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Long-Term Outcome of 254 Complex Incisional Hernia Repairs Using the Modified Rives-Stoppa Technique

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Abstract
Background Repair of complex incisional hernias poses a major challenge.
Aim The aim of this study was to review the outcomes of the modified Rives-Stoppa repair of complex incisional hernias using a synthetic prosthesis.
Methods We reviewed patients undergoing a modified Rives-Stoppa repair of complex incisional hernias from 1990 to 2003. Patients were followed through clinic visits and mailed questionnaires. Follow-up data were complete in all patients (mean 70 months, range 24–177 months), and 87% of patients completed a mailed questionnaire. Primary outcome included mortality, morbidity, and hernia recurrence. Secondary outcome measures were duration of hospital stay, long-term abdominal wall pain, and self-reported patient satisfaction.
Results Altogether, 254 patients underwent a modified Rives-Stoppa repair. Among them, 60% had a significant co-morbidity, and 30% had one or more previously failed hernia repairs. Mortality was zero, and overall morbidity was 13% (wound infection 4%, prosthetic infection 3%, seroma/hematoma 4%). The overall hernia recurrence rate was 5%, including explantation of mesh because of infection. Wound/prosthetic infection was predictive for hernia recurrence (31% vs. 4%, $p = 0.003$). Among the respondents, 89% reported overall satisfaction with their repair.
Conclusion The Rives-Stoppa repair of complex incisional hernias using synthetic prosthetic materials is safe with a low recurrence rate (5%) and high patient satisfaction. Postoperative wound infection is a risk factor for hernia recurrence.

Incisional hernias develop in 4% to 11% of patients after open abdominal operations and may occur with a frequency as high as 23% when the abdominal incision is complicated by a postoperative wound infection [1–3]. When the defect(s) is large, recurrent after one or more previous repairs, associated with extensive intraabdominal adhesions, multiple in number, or occurs in patients with multiple risk factors for recurrence, repair poses a major challenge, because commonplace options for repair are associated with unsatisfactory recurrence rates [1–3]. Repair of complex hernias by primary fascial approximation carries a recurrence rate of more than 50% [3–8] Autologous "tension-free" repairs using the various techniques of components separation have a reported recurrence rate that ranges from 10% to 30% [9–12] Repairs that use permanent prostheses differ based on where the prosthesis is placed anatomically: onlay (superficial) versus inlay (patch) or a sublay placed intraperitoneally versus an extraperitoneal yet intramural sublay. Onlay techniques have reported recurrence rates as high as 23%; and the laparoscopic approach, with an intraperitoneal sublay, has a reported recurrence rate up to 11% [3, 13].

The Rives-Stoppa technique of hernia repair is a well described open repair that places the prosthesis

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extraperitoneally as a sublay with wide overlapping coverage (≥ 10 cm) of the fascial defect to achieve a tension-free closure that also maximizes the surface area for tissue ingrowth through the prosthetic mesh [14–16]. The original description of the Stoppa repair noted prosthetic mesh placement in the intraparietal (intramural) plane—deep to the transversalis fascia and superficial to the peritoneum [17]. A later modification of the original technique for ventral hernias places the prosthesis anterior to the posterior rectus fascia and posterior to the rectus abdominis muscles [18]. These techniques, popularized more recently by Stoppa and colleagues [14–16], achieve three major goals of herniorraphy: (1) extensive overlap between the prosthesis and the fascial edges allows a tension-free closure as well as a large surface area for tissue incorporation; (2) the mechanical strength of the synthetic prosthesis reinforces the abdominal wall, especially when there is increased intraabdominal pressure; and (3) placement of the prosthesis adjacent to the vascular-rich rectus muscles facilitates tissue incorporation, promotes resistance to mesh infection, and allows interposition of autologous tissue between the prosthesis and the skin/subcutaneous tissues anteriorly and the peritoneum posteriorly.

This study reviews our 15-year experience using a modified Rives-Stoppa technique to repair complex abdominal hernias. Our goals were to evaluate the short- and long-term outcomes of the repair and identify risk factors for hernia recurrence.

Materials and methods

Patients

After Institutional Review Board approval, we queried our prospective database to identify all patients who had undergone a modified Rives-Stoppa repair for a complex incisional hernia at the Mayo Clinic (Rochester, MN) using a synthetic prosthetic graft. We defined a complex incisional hernia as an incisional hernia characterized by a large defect (>6 cm in diameter), multiple defects, previously failed repair(s), and/or a body mass index (BMI) of >30. A total of 254 consecutive patients underwent a Rives-Stoppa repair from October 1991 to October 2003; this experience is in large part a tertiary referral practice. Review of the medical records elicited patient demographic and medical data, characteristics of the hernia, number/type of previous repairs, perioperative course, and long-term outcomes. Follow-up data via chart review was complete for all 254 patients with a mean follow-up of 70 months (range 24–177 months; median 59 months from the time of last contact). A tailored questionnaire designed to gather further data regarding hernia recurrence, incidence of abdominal wall pain, and degree of patient satisfaction with their hernia repair was mailed to each patient. The response rate to this questionnaire was 87% ($n = 221$). All patients reporting a recurrence or concern about a recurrence were contacted via telephone, and the presence or absence of a hernia was confirmed with their primary doctor or during follow-up in our clinic by physical examination and/or imaging.

Outcome measures

Our primary outcome measures were the 30-day perioperative morbidity and mortality rates in addition to the overall rate of hernia recurrence. All perioperative morbidities were reported with particular attention to wound infection, prosthesis infection, and clinically important seroma or hematoma formation. Secondary outcome measures included the duration of hospital stay, presence of abdominal wall pain during long-term follow-up, and each patient's self-reported satisfaction.

Operative material and technique

General surgery residents, in conjunction with attending surgeons, performed all Rives-Stoppa procedures (Fig. 1) with the following objectives: (1) development of a viable, extraperitoneal tissue plane for placement of the prosthesis; (2) use of a synthetic prosthesis to cover the hernia defect minimizing tension with wide lateral overlap; and (3) coverage of the prosthesis with vascularized autogenous tissues to maximize tissue incorporation and prevent prosthetic infection. To achieve these objectives, all attempts were made to place the prosthesis in a plane developed between the posterior rectus fascia and rectus muscle with at least a 5-cm and preferably a 10-cm overlap between the edge of the hernia defect and the lateral border of the prosthesis. Polypropylene [either Prolene Mesh or, more recently, Ultrapro (Ethicon, Somerville, NJ, USA)] was the preferred prosthesis; however, when the prosthesis was subject to direct intraperitoneal exposure, a composite prosthesis of polypropylene on the abdominal wall side and expanded polytetrafluoroethylene (ePTFE) on the intraperitoneal side (Bard Composix E/X Mesh; Davol, Cranston, RI, USA) or, rarely, a prosthesis of ePTFE alone (DualMesh; Gore Creative Technologies, Newark, DE, USA) was used. In addition, if the hernia defect was very wide (≥ 10 cm), if dissection of the subcutaneous hernia sac would otherwise require a very wide mobilization, or if the overlying skin and subcutaneous tissues were thin and unable to be excised, the prosthesis was placed as an

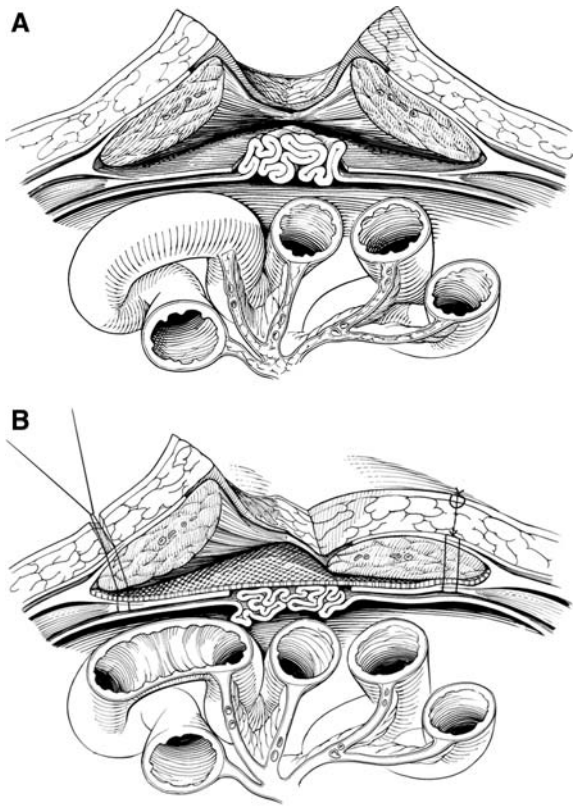

Fig. 1 **a** Rives-Stoppa repair involves establishing a plan between the posterior rectus fascia and the rectus muscle with wide overlap for prosthetic placement. The repair remains extraperitoneal with reduction of the hernia sac. **b** Fixation of the mesh is performed through circumferential stab incisions, taking bites of the anterior rectus fascia, the rectus muscle, and the prosthesis. The knot lies in the subcutaneous space. (From Farley DR, Sawyer MD, Sarr MG. Ventral and incisional hernia. In: Kelly KA, Sarr MG, Hinder RA (eds) Mayo Clinic Gastrointestinal Surgery. Philadelphia: Saunders; 2004. p. 665–678.)

intraperitoneal sublay to avoid the risk of infection in a large subcutaneous dead space.

Each operation started with a limited midline incision (unless the hernia was a flank hernia or in a transverse incision), excising the previous scar back to healthy skin and exposing the hernia sac and its associated fascial defect(s). Careful examination of the fascia was carried out routinely to identify multiple or other discrete defects. Every attempt was made to remain extraperitoneal with reduction of the hernia sac into the peritoneal cavity. In the event that the peritoneal cavity was violated, an attempt was made to close the peritoneum to avoid any direct contact between the bowel and the prosthesis. The hernia sac was preserved whenever possible to provide another layer of autogenous tissue interposed between intraperitoneal contents and the posterior surface of the prosthesis. A plane was then developed between the posterior rectus fascia and the rectus muscles, or, when below the arcuate line, the transversalis fascia and the rectus muscles. Dissection was carried out laterally to, at least, the midclavicular line or even further laterally underneath the external or internal oblique muscles to the anterior axillary line, depending on the size of the hernia and the presence or condition of the ipsilateral rectus muscle. Rostral and caudal dissection provided at least a 5- to 10-cm margin between the edge of the plane and the hernia defect.

In situations where extensive fascial scarring or tissue loss obliterated this plane, an attempt was still made to place the mesh extraperitoneally—if such a plane could be developed. Occasionally, the severe scarring of abdominal layers or extensive loss of abdominal wall domain necessitated intraperitoneal placement of the prosthesis, in which case a composite prosthesis was used with the ePTFE side facing the abdominal cavity and the polypropylene side facing the abdominal wall.

Once in appropriate position, the lateral edges of the prosthesis were fixed in a radial fashion to the anterior abdominal wall using absorbable or nonabsorbable sutures through multiple skin stab incisions at the lateral borders of the prosthesis. A long, straight needle with suture was passed through the stab incision through the anterior rectus fascia and rectus muscle anterior to the developed plane, through the prosthesis with a 1- to 2-cm bite, and then back out the stab incision in a horizontal mattress fashion. More recently, a laparoscopic suture passer (Endoclose; Autosuture, Norwalk, CT, USA) was used. Finally, the suture was tied with the knot lying on top of the anterior fascia. No attempt was made to dissect out the subcutaneous space laterally, anterior to the anterior rectus fascia to the extent of the mesh; this maneuver would lead to a much larger subcutaneous space and further devascularize the skin/subcutaneous tissues lateral to the incision.

Autogenous tissues anterior to the prosthesis were approximated in the midline whenever possible to cover the anterior surface of the prosthesis after it was secured properly. Rarely, lateral fascial relaxing incisions or a components separation technique was used to reapproximate the midline fascia to protect the prosthesis from potential infection by covering the prosthesis with another layer of vascularized tissue. As stated above, if initial inspection of the defect suggested that a large surface area of the prosthesis would remain exposed in the subcutaneous space because no fascia or muscle could be approximated over the prosthesis, the decision was made early to place the prosthesis fully intraperitoneally as a wide sublay, and minimal lateral dissection was then performed. This approach was used most commonly for very large defects ($\geq$ 20 cm) or when the overlying skin/subcutaneous tissues were markedly scarred or attenuated and there was insufficient, redundant healthy skin and subcutaneous tissue that could be mobilized and advanced medially by lateral dissection to close the incision.

One to three closed suction drains were placed in the subcutaneous tissue or just anterior to the prosthesis prior to skin closure. Drains were removed once the output was decreased markedly or, in more recent years, within 1 to 2 days. Clinically significant seromas were aspirated repeatedly—all attempts were made to avoid placement of an indwelling, transcutaneous drain.

All patients received prophylactic, preoperative intravenous cefazolin and, on occasion, postoperative oral antibiotics until the drains were removed, but no formal protocol for postoperative antibiotics was followed. Additional standard postoperative care included patient-controlled analgesia for pain management or epidural analgesia, perioperative subcutaneous heparin, and restricted heavy lifting for 6 weeks.

Statistical analysis

Analysis of variance (ANOVA) was used to determine differences between multiple groups and Student's *t*-tests to compare two groups directly. A value of $p < 0.05$ was considered statistically significant. Logistic regression was used to assess recurrent risk and to compute the odds ratio. Values are expressed as mean ± standard error of the mean (± SE), unless specified otherwise.

Results

We studied 254 patients who underwent a modified Rives-Stoppa repair for complex incisional hernias from 1990 to 2003. Table 1 summarizes the patients' demographics, the preoperative risk factors, and the nature of procedures that preceded the development of an incisional hernia. The predominant risk factors for hernia development included current or morbid obesity (BMI > 35) (33%, $n = 84$), diabetes (16%, $n = 41$), chronic obstructive pulmonary disease (COPD) (8%, $n = 20$), and a history of an abdominal aortoiliac aneurysm repair (3%, $n = 8$). Most of the hernias (81%, $n = 206$) were located in the midline, with the presence of more than one defect in 31% ($n = 79$) (Table 2). Many of the patients had undergone previous complex gastrointestinal procedures (35%, $n = 89$), and 23% ($n = 58$) had undergone multiple laparotomies prior to the development of an incisional hernia. In total, 30% ($n = 76$) of the patients had undergone at least one previously failed primary hernia repair. Of the 76 patients who had had a previous hernia repair, 13 had undergone multiple previous attempts.

Table 3 summarizes the distribution of prostheses used. Polypropylene mesh was used in 75% ($n = 191$) of the repairs, composite mesh (polypropylene and ePTFE) in 14% ($n = 35$), and ePTFE alone in 9% ($n = 23$). When described ($n = 147$ patients), the mean estimated area of the prosthesis used was 745 ± 25 cm^2; and the prosthesis was placed between the posterior surface of the rectus muscle and the anterior surface of the posterior rectus fascia in 81% ($n = 206$). Intraperitoneal placement of

Table 1 Patient characteristics

Age (years)	
Mean ± SE	55.8 ± 0.8
Range	27–91
Sex	
Female	137 (54%)
Male	117 (46%)
Total	254 (100%)
Preoperative risk factors	
Morbid obesity (BMI >36)	84 (33%)
Diabetes	41 (16%)
COPD	20 (8%)
Active malignancy	8 (3%)
Abdominal aortic aneurysm	8 (3%)
Types of operation leading to incisional hernia	
Gastrointestinal procedures[a]	89 (35%)
Failed primary hernia repairs	76 (30%)
Multiple abdominal procedures[b]	58 (23%)
Gynecologic procedures	15 (6%)
Abdominal vascular procedures	18 (7%)
Genitourinary procedures	10 (4%)

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

[a] In descending order, the four most frequent gastrointestinal procedures include open gastric bypass, colectomy, small bowel procedures, and open cholecystectomy

[b] Patients with three or more open laparotomy procedures

Table 2 Ventral hernia characteristics

Location	
Midline	206 (81%)
Paramedian	15 (6%)
Subcostal	10 (4%)
Flank	10 (4%)
Type of fascial defects	
Single defect	175 (69%)
Multiple (Swiss-cheese) defects	79 (31%)
Prior attempts to repair hernia	
None	165 (65%)
One	76 (30%)
Two or more	13 (5%)

Table 3 Characteristics of synthetic prosthesis

Type of mesh used in repair	
Polypropylene	191 (75%)
Composite mesh (polypropylene + ePTFE)	35 (14%)
ePTFE alone	23 (9%)
Other	5 (2%)
Prosthetic size (area: cm^2)[a]	745 ± 25
Location of prosthetic placement	
Extraperitoneal (anterior to posterior rectus sheet)	206 (81%)
Intraperitoneal	41 (16%)
Combined intraperitoneal and extraperitoneal	7 (3%)
Prosthetic exposure to subcutaneous tissue	
No	239 (94%)
Yes	15 (6%)

ePTFE: expanded polytetrafluoroethylene

[a] Mean ± SE; $n = 147$ patients with size of mesh noted

Table 4 Perioperative outcome

Mortality (30-day)	0
Morbidity (30-day)	
Wound or prosthetic infection	10 (4%)
Seroma or hematoma	10 (4%)
Small bowel obstruction	1 (1%)
Respiratory complications[a]	3 (1%)
Others[b]	2 (1%)
Total	33 (13%)
Duration of stay (days), mean ± SE	6 ± 1

[a] Pneumonia, respiratory failure, and pulmonary edema ($n = 1$ each)

[b] Pulmonary embolus and stroke ($n = 1$ each)

composite or ePTFE mesh was deemed necessary in 16% ($n = 41$) of the patients.

The 30-day postoperative mortality and morbidity rates were 0% and 13%, respectively (Table 4). The acute wound and prosthesis infection rates were 2% each ($n = 5$ each); the five patients with a superficial wound infection did not require removal of the prosthesis. The remaining five patients had early prosthetic infection that required explantation of the prosthesis within the first 30 postoperative days. The type of prosthesis used did not appear to predispose to infection, and all these patients are included in the recurrent hernia group. The incidence of seroma/hematoma was 4% ($n = 10$); these complications were managed conservatively or with percutaneous aspiration (if symptomatic) without further sequelae. The mean duration of the hospital stay was 6 ± 1 days.

Table 5 shows the long-term outcomes of all 254 repairs. The mean follow-up duration, either through clinic visits, telephone calls, or questionnaires, was 70 months (range 24–177 months). The overall hernia recurrence rate was 5% ($n = 13$), with most of these recurrences being evident clinically within 12 months of the repair; this rate includes the patients with mesh infection requiring early or late mesh explantation. Patients with a postoperative wound infection had an increased risk for hernia recurrence compared to those without an infection, 30% ($n = 3$) vs. 4% ($n = 10$) ($p = 0.003$). Patients with COPD also had a greater recurrence rate (20% vs. 4%; $p = 0.07$). Other factors, including BMI, diabetes, postoperative seroma/hematoma, type of prosthetic, and nonmidline hernias were not predictive of recurrence ($p > 0.05$). Altogether, 87% ($n = 221$) of patients responded to the follow-up survey, among whom 89% ($n = 197$) reported satisfaction with their repair. The most common reasons given for dissatisfaction were recurrence requiring reoperation, postoperative complications, and persistent pain at follow-up. In total, 27% of the respondents reported having intermittent abdominal wall pain and rated their worst pain during the entire follow-up period since discharge at a mean score of 4.3 ± 0.3 on the standard 0 to 10 pain scale. Of the 34 patients not returning the survey, 91% were deceased by the time of our questionnaire, and there were no differences in demographics, type of hernias, or perioperative characteristics by chart review.

Table 5 Long-term outcome

Follow-up duration (months), mean ± SE and range	70 ± 3 (24–177)	
Reported satisfaction		
Satisfied	197 (89%)	
Not satisfied	24 (11%)	
Worse pain at follow-up		
No. of patients with pain at follow-up	60 (27%)	
Mean ± SE (scale 0–10, where 0 = no pain)	4.3 ± 0.3	
Hernia recurrence rate		
No infection group	10/244	$p = 0.003$*
Infection group ($n = 10$)	3/10	
Overall	13/254	

* No infection vs. infection

Discussion

This study is one of the largest series to date to evaluate the durability and safety of the modified Rives-Stoppa repair for complex incisional hernias. Like most institutions, treating incisional hernias in our practice has been a challenging ordeal due to the complexity of incisional hernias and patient risk factors we see in our referral

patient population. These patients are almost always obese and have multiple other co-morbidities, such as diabetes and COPD; in addition, many have undergone multiple celiotomies with subsequent formation of dense adhesions, have had previously failed hernia repairs, or have large hernias with multiple defects. In our initial series of 50 patients undergoing a Rives-Stoppa repair for incisional hernias, we had a recurrence rate of 4% with a mean follow-up for all patients of only 24 months [14]. It was apparent from this initial experience that concomitant gastrointestinal procedures should not be performed with a Rives-Stoppa repair due to the high risk of wound and prosthetic infection requiring subsequent exploration. Since that time, we have followed this strategy in our current series and have been satisfied with the durability and safety of this technique for complex incisional hernias. The relatively low morbidity rate and 0% mortality rate in this review demonstrate that this procedure can be performed safely; in addition, the 5% recurrence rate, which includes patients in whom the prosthesis was explanted during the early postoperative period for infection, over a mean follow-up of 70 months, signifies that the modified Rives-Stoppa repair has excellent long-term durability. Notably, 89% of all patients undergoing this procedure were satisfied with their outcome.

This current analysis, however, is limited by its retrospective nature—in some situations patient self-reported data—and that our recurrence rate is based on a chart review coupled with a questionnaire. Even though most (91%) of the 34 patients of those who had not completed the survey were lost to follow-up due to deaths unrelated to their hernia repair, it is possible that there were recurrences that have gone undetected by our means of follow-up. If we assume that those patients, still living, who did not complete the survey had a recurrence, it would still make our recurrence rate 6%. Furthermore, we called, talked with, or examined every patient who claimed they had a recurrent hernia; in questionable cases, we talked with their home physician or had them return to see us in the clinic. In fact, 19 patients reported a hernia recurrence; but on further evaluation in our clinic or with their local physician (including physical examination and imaging), only 7 actually had a recurrence. Again, we acknowledge that we might have missed some patients with a recurrent hernia because they did not recognize it; yet the volume of patients in this series is such that a large number of patients with a recurrence would have had to be missed to affect the recurrence rate significantly. With our diligence in follow-up, we believe that the results presented here are accurate.

The modified Rives-Stoppa repair utilizes a strategically placed prosthetic graft with wide overlap of the hernia defect to create a tension-free closure and optimize tissue incorporation of the prosthesis into the abdominal wall. Additionally, placement of the prosthesis adjacent to the highly vascularized rectus abdominis muscle may also minimize infection. Care to remain extraperitoneally when performing this repair, as well as not performing any other contaminated or even clean-contaminated gastrointestinal procedures, is also believed to be important in minimizing infection [14] because prosthetic infection can be a devastating complication that inevitably leads to hernia recurrence if explantation of the prosthesis is necessary. In the event that an extraperitoneal repair is not possible, use of a composite mesh to protect the bowel but still allow tissue incorporation anteriorly is acceptable in the absence of bacterial contamination or colonization. Opening the gastrointestinal tract, the presence of active infection, or a history of explantation of a previously infected prosthetic material should be considered relative contraindications to the Rives-Stoppa repair using placement of a permanent prosthetic material.

The two alternative approaches to the Rives-Stoppa repair of a ventral hernia include laparoscopic repair and autologous repair by the components separation technique. Laparoscopic repair has been reported to decrease hospital stay and to have less postoperative pain, but its long-term durability is less well known [3, 13] Unlike the Rives-Stoppa repair, the laparoscopic approach does not permit tissue incorporation of the prosthesis because these repairs almost exclusively use ePTFE, and controversy exists over how to fix the prosthesis to the abdominal wall to prevent laxity in the prosthesis and also prevent bowel from sliding between the prosthesis and the abdominal wall. Moreover, this approach can be difficult if there are multiple adhesions, predisposing to recognized or even unrecognized injury to the bowel during mobilization of adherent bowel from the posterior surface of the abdominal wall and hernia sac.

Autologous repairs using either simple approximation (accepting a recurrence rate of >50%) [3–6] or using a components separation technique in a more tension-free manner are particularly well suited for hernias of moderate size in the setting of an active infection. In fact, this is our current approach to hernia repairs complicated by the history or presence of bacterial colonization where a permanent prosthesis is contraindicated. One must remember that even the so-called tension-free components separation technique is an autologous tissue repair; and if the patient has an underlying biochemical abnormality in tissue healing, as do many or most patients with incisional hernias, the recurrence rate will probably remain high [19, 20].

Conclusions

The Rives-Stoppa repair of complex incisional hernias is a safe, durable technique that results in high patient satisfaction with an overall recurrence rate of 5%. Postoperative

wound and prosthetic infections were the main predictors of hernia recurrence; thus, meticulous measures should be implemented to minimize postoperative infection. In patients with active infection or bacterial contamination, repair should not be performed using a permanent prosthesis—other methods such as some form of primary repair using autologous tissues or bioprosthetic devices may be better suited for this scenario with consideration of a Rives-Stoppa repair electively in the future.

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