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ORIGINAL ARTICLE

Surgery for incarcerated hernia: short-term outcome with or without mesh

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Abstract
Background Incarcerated hernias represent about 5–15 % of all operated hernias. Tension-free mesh is the preferred technique for elective surgery due to low recurrence rates. There is however currently no consensus on the use of mesh for the treatment of incarcerated hernias, especially in case of bowel resection.
Aim The aims of this study were (i) to report our current practice for the treatment of incarcerated hernias, (ii) to identify risk factors for postoperative complications, and (iii) to assess the safety of mesh placement in potentially infected surgical fields.
Methods This retrospective study included 166 consecutive patients who underwent emergency surgery for incarcerated hernia between January 2007 and January 2012 in two university hospitals. Demographics, surgical details, and short-term outcome were collected. Univariate analysis was employed to identify risk factors for overall, infectious, and major complications.
Results Eighty-four patients (50.6 %) presented inguinal hernias, 43 femoral (25.9 %), 37 umbilical hernias (22.3 %), and 2 mixed hernias (1.2 %), respectively. Mesh was placed in 64 patients (38.5 %), including 5 patients with concomitant bowel resection. Overall morbidity occurred in 56 patients (32.7 %), and 8 patients (4.8 %) developed surgical site infections (SSI). Univariate risk factors for overall complications were ASA grade 3/4 (P=0.03), diabetes (P=0.05), cardiopathy (P=0.001), aspirin use (P=0.023), and bowel resection (P=0.001) which was also the only identified risk factor for SSI (P=0.03). In multivariate analysis, only bowel incarceration was associated with a higher rate of major morbidity (OR=14.04; P=0.01).
Conclusion Morbidity after surgery for incarcerated hernia remains high and depends on comorbidities and surgical presentation. The use of mesh could become current practice even in case of bowel resection.

Keywords Hernia · Incarceration · Mesh · Surgical site infection · Bowel resection

Introduction

Incarcerated hernias represent between 5 and 15 % of groin hernia repairs [1–4] and about 10 % of operated umbilical hernias [5]. In elective hernia surgery, tension-free mesh repair (open or endoscopically) has been proven to be more effective than suture reconstruction (odds ratio = 0.43) in terms of long-term recurrence [6–10]. Wound infection rates vary between 1 and 7 % in both mesh and no-mesh repair [6].

Recommendations differ for the treatment of incarcerated hernias which are typically performed as emergency procedures. The use of prosthetic material is generally avoided, especially in a septic environment such as in case of concomitant bowel resection. Recent reports challenged these preconceptions. The first study comparing mesh and no-mesh in strangulated groin hernia repair was published in 2008 and reported favorable outcomes for the mesh group [11]. These initial data were confirmed recently showing similar infection rates but reduced recurrence rates in the long-term follow-up

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in the mesh group [11–14]. These results have been reproduced even in the context of concomitant bowel resection [15, 16]. So far, no consensus has been reached on mesh placement for the treatment of incarcerated hernias.

The aims of our study were (i) to report our current practice for incarcerated hernia repair, (ii) to identify risk factors for postoperative complications, and (iii) to assess the safety of mesh placement during contaminated surgery (class 2, 3) [17–19].

Methods

This retrospective study included all consecutive patients >18 years who underwent emergency repair for incarcerated hernia between January 2007 and January 2012 in two tertiary referral centers, the University Hospital of Lausanne, Switzerland, and of Angers, France. This study obtained approval by the ethical committees of both institutions.

Only true emergency cases were considered. Emergency surgery was defined as any intervention performed within 6 h after hospital admission. Inguinal, femoral, and umbilical hernias were included; exclusion criteria were recurrent or incisional hernias, elective surgeries, and patients presenting with ascites or frank peritonitis requiring laparotomy. Incarceration was defined based on clinical grounds as nonreducible, painful hernia associated with nonimpulsiveness during Valsalva maneuver [20].

The surgeon chose the surgical access according to his habits and his knowledge.

Data were retrospectively retrieved from the medical files and entered anonymously into an electronic database. Items to collect and outcome measures were defined a priori. Collected data included (i) demographic information such as age, gender, American Society of Anesthesiologists (ASA) grade, body mass index (BMI), usual medication, and comorbidities. Obesity was defined by a BMI > 30 kg/m^2 [21].

(ii) Surgical details were type of hernia (femoral, inguinal, umbilical), aspect of the bowel (normal, congestive, necrotic), aspect of eventual liquid in the hernia sac (clear or turbid), intestinal resection, prosthetic material, and the technique of repair. (iii) Clinical outcome measures were length of stay (admission–discharge) and overall, infectious, and major complications. Complications were classified according to their severity using a validated 5-grade scale [22]. Major complications were defined as grade > II. Surgical site infection (SSI) was defined according to the CDC as any wound infection occurring within 30 days after operation and was classified as superficial incisional SSI (skin and subcutaneous tissue) or deep incisional SSI (deep and soft tissue) [23].

Length of follow-up was set at 45 days and corresponded with the usual date of routine postoperative control.

Following descriptive analysis, we compared patients with complications to patients without complications. Further analyses were performed with regard to the occurrence of major complications and surgical site infections, respectively.

Data are expressed as mean ± SD or median (range) as appropriate. Chi-2 square was used for the comparison of categorical variables. Student's *t* test and Mann-Whitney *U* test were employed to compare normal and nonnormal continuous variables. $P<0.05$ was considered statistically significant. Data analysis was performed with the Statistical Package for the Social Science version 15 Software (SPSS, Chicago, IL).

Multivariate logistic regressions were performed for studying the factors associated with complications. The model selection was performed using the Akaike criterion. Femoral hernia was considered as the reference for comparing the three kinds of hernias.

Results

During the 5-year study period, 166 unselected patients underwent emergency hernia surgery according to the strict inclusion criteria in the two participating hospitals. Demographics are displayed in Table 1. Seventy-six patients

Table 1 Demographics of patients with emergency repair of incarcerated hernia

	Number of patients (%)
Age (years)	74 (18–109)
Gender	
Male	97 (58.4)
Female	69 (41.6)
ASA grade	
I/II	55(30.1)
III/IV	23 (19.9)
Unknown	78 (50)
Comorbidities	
Hypertension	79 (47.6)
Diabetes	25 (15.1)
Bronchial asthma	23 (13.9)
Cardiopathy	52 (31.3)
Obesity	26 (15.7)
Treatment	
Antivitamin K	17 (10.2)
Aspirin	31 (18.7)
Immunosuppression	8 (4.8)
Type of hernia	
Groin hernia	129 (77.7)
Inguinal	84 (65.1)
Femoral	43 (33.3)
Femoral + inguinal (mixed)	2 (1.6)
Umbilical hernia	37 (22.3)

(45.8 %) were operated in Lausanne (Switzerland), and 90 patients (54.2 %) in Angers (France).

Eighty-four patients (50.6 %) presented with incarcerated inguinal, 43 femoral (25.9 %), 2 mixed (1.2 %), and 37 umbilical hernias (22.3 %), respectively. Bowel resection was required in 25 patients (15.1 %). Mesh was placed in 64 patients (38.5 %) including four patients with concomitant bowel resection (6.2 %). Surgical details are given in Table 2.

Short-term follow-up was available for 100 % of the patients. Overall morbidity occurred in 56 patients (33.7 %). Some patients had one or more complications. Class I complications (urinary retention, hematoma, seroma, ileus, and other nonspecific complications) occurred in 18 cases (32.1 %), class II complications (urinary retention or infection, superficial wound infection, hematoma, pneumopathy, and nonspecific complications) in 16 patients (28.6 %), class III complications (superficial and deep SSI, recurrence and ileus) in 13 patients (23.2 %), and class IV complications (multivisceral dysfunction on anastomotic fistula and sepsis from undetermined origin) occurred in 2 patients (3.6 %) (Table 3). In short-term follow-up, one and two patients developed recurrence after suture and mesh repair, respectively.

Nonspecific complications (not directly due to surgery) were in particular the following: acute coronaropathy, mesenteric ischemia, sepsis, disorientation, and acute hepatic failure.

Table 2 Surgical details of emergency repair of incarcerated hernia

	Inguinal hernia			
	Mesh, n=40 (47.6 %)		No mesh, n=44 (52.4 %)	
	Resection	No resection	resection	No resection
Number of patients	2	38	5	39
	Umbilical hernia			
	Mesh, n=9 (24.3 %)		No mesh, n=28 (75.7 %)	
	Resection	No resection	Resection	No resection
Number of patients	2	7	5	23
	Femoral hernia			
	Mesh, n=15 (34.9 %)		No mesh, n=28 (65.1 %)	
	Resection	No resection	Resection	No resection
Number of patients	0	15	10	18
	Femoral and inguinal hernia			
	Mesh		No mesh, n=2 (100 %)	
	Resection	No resection	Resection	No resection
Number of patients	0	0	1	1
	Incarcerated hernia: total			
	Mesh, n=64 (38.6 %)		No mesh, n=102 (61.4 %)	
	Resection	No resection	Resection	No resection
Number of patients	4	60	21	81

Table 3 Postoperative complications—overview

	Number of patients (%)
Overall morbidity	56 (33.7)
Medical complications	47 (28.3)
Urinary infection	4 (2.4)
Urinary retention	12 (7.2)
Pneumopathy	4 (2.4)
Other	27 (16.3)
Surgical complications	30 (1.8)
Recurrence within 30 days	4 (2.4)
Hematoma/seroma	12 (7.2)
Superficial incisional SSI	5 (3)
Deep incisional SSI	3 (1.8)
Anastomotic fistula	1 (0.6)
Ileus	3 (1.8)
Mortality	7 (4.2)

Mortality (class V) occurred in seven patients (4.2 %) (mortality was due to heart failure in three patients and pulmonary embolism, acute hepatic failure, acute hemorrhage, and mesenteric ischemia in one patient each).

On univariate analysis, patients with bowel resection, aspirin, cardiopathy diabetes, and ASA grade=3–4 had a significant higher risk for overall complications (P<0.001, P=0.02, P=0.001, P=0.04, and P=0.02) (Table 4).

Resection, small bowel incarceration, and femoral hernias were univariate risk factors for major complications (P=0.003, P=0.04, and P=0.04) (Table 5).

Eight patients develop SSI (4.8 %). Five of them were superficial infection. The other three patients presented mesh infections. Among these eight patients, two patients had a bowel resection (one with prosthetic infection and one with superficial wound infection). All patients with infections were managed without removal of the mesh. The only significant risk factor for surgical site infection (SSI) was the incarceration of colon (P=0.03) (Table 6).

In multivariate analysis, no interaction was found between the use of prosthesis and the rate of overall complications or the rate of major complications (Tables 7 and 8). Among the criterion studied, only ASA score and incarceration of bowel (small bowel or colon) were associated with a higher rate of complications, whereas only incarceration of bowel was associated with a higher rate of major complications.

Discussion

Incarcerated hernias entail high complication rates which depend on comorbidities and the severity of the intraoperative presentation. However, postoperative SSI remains low, and

Table 4 Univariate risk factors for postoperative complications

	No complications, % (*n*=110)	Complications, % (*n*=56)	Total. % (*n*=166)	*P* value
Female	43.6 (*N*=48)	37.5 (*N*=21)	41.6 (*N*=69)	0.45
Cardiopathy	**22.7 (*n*=25)**	**48.2 (n=27)**	**31.3 (*n*=52)**	**0.001**
BPCO	12.7 (*n*=14)	16.1 (*n*=9)	13.9 (*n*=23)	0.7
Diabetes	**10.9 (*n*=12)**	**23.2 (*n*=13)**	**15.1 (*n*=25)**	**0.04**
Obesity	15.5 (*n*=17)	16.1 (*n*=9)	15.1 (*n*=25)	0.91
Aspirin	**13.6 (*n*=15)**	**28.6 (*n*=16)**	**18.7 (*n*=31)**	**0.02**
AVK	8.2 (*n*=9)	14.3 (*n*=8)	10.2 (*n*=17)	0.22
Immunosuppresor	4.5 (*n*=5)	5.4 (*n*=3)	4.8 (*n*=8)	0.82
Femoral hernia	28.2 (*n*=31)	25 (*n*=14)	27.1 (*n*=45)	0.66
Inguinal hernia	50 (*n*=55)	55.4 (*n*=31)	51.8 (*n*=86)	0.51
Umbilical hernia	21.8 (*n*=24)	23.2 (*n*=13)	22.3 (*n*=37)	0.84
Omentum	36.1 (*n*=39)	28.6 (*n*=16)	33.5 (*n*=55)	0.33
Colon	10.2 (*n*=11)	17.9 (*n*=10)	12.8 (*n*=21)	0.16
Small bowel	48.1 (*n*=52)	61.8 (*n*=34)	52.8 (*n*=86)	0.1
Congestive bowel	41.4 (*n*=36)	25.5 (*n*=13)	35.5 (*n*=49)	0.06
Clear liquid	30 (*n*=21)	23.5 (*n*=8)	27.9 (*n*=29)	0.49
Turbid liquid	14.3 (*n*=10)	117.6 (*n*=6)	15.4 (*n*=16)	0.66
Mesh	38.2 (*n*=42)	39.3 (*n*=22)	37.5 (*n*=64)	0.89
Resection	**7.3 (n=8)**	**30.4 (*n*=17)**	**15.1 (*n*=25)**	**<0.001**

Entries in bold inside the table are stastistically significant results

even patients with concomitant bowel resection can safely be managed by use of mesh.

Surgical characteristics and outcome of our cohort are in accordance with the literature. A recent study reported that strangulated groin hernias represented around 1.7 % of all hernia repairs; hernia sites were inguinal in 61 % and femoral in 39 % of patients [24]. Morbidity and mortality after surgery for incarcerated

Table 5 Univariate risk factors for major complications

	No Clavien 3/5, % (n=144)	Clavien 3/5, % (*n*=22)	Total, % (*n*=166)	*P* value
Female	39.6 (*n*=57)	54.5 (*n*=12)	41.6 (*n*=69)	0.18
ASA > 2	34.7 (*n*=26)	53.8 (*n*=7)	37.5 (*n*=33)	0.29
Cardiopathy	29.2 (*n*=42)	45.5 (*n*=10)	31.3 (*n*=52)	0.12
BPCO	14.6 (*n*=21)	9.1 (*n*=2)	13.9 (*n*=23)	0.49
Diabetes	14.6 (*n*=21)	18.2 (*n*=4)	15.1 (*n*=25)	0.66
Obesity	17.4 (*n*=25)	4.5 (*n*=1)	15.7 (*n*=26)	0.12
Aspirin	18.8 (*n*=27)	18.2 (*n*=4)	18.7 (*n*=31)	0.95
AVK	10.4 (*n*=15)	9.1 (*n*=2)	10.2 (*n*=17)	0.85
Immunosuppressor	4.9 (*n*=7)	4.5 (*n*=1)	4.8 (*n*=8)	0.95
Femoral hernia	**24.3 (*n*=35)**	**45.5 (*n*=10)**	**27.1 (*n*=45)**	**0.04**
Inguinal hernia	52.8 (*n*=76)	45.5 (*n*=10)	51.8 (*n*=86)	0.52
Umbilical hernia	22.9 (*n*=33)	18.2 (*n*=4)	22.3 (*n*=37)	0.62
Omentum	35.2 (*n*=50)	22.7 (*n*=5)	33.5 (*n*=55)	0.25
Colon	12.7 (*n*=18)	13.6 (*n*=3)	12.8 (*n*=21)	0.9
Small bowel	**49.6 (*n*=70)**	**72.7 (*n*=16)**	**52.8 (*n*=86)**	**0.04**
Congestive bowel	36.2 (*n*=42)	31.8 (*n*=7)	35.5 (*n*=49)	0.69
Clear liquid	28 (*n*=26)	27.3 (*n*=3)	27.9 (*n*=29)	0.96
Turbid liquid	14 (*n*=13)	27.3 (*n*=3)	15.4 (*n*=16)	0.25
Mesh	38.2 (*n*=55)	40.9 (*n*=9)	38.6 (*n*=64)	0.81
Resection	**11.8 (*n*=17)**	**36.4 (*n*=8)**	**15.1 (*n*=25)**	**0.003**

Entries in bold inside the table are stastistically significant results

Table 6 Univariate risk factors for postoperative SSI

	No surgical site, % infection (n=158)	Surgical site infection, % (n=8)	Total (n=166)	P value
Female	41.8 (n=66)	37.5 (n=3)	41.6 (n=69)	0.81
Cardiopathy	29.7 (n=47)	62.5 (n=5)	31.3 (n=52)	0.051
BPCO	13.9 (n=22)	12.5 (n=1)	13.9 (n=23)	0.91
Diabetes	14.6 (n=23)	25 (n=2)	15.1 (n=25)	0.42
ASA > 2	39.3 (n=33)	0	37.5 (n=33)	0.11
Obesity	15.2 (n=24)	25 (n=2)	15.7 (n=26)	0.45
Aspirin	19 (n=30)	12.5 (n=1)	18.7 (n=31)	0.65
AVK	9.5 (n=15)	25 (n=2)	10.2 (n=17)	0.16
Immunosuppressor	5.1 (n=8)	0	4.8 (n=8)	0.51
Femoral hernia	27.2 (n=43)	25 (n=2)	27.1 (n=45)	0.89
Inguinal hernia	52.5 (n=83)	37.5 (n=3)	51.8 (n=86)	0.4
Umbilical hernia	20.9 (n=33)	50 (n=4)	22.3 (n=37)	0.054
Omentum	33.3 (n=52)	37.5 (n=3)	33.5 (n=55)	0.8
Colon	**11.5 (n=18)**	**37.5 (n=3)**	**12.8 (n=21)**	**0.03**
Small bowel	52.9 (n=82)	50 (n=4)	52.8 (n=86)	0.87
Congestive bowel	35.4 (n=46)	37.5 (n=3)	35.5 (n=49)	0.9
Turbid liquid	15.3 (n=15)	16.7 (n=1)	15.4 (n=16)	0.9
Mesh	38.6 (n=61)	37.5 (n=3)	38.6 (n=64)	0.95
Resection	14.6 (n=23)	25 (n=2)	15.1 (n=25)	0.42

Entries in bold inside the table are stastistically significant results

hernia were reported to be as high as 21–39 and 4–5 %, respectively [24–28].

In our work, five factors were associated with overall complications: bowel resection, treatment by aspirin, medical history of diabetes, cardiopathy, and ASA score > 2. Risk factors for morbidity are various according to studies. The factor reported as the sole factor affecting morbidity and mortality was intestinal necrosis followed by bowel resection [25].

The other factors have not been reported in the literature, but it can be easy to explain the role of aspirin and cardiopathy (often treated by antiaggregant) in the formation of hematoma or in general complication.

Moreover, a recent study reported that first intention exploratory laparotomy was a major cause of postoperative complication [24]. This was not tested in our work, but authors concluded that the best way for exploring abdominal cavity was hernioscopy or laparoscopy [24].

Risk factors for severe complications in our study were intestinal resection and femoral hernia site which is probably directly correlated with the first one, as incarcerated hernias require more frequent bowel resections (as we can see in our work). This factor was confirmed by multivariate analysis. Interestingly, none of the assessed patient-related risk factors was associated with major complications.

ASA score is not associated with the risk of major complication but with the risk of overall morbidity. This difference could be explained by the fact that ASA score reflects the status of the patient as a whole. Complications related to ASA score are more often medical complications that could be treated without anesthesia or intensive care.

The only significant risk factor for SSI was incarceration of the colon that has not been previously reported in the literature. However, colorectal procedures are associated with high SSI rates between 5.2 and 8.9 % [29]. Of note, Ueda et al. [16] reported 20 % SSI in their overall population with no

Table 7 Multivariate analysis risk factor for overall morbidity

Overall morbidity	Odds ratio	95 % Confidence interval	P value
Mesh	1.515	0.51–4.53	0.458
Femoral hernia	1	–	–
Inguinal hernia	1.534	0.47–5	0.478
Umbilical hernia	0.799	0.16–4	0.786
Bowel incarceration	3.225	1.13–9.18	0.028
ASA score > 2	2.912	1.05–8.1	0.041

Table 8 Multivariate analysis risk factor for major complication

Major complications	Odds ratio	95 % Confidence interval	P value
Mesh	1.21	0.32–4.59	0.77
Femoral hernia	1	–	–
Inguinal hernia	0.58	0.14–2.39	0.46
Umbilical hernia	0.56	0.08–4.11	0.57
Bowel incarceration	14.04	1.71–115.2	0.01
ASA score > 2	1.58	0.44–5.65	0.48

significant difference between the group mesh and no-mesh. A more recent study was more reassuring with a rate of mesh infection of 1.25 % and a rate of wound infection of 11.25 % [27]. Several studies conclude that the use of mesh does not increase the risk for complication in the absence of bowel resection [4, 11, 27, 30–32]. When bowel resection is needed, some studies suggest that mesh repair could be used [16, 27]. Bessa et al reported 5.6 % of SSI in case of bowel resection, and Ueda et al 18 % [16, 27]. In the last study, no infection of prosthesis occurred and no mesh has been removed. In our study, the observed SSI rate was 3.9 % with mesh repair, and no single infection required mesh removal in our patients.

The reason to use prosthesis despite strangulation in hernia repairs is the significant reduced hernia recurrence from 11.1 and 33.3 % in suture to 0 and 4.7 % with mesh [11, 30]. In case of paraumbilical hernia, the same observations have been made, and after a follow-up of 16 months, use of prosthetic repair led to superior results in terms of recurrence without increase of morbidity [33]. However, these data from elective surgery series have yet to be confirmed for emergency surgeries for incarcerated hernias. Lohsiriwat et al. published a series of long term follow-up of hernia repair proceeded in emergency [14]. They reported a ratio of recurrence of 10 % for Lichtenstein repair within 2.5 to 7.6 years.

This present study has several limitations inherent to its retrospective nature. Some data were missing, and complications might be underestimated. Further, surgical treatment was heterogeneous and decided by the surgeon on call. However, it was exactly the intent to report current practice in our institutions, and comprehensive guidelines for the use of mesh do not exist so far. Our study cohort is limited, and number of infections was too low to perform specific multivariate analysis. The risk factors identified by univariate analysis are likely to be confounded and have therefore to be interpreted with caution. We cannot provide long-term follow-up. Therefore, we cannot prove superiority of mesh repairs with regard to potentially lower recurrence rates. Nonetheless, we provide a well-documented audit of our institutional practice that contributes to the body of evidence in a controversial field of surgery where high-level evidence is scarce and difficult to obtain.

Conclusion

In conclusion, our study confirmed high morbidity after emergency surgery for incarcerated hernia. Mesh repair could be used and appears to be safe. Some elements are in favor of the use and the safety of prosthesis even in case of concomitant bowel resection. Larger prospective cohorts are needed to confirm our findings.

Conflicts of interest None.

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