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More than 150 consecutive open umbilical hernia repairs in a major Veterans Administration Medical Center

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Abstract

BACKGROUND: The purpose of this study was to determine the rate of surgical site infection for open elective umbilical hernia repairs and to identify the factors related to an increased risk of infection and/or recurrence.

METHODS: A retrospective analysis of 152 open elective umbilical hernia repairs between 2003 and 2007 was performed.

RESULTS: Overall, 19% of repairs became infected. Both high ASA classification ($P = .01$) and mesh repair ($P = .01$) significantly predicted wound infection, whereas age >60 years, body mass index >30, smoking, immunosuppression, diabetes, and hernia size did not. Only 2 of 17 infected mesh repairs required removal of the mesh. The recurrence rate was 1.5% for mesh and 9.2% for suture repairs.

CONCLUSIONS: Umbilical hernia repair is associated with a high rate of infection, and most superficial mesh infections can be treated with antibiotics alone. In addition, mesh repair of umbilical hernias decreased the rate of recurrence but increased the risk of infection compared with suture repairs. Published by Elsevier Inc.

Umbilical hernia repairs are a complex clinical problem. Despite improvements in surgical techniques, both recurrences and postsurgical surgical site infections continue to be common. Historically, umbilical hernias have been repaired with primary suture techniques; however, the use of synthetic mesh has gained significant popularity because of a decreased rate of recurrence.[1] Reflecting this evolution of surgical technique, a large population-based study showed a dramatic increase in the use of mesh from 34.2% in 1987 to 65.5% in 1999 for incisional hernia repairs.[2] Even in small umbilical hernias (<3 cm), mesh use appears to decrease the rate of recurrence.[3,4]

With the increased use of synthetic mesh for repair of abdominal wall hernias, the problem of surgical site infection is more significant because successful eradication of the infection commonly requires mesh removal. Mesh removal usually leaves the patient with his or her previous hernia plus the added morbidity of an additional operation. Interestingly, the rate of infection after umbilical hernia repair appears to be much higher than seen in other abdominal wall hernia repairs despite the use of similar mesh products. For example, the incidence of infection after umbilical hernia repairs with mesh has been reported to be less than 9.5%[4,5] compared with up to 3% for inguinal hernia repairs with mesh.[6] Importantly, postsurgical infection after ab-

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dominal wall hernia repair may predispose patients to recurrence[7] caused by disturbances of normal wound healing. Other studies have examined the risk factors for the development of infection and recurrences following incisional and inguinal hernia repairs; however, studies focused specifically on umbilical hernia repairs is lacking. One retrospective study of umbilical hernia repairs cited an 11.5% infection rate; however, the definition of infection was not precisely stated, and a thorough investigation of which factors contributed to the rate of infection was not part of that study.[8] Thus, the aim of this study was to evaluate the rate of surgical site infection for open elective umbilical hernia repairs and to determine the factors related to an increased risk of infection and/or recurrence.

Methods

Patients and study design

A retrospective analysis of all open umbilical hernia repairs performed between October 2003 and September 2007 at the Michael E. DeBakey Veterans Administration Medical Center (MEDVAMC) were identified using electronic surgical records. Patients who had undergone laparoscopic repair or open repair in the setting of incarcerated or strangulated bowel or rupture from massive ascites caused by cirrhosis were also excluded from analysis. After the exclusions, a total of 152 umbilical hernia repairs were used for the final analysis. Demographic (age and sex) and clinical data (body mass index [BMI], hernia size, smoking or drug use, American Society of Anesthesiology [ASA] classification) were obtained from the VA Computerized Patient Record System. The type of mesh used was also recorded. The study was approved by the Baylor College of Medicine Institutional Review Board and the MEDVAMC Research and Development Committee.

A surgical site infection (SSI) was defined in the study according to the Centers for Disease Control and Prevention (CDC) criteria for diagnosis of SSI:[9] either (1) purulent drainage from the incision; (2) at least 1 of the following signs or symptoms of infection: pain or tenderness; localized swelling, redness, or heat; and incision deliberately opened by surgeon; or (3) diagnosis of incisional SSI by the surgeon or attending physician. Hernia size was calculated based on the radius of the fascial defect, ie, πr.[2] Presence of comorbidities, including peripheral vascular disease, coronary artery disease, chronic obstructive pulmonary disease (COPD), and diabetes, were determined by clinical data and recorded. Drains were not routinely used, and patients were discharged on the same day of hospitalization unless comorbidities necessitated a hospital stay. Follow-up was determined by the most recent physical examination of the abdomen noted in the electronic medical record. A recurrence was deemed present if there was a recurrent fascia defect felt on physical examination or seen on an abdominal computed axial tomography scan.

Statistical analysis

Statistical analysis was performed using Fisher's exact test, unpaired Student *t* test, or chi-square test where appropriate. Two-tailed *P* values are reported. For all tests relationships were considered statistically significant at $P < .05$. Analysis was calculated using GraphPad Prism 5 (GraphPad Software, San Diego, California). Univariate and multiple logistic regression using SAS version 9.1 (SAS Institute, Cary, NC) were also performed to determine which patient or surgical factors were statistically significant predictors of SSI.

Results

Most patients (98%) were men, and the mean age at the time of umbilical hernia repair was 55.2 years old (range 26 to 84). The demographic description of the study group is listed in Table 1. The mean hernia size was 6.4 cm^2 (range 1 to 28 cm^2). The mean follow-up was 19.9 months (range 1 to 57).

Overall, there were 65 repairs using mesh ([94% with polypropylene and 5% with polytetrafluoroethylene) and 87 repairs using suture material alone. However, during the study period there was a statistically significant increase in the use of mesh to repair umbilical hernias. As shown in Fig. 1, in the first 2 years of the study 24% of umbilical hernias were repaired with mesh compared with the last 2 years of the study, when 60% were repaired with mesh ($P < .001$). Hernias repaired with mesh were larger, averaging

Table 1 Patient characteristics and complications

Patient characteristics	Mean	Range
Age (y)	55.2	26–84
Body mass index (kg/m^2)	32.1	20–49
Hernia size (cm^2)	6.4	3.1–28
Albumin (mg/dL)	3.87	2.5–4.6
ASA class	2.6	1–4
Length of follow-up (months)	19.9	1–57
Patient characteristics (%/n)		
Male	98.0	149
Smoker	26.3	40
Mesh repair	42.8	65
Suture repair	57.2	87
Complications	%	n
SSI	19.7	30
Urinary retention	5.3	8
Recurrence	5.9	9
Mesh	1.5	1
Suture	9.2	8
Hematoma/seroma	4.6	7
Cardiac arrhythmia	1.3	2

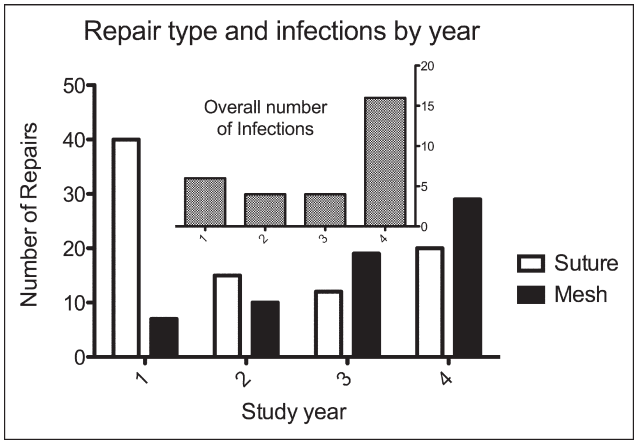

Figure 1 Frequency of mesh or suture repair and infection rate per year of the study. During the study period, the rate of mesh use increased, whereas the rate of suture repairs decreased. In the first 2 years of the study, 24% of umbilical hernias were repaired with mesh compared with the last 2 years of the study, when 60% were repaired with mesh ($P < .001$). The overall incidence of infection for mesh and suture repairs combined (shown in the inset graph) also increased in the last year of the study period, when mesh repairs were most prevalent.

8.3 cm^2 compared with 5.0 cm^2 for hernias repaired with suture material ($P < .001$).

Infections

Thirty patients were noted to have an SSI, yielding an infection rate of 19% during the study period. These SSIs were diagnosed at a mean of 10.4 days after surgery (range 1 to 44). The postsurgical day on which infections occurred is shown in Fig. 2. Interestingly, SSI incidence appeared to have a bimodal distribution, peaking around postsurgical days 4 to 6 and then again around on postsurgical days 13 to 15. Although the mean time to infection for mesh repairs was 11.6 days compared with 8.4 days for suture repairs, this difference was not statistically significant.

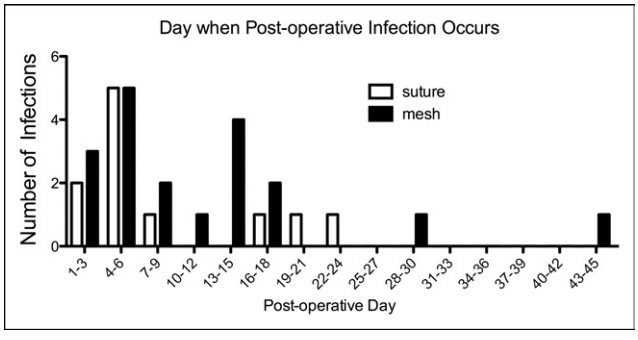

Figure 2 Postsurgical day on which SSI was diagnosed. SSIs occurring after suture or mesh repairs were diagnosed using the CDC criteria[9] (see Methods section) on the postsurgical day as indicated.

Table 2 Factors related to development of SSI

Factors	SSI	No SSI	*P*
Age >60 y	11	35	.38
BMI >35	11	30	.24
Smoker	10	30	.35
Diabetes	8	26	.62
CAD	4	25	.44
COPD	4	12	.52
Liver disease	3	7	.41
Hernia size >5 cm^2	8	51	.14
Mesh repair	19	46	.01
ASA class 3 or 4	23	62	.01

CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease.

Mesh repairs were statistically more likely to become infected compared with suture repairs ($P = .01$). In addition, patients who were assigned to ASA class ≥3 were also more likely to develop postsurgical SSI compared with those assigned to ASA class <3 ($P = .013$). Conversely, age >60 years, obesity (BMI >30 kg/m^2), smoking, diabetes, immunosuppression, and size of the hernia defect were not statistically associated with an increased risk of SSI (Table 2). Culture results were available for 9 of the patients with SSIs; when a causative organism was identified, 6 of 9 (66%) were methicillin-resistant *Staphylococcus aureus* (MRSA).

Multiple logistic regression analysis was used to test the association between SSI after umbilical hernia repair and risk factors that were either features of patients or characteristics of surgery. The following variables were placed in the regression model: age, BMI, smoking, diabetes, COPD, immunosuppression, hernia size, albumin, postgraduate year (PGY) level of resident surgeon, ASA classification, and use of mesh. In the multiple logistic regression model, use of mesh was a significant and independent predictor of surgical site infection (odds ratio 2.45, 95% confidence interval 1.05 to 5.71, $P = .039$) as was ASA classification (odds ratio 2.23, 95% confidence interval 1.06 to 4.70, $P = .035$). No other variables were significantly associated with SSI.

Management of infections

A summary of how the SSI patients were managed is shown in Fig. 3. All of the SSI patients were treated with antibiotics, either orally (60%) or intravenously (40%). Twelve patients were admitted to the hospital for SSI treatment and stayed for an average of 3.1 days (range 1 to 6). Only 3 (10%) of the SSIs necessitated surgical drainage, and 2 (6.7%) other SSIs involved the deep fascial layers of the wound, requiring surgical debridement and removal of the mesh for source control. These latter patients underwent immediate repair using acellular dermal matrix.

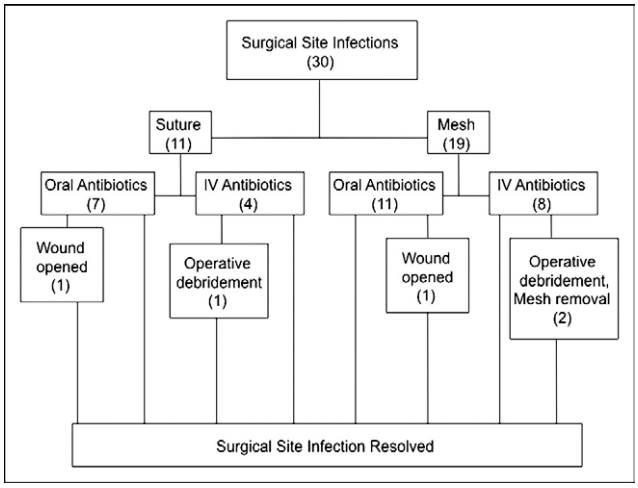

Figure 3 Management of SSIs. Thirty SSIs were identified during the study and managed as indicated described previously. Unless otherwise stated, SSIs resolved with antibiotics alone, given orally or intravenously as indicated.

Recurrence

There were 9 recurrences in the study group, yielding an overall recurrence rate of 6%. Despite there being only 1 recurrence in the mesh-repair group (1.5%) and 8 in the suture-repair group (9.2%), this was not statistically significant ($P = .16$). Seven recurrences occurred in patients with BMI >30 compared with only 2 in patients with BMI ≤30; however, this also did not reach statistical significance. No recurrences occurred in patients who had SSIs regardless of the type of hernia repair performed.

Prevention of infection

In the final 3 years of the study, additional data became available regarding factors that may prevent or predispose patients to SSIs after open umbilical hernia repair. One hundred five repairs and 24 SSIs were diagnosed during this period, yielding an infection rate of 22.8%, which is comparable with the overall infection rate of 19% for the study. In this subset analysis, 98 patients (93%) received preoperative antibiotic prophylaxis: 85 were administered cefazolin and 13 were given other antibiotics. There was no statistically significant decrease in SSIs with antibiotic prophylaxis ($P = .68$). The skin was prepared with Betadine-based solution in 64 patients and alcohol-based prep in 41 patients; there was no statistically significant decrease in SSI rate with alcohol-based prep ($P = .14$). There was also no significant difference in mean surgical time in patients with or without SSIs (71.6 min vs. 69.1 minutes, respectively; $P = .70$). Finally, a contingency table was used to determine whether PGY level of training of the operating resident was related to SSI; PGY1 residents did not have a statistically significant higher rate of SSIs despite having performed 48 repairs in this subset ($P = .10$).

Comments

In this study, it was demonstrated that the rate of infection after elective open umbilical hernia repair in this population of veterans was 19%. This is higher than the 1.8% to 11.5% SSI incidence reported in other studies for elective umbilical hernia repair.[3–5,8,10] One explanation for this high infection rate in the present study is that the patient population was typically older with a greater number of comorbidities. For example, 56% of the patients were ASA class 3 or 4 compared with only 13.5% in a large prospective study of umbilical hernia repairs, which reported a 2.5% infection rate.[3] In addition, all of the patients received follow-up at this institution or at other VA hospitals, where electronic access to any follow-up examinations within the VA system could be had. Therefore, the higher SSI rate in this study, compared with other reports, may reflect the fact that all of these patients returned for treatment of any complications (ie, 100% follow-up).

There are several possible reasons for the high SSI incidence after umbilical hernia repair compared with after other abdominal wall hernias. Vascular supply to the umbilicus may be less compared with that to the groin, thus limiting access to the area by the body's immune system, prolonging the wound healing process, and inhibiting the delivery of prophylactic antibiotics. This may be further exacerbated when the umbilical skin flap is excessively undermined and becomes necrotic. In addition, the umbilicus may harbor a large number of bacteria, providing a source of pathogenic organisms directly adjacent to the surgical wound.[11] This theory is supported by evidence that MRSA, found in most infections in this study, colonizes the umbilicus almost as often as the nares.[12]

Large prospective randomized studies have failed to show a statistically significant decrease in SSI incidence with antibiotic prophylaxis in inguinal hernia repair,[13] probably because the overall incidence of infection is low. With a higher rate of infection, as seen in this study, the potential benefit of prophylaxis increases dramatically, thus preoperative administration of antibiotics may be effective in preventing infection after umbilical hernia repair. In the final 3 years of the study, when administration of prophylactic antibiotics could be accurately determined, 87% of the patients received preoperative cefazolin. Although the groups were small, antibiotic use did not appear to decrease the incidence of infection, probably because the prophylactic antibiotics that were administered did not have efficacy against MRSA. Given the high incidence of MRSA infection in this study (66%), the use of preoperative vancomycin or other antibiotics effective against MRSA appears justified, especially when patients are colonized with MRSA.

Relatively few studies have examined the success rate of mesh salvage after infection. A 30% salvage rate for infected polytetrafluoroethylene-based mesh has been reported;[14] however, there are no large studies of salvaging polypropylene mesh (used in 94% (n = 61) of the mesh hernia repairs). In this study, an 89% salvage rate for polypropylene mesh after in-

fection, using the management strategy outlined in Fig. 3. Moreover, the results of this study showed that when infection occurs, it is possible to salvage the mesh without increasing the rate of recurrence.

The rate of recurrence in the present study was similar to that published for umbilical hernia repairs during the last 3 to 5 years, when the use of mesh became much more common.[3,10] Interestingly, a higher incidence of recurrences after SSI, as has been reported previously,[7,15] was not found. This may be related to the low number of recurrences in this study or possibly to the successful treatment of infections without mesh removal (antibiotics alone). The data may also be confounded by the fact that SSIs were more common in mesh repair, whereas recurrence was higher in suture repair; thus, recurrences may be prevented by mesh despite the presence of infection. Recurrence after abdominal wall hernia repair has been shown to be correlated with factors that cause poor wound healing and/or tissue ischemia, such as obesity,[16] diabetes,[10] and smoking.[17] In this study, the rate of hernia recurrence was not increased by obesity (BMI >30), by diabetes, or by smoking; however, the low number of recurrences may have contributed to the lack of statistical significance.

Finally, the lack of correlation between other clinical variables and the rate of recurrence and infection in this population after umbilical hernia repair is consistent with previous reports.[4,10] Further clinical studies may help identify high-risk individuals; however, the impact on the surgical management of umbilical hernia repair is unlikely to be significant. In this study, it was demonstrated, as reported by many others,[3,4,10,18] that the rate of recurrence is much higher with suture repair compared with mesh repair (in this study, 9.2% and 1.5% for suture and mesh repairs, respectively). It is unlikely that many suture repairs of umbilical hernias will be performed in the future because mesh repairs are simple, cost-effective, and not technically difficult.

There were a few limitations of this study. First, although the CDC criteria for diagnosis of SSI were used, wound cultures were obtained from only 30% of the SSI patients. Second, this was a retrospective study; therefore, there are inherent limitations in a study of this nature. The accuracy of the data collected is dependent on the quality of information in the medical record, and in a retrospective study one cannot control for confounding factors, which may have affected the relationships between clinical variables.

In conclusion, the results of this study demonstrated that open elective umbilical hernia repair is associated with a high incidence of SSI. The data suggest that given this high incidence of infection, the use of antibiotic prophylaxis directed at likely causative organisms, such as MRSA, especially in mesh repair, should be considered. Larger prospective studies are needed to assess the effectiveness of antimicrobial prophylaxis in this patient population.

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