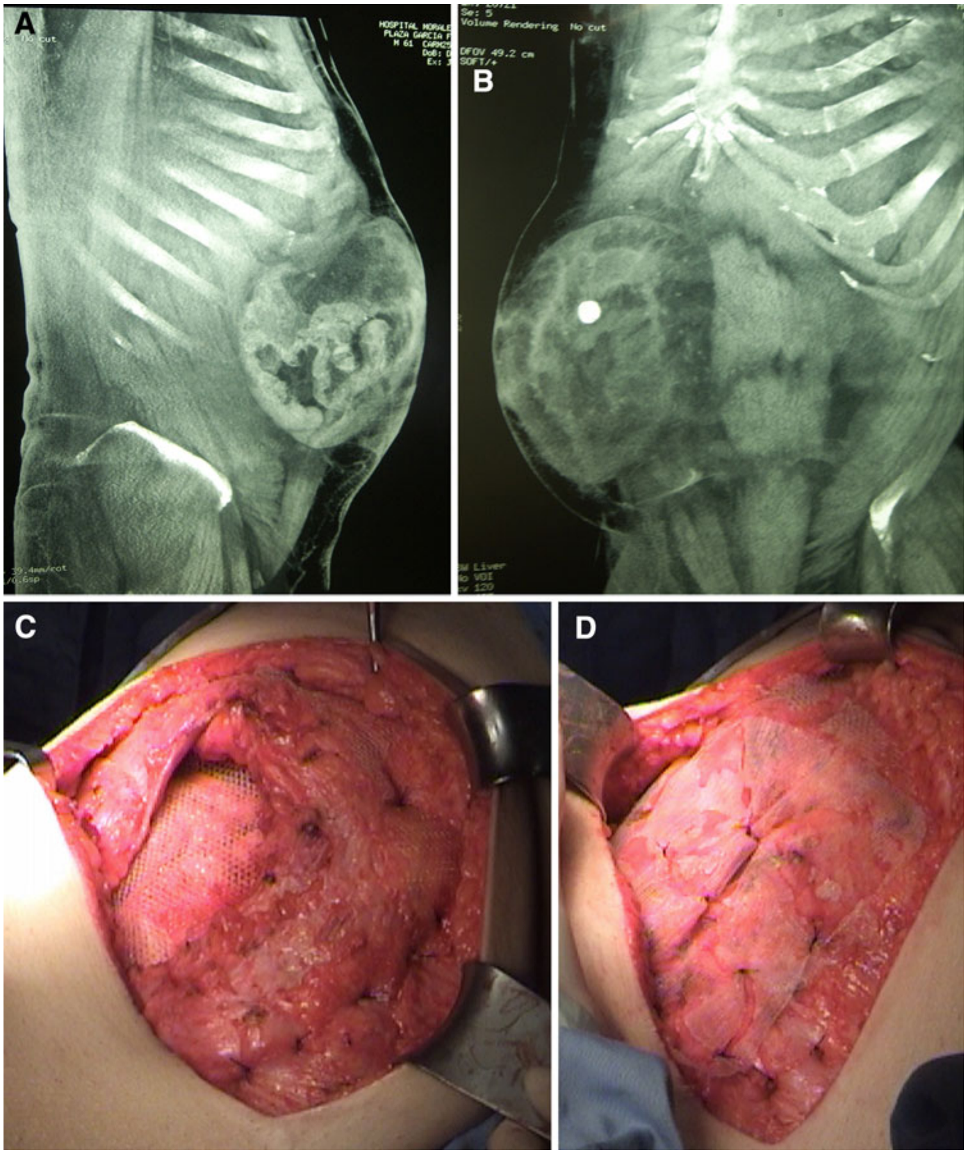

Fig. 6 Subcostal hernia recurrent after laparoscopic treatment. (**A**, **B**) Computed tomography (CT) study. (**C**, **D**) Double prosthetic repair

shown that local morbidity is an independent risk factor for recurrence and that obesity is the only comorbidity influencing the final outcome of this surgery. Preperitoneal dissection of an iliac or lumbar hernia in an obese patient requires more difficult, more time-consuming surgery and is associated with hematomas and postoperative pain, and ultimately with a high rate of recurrence.

Although obesity has been used as a good indication for laparoscopic surgery, this study shows that obesity (BMI, >30 kg/m^2) also should be considered a limiting factor. Weight loss before laparoscopic repair of non-midline incisional hernia should be considered a standard optimization for patients. Other comorbidities have been identified that increase the risk of recurrence with the open repair including male gender, smoking, wound contamination, age exceeding 45 years, reinterventions, and postoperative complications [3, 21]. An algorithm is suggested to guide the "rational" treatment for non-midline hernias of the abdominal wall (Fig. 7).

The main limitation of this study was its observational nature, which prevents assertion of conclusions with greater severity. While waiting for a future randomized controlled trial, we conclude that the laparoscopic approach is a safe and effective treatment for non-midline incisional hernias. The risk of recurrence is low, and it avoids technical mistakes. Caution should be taken with subcostal hernias, obese patients, and defect sizes larger than 15 cm.

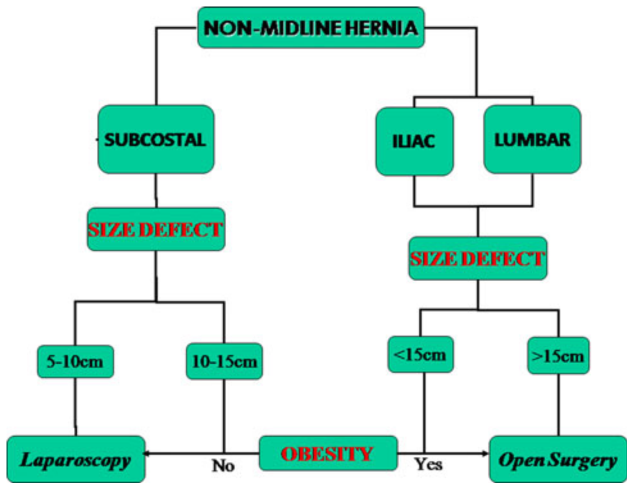

Fig. 7 Algorithm for the treatment of non-midline incisional hernias

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