



Emergent groin hernia repair: A single center 10-year experience[☆]

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ABSTRACT

Background: Emergent groin hernia repair can be a challenging clinical scenario. We aimed to evaluate the perioperative and long-term outcomes of emergent groin hernia repair at our institution over the last 10 years, with particular interest in surgical approach and mesh use for such cases.

Methods: Adult patients who underwent emergent groin hernia repair from 2005–2015 were retrospectively reviewed. Outcomes included surgical site infections, perioperative complications, readmissions, reoperations, mortality, and long-term hernia recurrence. Predictors of surgical site infection and perioperative complications were investigated using multivariate logistic regression.

Results: A total of 257 patients met inclusion criteria (62% males, median age 72). Hernias were most often indirect inguinal (40.9%) and femoral (33.5%), and 45 cases (17.5%) required a bowel resection. Laparoscopic repair was performed in 3 patients (1.2%). Synthetic mesh was placed in 70% of repairs but in only 15% of cases associated with a bowel resection. The medical complications rate was 16.7%; 3.6% had a surgical site infection, and 30-day mortality rate was 3.1%. Older age (odds ratio 1.05) and gross contamination (odds ratio 4.3) were independently associated with complications. Mesh use was not associated with surgical site infection (odds ratio 1.83, $P = .49$) or perioperative complications (odds ratio 1.02, $P = .96$). With a median follow-up of 43 months, there were no mesh infections and recurrence rates were similar between mesh and tissue repairs (6.3% vs 6.8%, $P = .91$).

Conclusion: Emergent groin hernia repair has high rates of morbidity and mortality most closely associated with increasing age and the presence of contamination. Although mesh use appears to be well tolerated when used in the absence of contamination during emergent groin hernia repair, recurrence rates were similar to tissue repairs.

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Introduction

Groin hernia repair is one of the most commonly performed operations in general surgery. A total of 850,000 inguinal hernia operations are performed yearly in the United States and approximately 20 million are treated worldwide.^{1–3} Because of their proven benefits in recurrence reduction, tension-free mesh repairs have played a central role in the surgical armamentarium of groin hernia repair over the last 4 decades. In addition, minimally invasive techniques

have been successfully incorporated into inguinal hernia surgery and are being used more commonly.

The optimal management of groin hernias in an emergent setting remains controversial, particularly in the presence of contamination. Given the rarity of these events, there is a relative paucity of literature examining outcomes of patients with emergent groin hernia repairs to draw relevant conclusions. Because of classical surgical teaching, which propagates the idea that the risk for infectious complications in such scenarios would outweigh the benefit of increased repair durability, the use of synthetic mesh in this situation is not universally accepted. Furthermore, unlike an elective operation where repair durability and avoidance of chronic groin pain are the primary goals, an emergent groin hernia repair (EGHR) has the primary objective of resolving the gastrointestinal emergency in a timely fashion, thus preventing intestinal compromise and intra-abdominal complications.¹ Another contrast between the elective and emergent management of groin hernias is the use of

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laparoscopic repairs, which appear to be used less often in the context of EGHR.¹ With very little published data evaluating the long-term outcomes of synthetic mesh use during EGHR, the benefits and potential consequences of mesh use remain unknown in this challenging setting.

Keeping these observations in mind, we aimed to evaluate the perioperative and long-term outcomes of EGHR at our institution over the last 10 years, with particular interest in surgical approach and mesh use for such cases. We have hypothesized that mesh use in the setting of contamination would be low but would not be independently associated with increased odds for surgical site infection (SSI).

Methods

Patient identification and inclusion and exclusion criteria

After obtaining Institutional Review Board approval, all consecutive adult patients (≥ 18 years old) who underwent EGHR at our institution between 2005 through 2015 were retrospectively identified in a prospectively maintained administrative database. EGHR was defined as inguinal, femoral, or obturator hernia repaired within 24 hours of an emergency department visit or a hospital admission as a consequence of acute incarceration or strangulation. Acute incarceration was defined as the sudden development of an irreducible painful bulge in a patient with or without a previous diagnosis of a groin hernia, which resulted in the patient seeking emergent hospital care. Strangulation was defined intraoperatively by the evidence of ischemia or necrosis of the incarcerated viscera. We excluded from this analysis repairs performed electively after a successful manual hernia reduction in the emergency department (ED), even if the repair was performed in the same hospital encounter.

Data collection

Electronic medical records (EMR) were reviewed, and patient demographic characteristics, hernia variables, operative details, and 30-day and long-term outcomes were analyzed. Patient demographic characteristics included age, sex, ethnicity, body mass index, American Society of Anesthesiologists class, cardiac disease (defined as diagnosed congestive heart failure or coronary artery disease), chronic obstructive pulmonary disease, diabetes, ascites, immunosuppression (defined as daily use of steroids or any other immunosuppressant medication), benign prostatic hyperplasia, and smoking status. Clinical evidence of peritonitis on presentation was considered when the following information was documented in the EMR by an emergency room physician or the acute care surgeon: (1) rebound tenderness or involuntary guarding on abdominal physical examination or (2) when the word “peritonitis” was documented. Operative details included side of hernia, hernia type, intraoperative findings, repair technique, mesh type, performance of bowel resection, and the presence of contamination. Gross contamination was defined by intestinal contents or purulence found on opening the hernia sac. Thirty-day outcomes included all intraoperative, medical, and surgical complications recorded in the EMR as well as unplanned readmissions, reoperations, mortality, and hospital duration of stay. Hernia recurrence was assessed for all patients who had at least 1-year follow-up available as further detailed.

Telephone interviews

Telephone interviews were performed to obtain longer-term follow-up and to confirm and complement information of EMR information when necessary. During telephone interviews, patients

were queried as to the occurrence of any type of postoperative complications, including surgical site infection, reoperation, readmission to outside facilities, and hernia recurrence. For the patients who denied having a hernia recurrence diagnosed, the Ventral Hernia Recurrence Inventory (VHRI) survey was applied. The VHRI is a patient-reported outcomes tool that was previously reported to be a reliable and accurate method to assess ventral hernia recurrence.⁴ The key questions in this tool include “Do you feel a bulge?” and “Do you think your hernia has come back?” Any positive response prompted a request for a follow-up for a physical examination. We elected to use this tool because in our opinion there is no similar validated questionnaire to assess for inguinal hernia recurrence with sufficient discriminative power. In fact, we have already validated this questionnaire for inguinal hernia recurrence assessment in a prospective multi-institutional study, but the results are under separate consideration for publication. All study data were collected and managed using REDCap (Research Electronic Data Capture)⁵ hosted at our institution.

Outcomes definition

SSIs were reported and classified according to the Centers for Disease Control and Prevention classification⁶ as superficial, deep incisional, and organ space. Perioperative complications included medical and surgical complications. For the patients who had at least 1-year follow-up available, hernia recurrence and mesh infection rates (when it was used) were reported. For assessment of hernia recurrence, all further clinical notes, operative reports, and imaging studies recorded after the index operation were analyzed. Hernia recurrence was diagnosed by physical examination by surgeon, retrospective analysis of subsequent computed tomography (CT) scans contained in patient medical records, review of subsequent operative notes reporting ipsilateral recurrent groin hernia repair, or patient telephone interviews using the VHRI, as previously detailed.

Statistical analysis

Data were described using medians and interquartile ranges (IQRs) for continuous variables and counts and percentages for categorical variables as appropriate. Patients were divided into 2 groups: patients who received a mesh-based repair and patients who received a tissue repair. Univariate comparisons on demographic information, operative details, and 30-day and long-term outcomes between groups were performed using χ^2 , Fisher exact, and Wilcoxon rank sum tests. Two logistic regression models were built, one using SSI as the outcome and the other using any complications as the outcome. Covariates included in the models were based on clinical consensus and according to significance seen in univariate analysis. Time to recurrence analyses was estimated by the Kaplan-Meier method and tested for significance with the log-rank test. All tests were 2-tailed and performed at a significance level of .05. R software Version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria) was used for all analyses.

Results

A total of 285 patients underwent EGHR at our institution during the study period and had their EMR reviewed. From these, 257 patients met criteria and were included for analysis. Fig. 1 depicts study population selection and reasons for exclusion of the other 28 participants. The operations were performed by 69 different surgeons practicing either in academic or community hospitals affiliated with our institution. The majority of repairs were performed through an open approach (98.8%), and only 3 repairs were performed laparoscopically (1.2%). From this population, 190

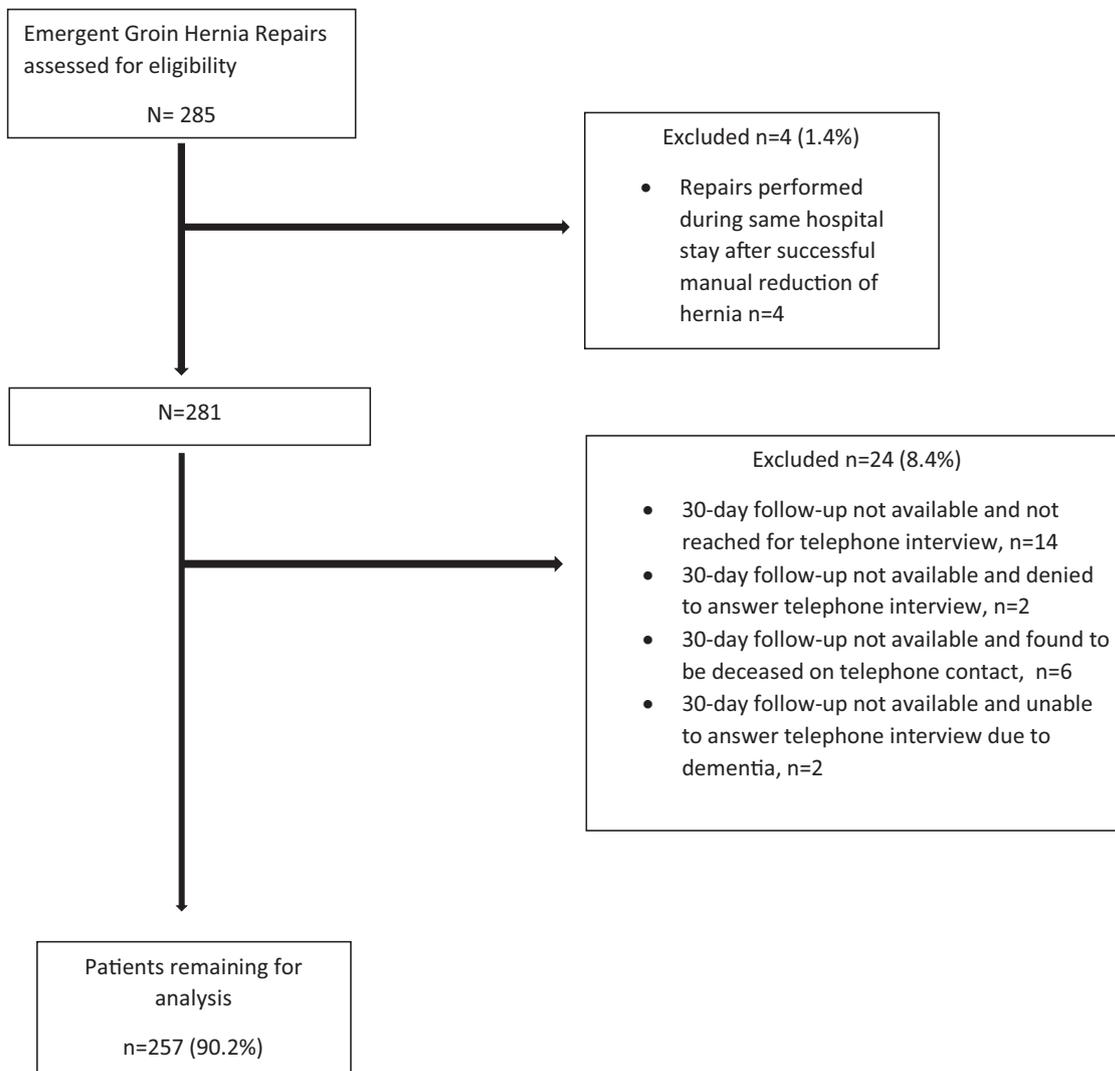


Fig. 1. Study population.

patients (74%) were repaired with mesh and 67 patients (26%) underwent a tissue repair.

Table 1 details demographic and clinical information of the study population as well as univariate comparisons between groups for such variables. The median age of the study group was 72 years (IQR 60–83), with a median body mass index of 25.2 kg/m² (IQR 21.5–27.8), and 160 patients (62.2%) were male. As reflected by the high rate of elderly patients in this cohort, there were a large number of patients with medical comorbidities, with the most prevalent being heart disease, which was present in more than 40% of affected individuals. Univariate comparisons revealed that in the tissue repair group, the patients were more often female (49.3% vs 33.7%, $P = .035$) and had presented to the emergency department with clinical evidence of peritonitis on physical examination (14.9% vs 5.3%, $P = .013$). No other statistically significant differences were noted in demographic and clinical variables.

Hernia variables and intraoperative details are listed in Table 2. Hernias were more common on the right side (60%), and the most common hernia type was indirect inguinal (40.9%), followed by 86 femoral hernias (33.5%); indeed, the majority of inguinal hernias were seen in men and the majority of femoral hernias were seen in women (72%). Forty-five patients (17.5%) had recurrent groin hernias. Intraoperatively, small bowel (55.3%) and omentum (19.5%) were the most commonly incarcerated viscera found in the hernia

sac. A bowel resection was performed in 45 cases (17.5%) and was performed more often through an inguinal approach (62.2%) than a laparotomy (31.1%). A diagnostic laparoscopy was performed in 36 cases (14%), but in only 3 cases was the bowel resection completed laparoscopically. These cases were in fact laparoscopic appendectomies, in which the appendix was incarcerated within the hernia sac. Two such cases were associated with acute appendicitis, and in the other patient, the appendix was removed because of an inadvertent injury to the mesoappendix during hernia reduction. Univariate comparisons revealed that a tissue repair was performed more often in femoral hernias (59.7% vs 24.2%), when there was necrosis of hernia sac contents (54.7% vs 11.1%, $P < .001$), after a bowel resection (49.2% vs 6.3%, $P < .001$), or in the presence of gross contamination (14.9% vs 2.1%, $P < .001$). In the mesh group, a permanent synthetic mesh was used in the majority of the cases (180/190, 94.7%) mainly using a standard piece of polypropylene (55.8%) or polyester (39%). Although its use was relatively common in the entire study population, mesh was placed in only 26.7% (12/45) of the cases where bowel resection was necessary. Similarly, mesh was used in 28.6% (4/14) of the cases associated with gross contamination. Even if mesh was used, it was not always permanent synthetic material. Of the 12 cases in which mesh was placed in the presence of bowel resection, permanent synthetic mesh was used in 7 cases, with the remaining cases

Table 1
Demographic information of patients undergoing emergent groin hernia repair with or without mesh placement.

Variable	Overall N = 257	Mesh group n = 190	Tissue repair group n = 67	P
Age, median (IQR)	72 (60–83)	71.5 (59–83)	76 (61–82)	.39
Sex, n (%)				.035
Male	160 (62.25)	126 (66.3)	34 (50.75)	
Female	97 (37.7)	64 (33.7)	33 (49.25)	
BMI, kg/m ² , median (IQR)n = 253*	25.2 (21.5–28)	25.4 (22–28)	25 (21–27)	.21
Ethnicity, n (%), n = 253*				.27
Caucasian	209 (82.6)	152 (81.7)	57 (85)	
African American	37 (14.6)	29 (15.6)	8 (12)	
Hispanic	4 (1.6)	4 (2.15)	0	
Asian	2 (0.8)	1 (0.5)	1 (1.5)	
other	1 (0.4)	0	1 (1.5)	
Comorbidities, n (%)				
Congestive heart failure or coronary artery disease	103 (40.1)	78 (41)	25 (37.3)	.70
Benign prostatic hyperplasia	49 (19.1)	40 (21)	9 (13.4)	.24
Chronic obstructive pulmonary disease	41 (16)	31 (16.3)	10 (15)	.94
Diabetes	39 (15.2)	27 (14.2)	12 (17.9)	.60
Ascites	19 (7.4)	13 (6.8)	6 (9)	.59
Immunosuppression	29 (11.3)	18 (9.5)	11 (16.4)	.19
ASA class, n (%)				.26
1/2	109 (42.4)	85 (44.7)	24 (35.8)	
3/4	148 (57.6)	105 (55.3)	43 (64.2)	
Active smoking	44 (17.1)	31 (16.3)	13 (19.4)	.56
Peritonitis on presentation	20 (7.8)	10 (5.3)	10 (14.9)	.013

ASA, American Society of Anesthesiologists; BMI, body mass index.

* Varying n reflects missing data.

Table 2
Hernia variables.

Variable, n (%)	Overall N = 257	Mesh group n = 190	Tissue repair group n = 67	P
Prophylactic antibiotics administered,* n = 251	247 (98.4)	182 (98.4)	65 (98.5)	>.99
Antibiotics duration,* n = 238				.005
Prophylactic (<24 h)	184 (77.3)	145 (82.4)	39 (62.9)	
Extended (>24 h, <48 h)	5 (2.1)	3 (1.7)	2 (3.2)	
Therapeutic (>48 h)	49 (20.6)	28 (15.9)	21 (33.9)	
Hernia type				<.001
Inguinal indirect	105 (40.9)	87 (45.8)	18 (26.9)	
Femoral	86 (33.5)	46 (24.2)	40 (59.7)	
Inguinal direct	43 (17.9)	35 (18.4)	6 (9)	
Pantaloon	23 (8.94)	20 (10.5)	3 (4.5)	
Obturator	1 (0.4)	1 (0.5)	0	
Sliding hernia	11 (4.3)	11 (5.8)	0	.072
Recurrent	45 (17.5)	32 (16.9)	13 (19.9)	.79
Diagnostic laparoscopy performed	36 (14)	24 (12.6)	12 (17.9)	.28
Hernia sac contents				
Small bowel	142 (55.3)	92 (48.4)	50 (74.6)	<.001
Omentum/preperitoneal fat	50 (19.4)	43 (22.6)	7 (10.4)	.004
Colon	31 (12.1)	27 (14.2)	4 (6)	.12
Bladder	6 (2.3)	4 (2.1)	2 (3)	.65
Appendix	5 (1.9)	2 (1)	3 (4.5)	.08
Fallopian tube	1 (0.4)	1 (0.5)	0	.03
Not reported	21 (8.2)	20 (10.5)	1 (1.5)	.10
Reported as empty at time of opening	22 (8.6)	20 (10.5)	2 (3)	.10
Necrotic contents, n = 217	52 (24)	17 (11.1)	35 (54.7)	<.001
Gross contamination	14 (5.4)	4 (2.1)	10 (14.9)	<.001
Bowel resection performed	45 (17.5)	12 (6.3)	33 (49.2)	<.001

* Varying n reflects missing data.

undergoing biologic (4) or biosynthetic mesh (1) mesh repair. In the 14 cases with associated gross contamination, only 1 patient underwent permanent synthetic mesh placement, with the remaining cases receiving a tissue repair (10) or biologic mesh (3).

Table 3 details mesh use, mesh types, and repair techniques for the entire study population. Thirty-day outcomes were available for 251 patients (97.7%) of the entire study cohort, and long-term outcomes were available for 186 patients (72.4%), with a median follow-up of 43 months (IQR 26–62). Medical 43 complications occurred in 16.7% of the 257 patients and mortality rate was 3.1%

(n = 8). Sepsis as a result of pneumonia (4/12) was the most common cause of death. Other causes included pulmonary embolism (1), myocardial infarction (1), sepsis as a result of urinary tract infection (1), and septic shock caused by bloodstream infection (1). From those, 3 (37.5%) underwent a bowel resection but only 2 had gross contamination noted intraoperatively.

Table 4 details 30-day and long-term outcomes as well as univariate comparisons between groups with and without mesh. Patients undergoing a tissue repair experienced a median 2-day longer hospital stay, but no statistically significant differences

Table 3
Operative details and mesh repair characterization.

Mesh use, n (%)	190 (74)
Mesh type	
Permanent synthetic	180 (94.7)
Polypropylene	106 (55.8)
Polyester	74 (39)
Biologic	7 (3.7)
Absorbable synthetic (Vicryl)	2 (1)
Biosynthetic (Gore BioA)	1 (0.5)
Open mesh repairs	187 (72.8)
Lichtenstein	82 (31.9)
Plug and patch	46 (17.9)
Mesh plug	33 (12.8)
Dual layer mesh repairs (PHS or UHS)*	11 (4.2)
McVay tissue repair + Onlay patch	9 (3.5)
Kugel patch	2 (0.8)
Other	4 (1.5)
Laparoscopic repairs	3 (1.2)
Tissue repairs	67 (26)
McVay	39 (15.2)
Bassini	18 (7)
Other sutured repairs without mesh	10 (3.9)

PHS, Prolene Hernia System; UHS, Ultrapro Hernia System.

* Femoral hernias, $n=86$: 62 women (72%), 24 men (28%).

were found in SSI, other perioperative complications (detailed in Table 5), 30-day unplanned readmissions, reoperations, or mortality. Recurrent hernias had higher rates of SSI than nonrecurrent hernias (8.9% vs 2.4%, $P=.053$) despite not reaching statistical significance. Also, no statistically significant differences were found on bowel resection (24.4% vs 16%, $P=.17$) or intraoperative gross contamination (4.4% vs 5.7%, $P=.10$) rates when comparing recurrent versus nonrecurrent hernias. With respect to hernia recurrence, no statistically significant difference was found between mesh and tissue repairs (6.3% vs 6.8%, $P=.91$). Fig. 2 represents Kaplan-Meier estimates of recurrence rates between mesh and tissue repair groups. The 12 recurrent hernias identified in this study were defined by CT imaging alone (5/12), CT imaging and physical examination (3/12), physical examination alone (1/12), VHRI and physical examination (1/12), VHRI and CT imaging (1/12), and VHRI alone (1/12). In specifically reviewing permanent synthetic mesh repairs, there were 138 patients with a median follow-up of 41 months (IQR 26–59). No delayed SSIs or mesh infections were identified in this study population. There was a recurrence rate of 6.5% in the subgroup of patients who underwent a repair with permanent synthetic mesh. From the 9 recurrences in the mesh group, 5 were originally direct inguinal hernias, 3 were indirect in-

Table 5
Perioperative medical complications.

Medical complications, n (%)	43 (16.7)
Clavien-Dindo 1	10 (3.9)
Clavien-Dindo 2	12 (4.7)
Clavien-Dindo 3	6 (2.3)
Clavien-Dindo 4	8 (3.1)
Clavien-Dindo 5 (mortality)	8 (3.1)
Respiratory complications	16 (6.2)
Small bowel obstruction	7 (2.7)
Sepsis	6 (2.3)
<i>Clostridium difficile</i> colitis	4 (1.5)
Renal failure requiring dialysis	3 (1.2)
Venous thromboembolic event	3 (1.2)
Cardiologic complication	2 (0.8)
Urinary retention	2 (0.8)
Liver failure	1 (0.4)
Scrotal hematomas	9 (3.5)

Table 6
Results of multivariate logistic models.

	OR	95% CI	P
Outcome: SSI			
Mesh use	1.83	(0.339, 11.672)	.496
Bowel resection	5.87	(1.05, 30.33)	.0368
Outcome: any complications			
Mesh use	1.02	(0.419, 2.632)	.96
Bowel resection	1.12	(0.386, 3.069)	.826
Age at surgery	1.05	(1.024, 1.081)	.00035
Gross contamination	4.3	(1.020, 18.316)	.043
Hernia type (femoral)	1.05	(0.427, 2.548)	.917

guinal hernias, and 1 was a femoral hernia. Of the 3 recurrences in the tissue repair group, 2 were femoral hernias repaired with the McVay technique and 1 was an indirect inguinal hernia repaired through the Bassini approach.

Results of the multivariate analysis are detailed in Table 6. Bowel resection was found to be independently associated with increased odds for SSI (odds ratio [OR] 5.9, 95% confidence interval [CI] 1.05–30.33, $P=.0368$) and age at surgery and gross contamination were independently associated with other perioperative complications (OR 1.05 and 4.3, respectively). Mesh use was not independently associated with SSI (OR 1.83, 95% CI 0.339–11.672, $P=.496$) or other perioperative complications (OR 1.02, $P=.96$).

Discussion

Our study presents one of the largest case series of emergent groin hernia repairs in the literature and, to the best of our knowl-

Table 4
Outcomes.

Outcome, n (%)	Overall $N=257$	Mesh group $N=190$	Tissue repair group $n=67$	P
Duration of stay, median (IQR)	3 (2–5)	3 (2–4)	5 (3–7)	<.001
SSI $n=251^*$	9 (3.6)	6 (3.2)	3 (4.5)	.70
Superficial	4 (1.6)	3 (50)	1 (33.3)	
Deep incisional	4 (1.6)	3 (50)	1 (33.3)	
Organ space	1 (0.4)	0	1 (33.3)	
Medical complications	43 (16.7)	31 (16.3)	12 (17.9)	.91
Postoperative hematomas	9 (3.5)	8 (4.21)	1 (1.5)	.68
30-day unplanned readmissions	40 (15.6)	32 (16.8)	8 (12)	.47
30-day unplanned reoperation	7 (2.7)	4 (2.1)	3 (4.5)	.30
30-day mortality	8 (3.1)	5 (2.6)	3 (4.5)	.43
Mesh infection	0	0	—	
Hernia recurrence, $N=186^{\ddagger}$	12 (6.45)	9 (6.3)	3 (6.8)	.91

* Reflects missing data.

† Long-term follow-up available: mesh group $n=142$; tissue repair group $n=44$.

‡ Permanent synthetic mesh $n=138$.

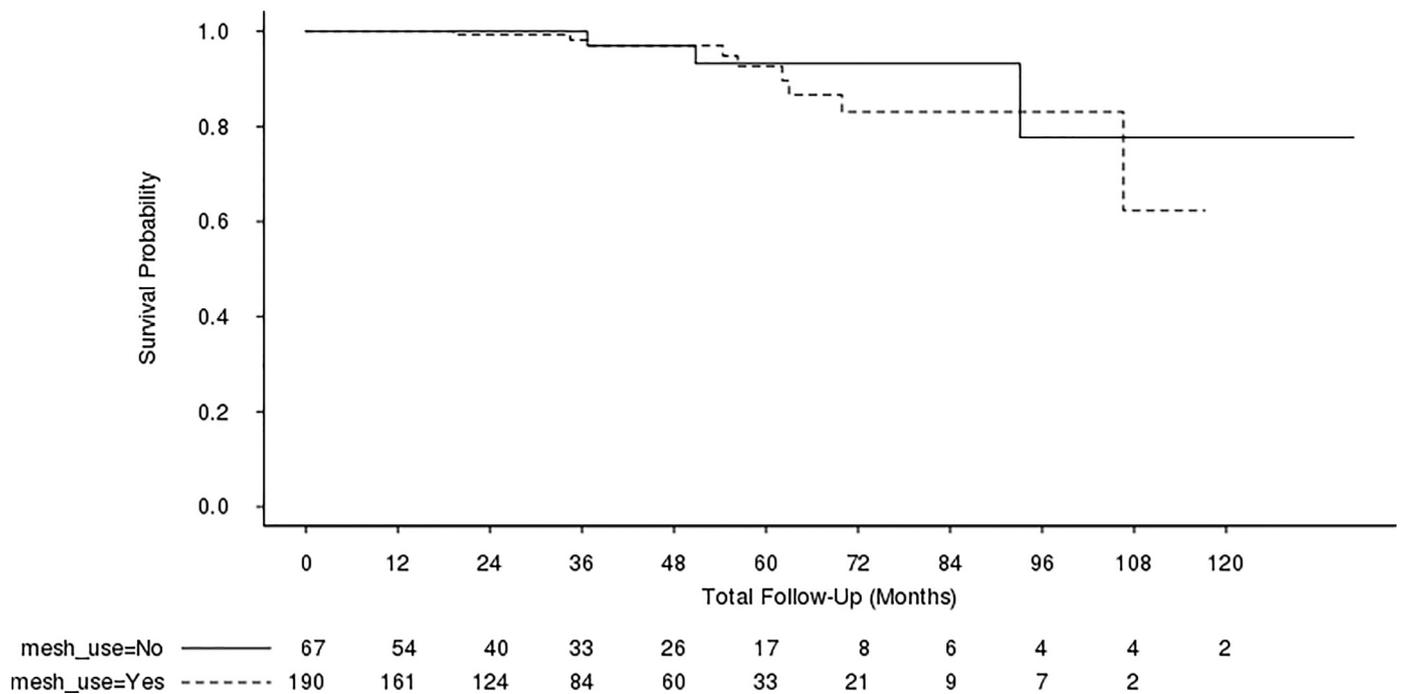


Fig. 2. Kaplan-Meier estimates for long-term hernia recurrence.

edge, is the first series assessing outcomes of EGHR in the United States. During the past 10 years, mesh was used in almost 75% of the EGHR at our institution. However, bowel resection and contamination significantly influenced surgeons' intraoperative decision-making, highly limiting the placement of mesh. Our analysis found that mesh was not independently associated with increased odds for SSI and no mesh infections were identified in the long term. Bowel resection and the presence of gross contamination were, as expected, the intraoperative factors found to be independently associated with SSI and any complications. On long-term follow-up, mesh repair did not result in a significant difference in recurrence rates compared with tissue repairs. Our study supports that mesh is safe when used cautiously in the presence of contamination during EGHR. Also, we found that technically well-performed tissue repair remains a perfectly acceptable option for EGHR in the presence of contamination with good long-term repair durability.

Only a minority of groin hernias require emergent repair. Hernia accidents, defined as bowel obstruction or strangulation,^{7,8} are relatively rare events and their incidence seems to be decreasing. Hernandez-Irizarry et al⁹ reported an emergent inguinal hernia repair incidence of 7.6 per 100,000 person-years as opposed to 200 per 100,000 person-years of simple elective repairs in a population-based study in Olmsted County, Minnesota. The low incidence of acute incarceration and strangulation is further supported by prospective trials evaluating the safety of a nonoperative approach in patients with asymptomatic or minimally symptomatic inguinal hernias (watchful waiting), where a 2.4% to 2.5% reported incidence of hernia accidents over a 7- to 10-year observation period was identified.^{1,2,10} Despite the rarity of this event, there is a dramatic increase in the incidence of hernia accidents after the age of 70. Hernandez-Irizarry⁹ reports an incidence of 80.9 per 100,000 persons-year for men and 38.9 per 100,000 persons-year for women aged 80 to 89 years, compared with an incidence of 10.1 per 100,000 persons-year for men and 8.1 per 100,000 persons-year for women aged 60 to 69. Similarly, patients who underwent an emergent groin hernia repair at our institution were usually elderly. In this patient population, the median age was 72

years, whereas more than 57% of the patients were 70 years or older and 34% were 80 years or older. This demographic finding is similar to several case series of emergent inguinal hernia repairs,¹¹⁻²¹ with reported average or median ages higher than 60 to 70 years old. A geriatric patient group is naturally associated with a high number of comorbidities, further complicating the management of this challenging population. Consequently, a high rate of medical complications (16.7%), readmissions (15.6%), and mortality (3.1%) were found in our cohort. These numbers are similar in previously published data.²²⁻²⁶ Other than age and comorbidities, delay to admission, diagnosis, and surgery²²; prolonged time of incarceration²³; femoral hernias²²; and female sex^{24,25} were found to contribute to morbidity and mortality in emergent repairs. Therefore we can hypothesize that medically fit older patients with inguinal hernias could benefit from elective repair despite absent hernia symptoms as a way to decrease the risk of the complications associated with an emergent repair. In cases of patients with femoral hernias, it is well established that elective repair is recommended on diagnosis because the risk for a hernia accident is high.¹

An optimal approach for EGHR continues to be elusive because high-quality data on the subject are lacking. One heavily debated topic is the safety of placing mesh in the clean-contaminated or contaminated settings of an EGHR. According to our study, most surgeons, at least from our institution, remain reluctant to use mesh for groin hernia repairs in a nonclean setting. Even in the instances where the surgeon opted to reinforce the repair with mesh in clean-contaminated situations (bowel resection), a nonpermanent synthetic was preferred in 42% of the cases (5/12). For grossly contaminated fields, all patients received either a tissue repair or a nonpermanent synthetic mesh. Logically, a patient with incarcerated bowel who undergoes surgery without strangulation of the viscera could be considered a clean case and therefore warrant a mesh-based repair. In such a scenario, several case series have reported that mesh has a positive safety profile.^{13-17,20,26} The largest series, published by Bessa et al,²⁶ included 234 patients undergoing EGHR with monofilament polypropylene placed through

an open anterior approach, who were followed over a 10-year period. The only limitation to using mesh was the presence of gross contamination (bowel resection did not preclude mesh use). This author reported an SSI rate of 5.7% and a single mesh infection (0.5%). Sawayama¹⁷ reported no SSIs among 64 EGHR patients who were repaired with synthetic mesh through different approaches (Lichtenstein, Plug-and-Patch, and Kugel patch). Similarly, Atila¹³ reported an SSI rate of 1.2% and no mesh infections in a group of 81 patients undergoing EGHR with mesh at a mean 43 months follow-up. Those findings were later supported by a systematic review and meta-analysis.²⁷ The findings of our study correspond with the existing literature. Among 168 patients who received permanent synthetic mesh and in whom a bowel resection was not performed, the 30-day SSI rate was 3.0%. On long-term follow-up, no mesh infections were found in 138 available patients. Although mesh use in such a scenario is not unusual, because it is similar to a clean elective repair, the use of mesh in instances requiring bowel resection remains controversial even among hernia experts. In a recent expert consensus,²⁸ only 69% of the panelists agreed that it is acceptable to use mesh in this situation. This opinion clearly results from the limited evidence available to address this question. Although the aforementioned studies^{13,17,26} have advocated that mesh is well tolerated for EGHR, bowel resection with mesh placement was performed in the minority of cases (14.7%, 25.6%, and 13.7%, respectively). In our study, bowel resection and mesh placement were performed in only 12 patients, of whom only 7 received permanent synthetic mesh. Six of these patients did not develop an SSI, and 1 patient died postoperatively without a wound infection. Because there was clear bias for tissue repairs in the presence of contamination in our study, we cannot draw any conclusions regarding mesh use in this scenario. Apropos, the HerniaSurge Group recently published their guidelines²⁹ where this topic is discussed. Endorsed by several surgical societies, this document suggests that monofilament large-pore polypropylene mesh is safe for EGHR in clean or clean-contaminated surgical fields. The group also suggests that synthetic mesh should not be placed in contaminated or dirty surgical fields, similar to those patients with gross contamination in our study.

Another objective of our study was to identify trends in the use of laparoscopy for EGHR, both as an adjunct in the diagnosis of strangulation and bowel viability assessment and as an approach for hernia repair. We found that although a diagnostic laparoscopy was used in nearly 15% of cases ($n=37$), a laparoscopic repair was performed in only 3 instances. These findings are mirrored in the previously mentioned population-based study⁹ where a laparoscopic repair was performed in only 2% of the 136 emergent inguinal hernia repairs over a 20-year period. The results highlight that laparoscopy is still used mainly for diagnostic purposes during EGHR, and there are several reasons that might explain such findings. Importantly, many of these cases are performed in the middle of the night as a consequence of their acute presentation, with surgery being performed by surgeons with varying degrees of laparoscopic skills. Moreover, there is a genuine concern for the risk of a synthetic mesh infection in the preperitoneal space, which ultimately can have more severe consequences. The first report of a laparoscopic repair of an acutely incarcerated groin hernia dates from 1993.^{30,31} Since then, other authors have reported successful repair of acutely incarcerated and strangulated hernias using laparoscopy, both through the TAPP (transabdominal preperitoneal)³² and TEP (totally extraperitoneal)^{19,31} techniques. A systematic review³³ evaluated pooled data from 6 studies and 328 patients undergoing laparoscopic EGHR, from which only 17 patients required bowel resection. The study found an incidence of 2 mesh infections (0.6%) that were successfully managed without mesh removal. Further current literature consisting of a limited number of highly selected patients and supporting that EGHR is feasible

laparoscopically through both TAPP or TEP approaches have not raised safety concerns.

Interestingly, we did not find a statistically significant difference in recurrence rates between the mesh and tissue repair groups (6.5% vs 6.8%, $P=.65$). However, this finding should be interpreted with caution because there is significant heterogeneity in the hernia types and repair techniques in both groups. Nevertheless, it was remarkable that subgroup analysis of the tissue repairs group found that 93% (41/44) of the patients who underwent a tissue repair were recurrence free during long-term follow-up. As such, we can maintain that tissue repair remains an important component of the general surgeon's armamentarium and that such repairs are absolutely appropriate in the face of surgical field contamination.

Our study has several limitations that deserve mention. First, this is a retrospective cohort study, carrying inherent loss-to-follow-up, recall, and selection biases. Although a determined effort was made with telephone contacts to assess hernia recurrence and long-term infectious complications for all patients, this was completed for only 72% of the participants. The main reason patients were lost to follow-up was that the majority of patients were elderly and 57 participants (22.2%) were found to be deceased during the assessment. As such, we acknowledge that this considerable number of patients lost to follow-up might have an impact on our results. Nevertheless, those patients in whom telephone interviews were not completed had a median follow-up reported in EMR of 8.6 months (IQR 2–28) while seeking medical care for other pathologic conditions. Therefore a certain degree of confidence that serious infectious complications or early hernia recurrence have not occurred in this period seems to be appropriate in the setting of a retrospective study. However, to make our assessment for hernia recurrence more accurate, we preferred to report the long-term outcomes for patients that had this information available either in medical records or confirmed by telephone interviews, according to the definitions established in the methods section. It also should be considered that the rates of SSI and recurrence in the study were low and thus type II error cannot be excluded in the results of the multivariate analysis. Therefore, although clinically relevant, the findings should be interpreted with caution.

Another limitation of our study is that comparisons between patients who received mesh and those who did not were performed combining inguinal and femoral hernias together. Although the management and severity of the presentation are different for femoral hernias, we elected to analyze data combined because more than half of the femoral hernias were repaired using mesh, mostly through mesh plug or dual layer mesh techniques, almost in totality with permanent synthetic material. In addition, although this is one of the largest series in literature, the numbers are not sufficient to permit accurate subgroup analyses.

In conclusion, EGHRs are associated with high morbidity and mortality that is closely associated with patient's age and the degree of contamination found intraoperatively. Our study supports that mesh is well tolerated when used in the absence of contamination during EGHR. Also, we found that tissue repair remains a perfectly acceptable option in the setting of an EGHR, with equivalent rates of hernia recurrence in the long term compared with mesh-based repairs.

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