Incision and abdominal wall hernias in patients with aneurysm or occlusive aortic disease

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Introduction: **Patients undergoing midline incision for abdominal aortic reconstruction appear to be at greater risk for postoperative incision hernia compared with patients undergoing celiotomy for general surgical procedures. Controversy exists as to whether incidence of abdominal wall hernia and increased risk for incision hernia is higher in patients with abdominal aortic aneurysm (AAA) than in patients operated on because of aortoiliac occlusive disease (AOD). We conducted a prospective multi-institutional study to assess frequency of incision hernia after aortic surgery through a midline laparotomy and of previous abdominal wall hernia.**

Methods: **Patients with AAA (n = 177) or AOD (n = 82) from three major institutions were prospectively enrolled in the study and examined. Data collected included demographic data, cardiopulmonary risk factors, smoking status, history of previous or current abdominal wall hernia (incision, inguinal, umbilical, femoral), previous midline incision, suture type, and postoperative complications. At a minimum of 6 months after laparotomy, patients were evaluated clinically for a new incision hernia. Differences were tested with the unpaired *t* test, X^2 test, or Fisher exact test, and multiple logistic regression was used to control for confounding variables.**

Results: **Mean follow-up of the cohort was 32.8 ± 2.3 months. Rate of abdominal wall hernia and inguinal hernia in patients with AAA versus AOD was 38.4% versus 11% ($P = .001$) and 23.7% versus 6.1% ($P = .003$), respectively. Rate of postoperative incision hernia in patients with AAA was 28.2%, and in patients with AOD was 11.0% ($P = .002$). Adjusting for age, smoking, chronic obstructive pulmonary disease, body mass index, diabetes, bowel obstruction, and suture type, patients with AAA had almost a ninefold risk for postoperative incision hernia formation (odds ratio [OR], 8.8; $P = .0049$).**

Conclusion: **Compared with patients with AOD, patients with AAA have a higher frequency of abdominal wall hernia and inguinal hernia, and are at significant increased risk for development of incision hernia postoperatively. The higher frequency of hernia formation in patients with AAA suggests the presence of a structural defect within the fascia. Further studies are needed to delineate the molecular changes of the aorta and its relation to the abdominal wall fascia. (J Vasc Surg 2003;37:1150-4.)**

The rate of incisional hernia after midline laparotomy is estimated at 0.1% to 15%.[1,2] This incidence increases to 21.2% in patients undergoing midline laparotomy for aortic surgery[3]; after abdominal aortic aneurysm (AAA) repair the incidence of incisional hernia is reported to be 32% at mean follow-up of 48 months[4] and 37% at mean follow-up of 36 months.[3] Other single-institution retrospective studies have also reported increased incidence of incision hernia formation after aneurysm repair. However, there is considerable variability of reported rates of incision hernia, ranging from 10% to 37% for aneurysm and 3% to 17% for occlusive disease.[1,3,5-8] Other reports suggest no difference in incidence of incision hernia in patients undergoing aortic surgery because of aneurysm versus occlusive disease, and no difference between transverse or midline incisions.[9-11] Furthermore, it appears that patients with AAA have a greater propensity for history of abdominal wall hernia, especially inguinal hernia. The reported incidence of inguinal hernia varies between 19% and 41% in patients with aneurysm disease, compared with 5% to 20% in patients with aortic occlusive disease.[1,4,8,12,13] Because of these discrepancies, the present study was conducted to determine the incidence of previous abdominal hernia and of the formation of new incision hernia after celiotomy in patients with aortic disease evaluated prospectively and from multiple institutions.

METHODS

The study was approved by the institutional review board at each of the participating hospitals. Three institutions, ie, a university hospital, Veterans Administration hospital, and community hospital, enrolled consecutive patients for elective surgery with either infrarenal aneurysm or occlusive aortic disease. Imaging studies were obtained for all patients to evaluate the aortic disease. Patients with aneurysm underwent computed tomography or magnetic resonance imaging, whereas patients with aortoiliac occlu-

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Competition of interest: none.

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Table I. Comparison of demographic data risk factors, and history of midline incision or abdominal wall herniasin patients with AAA or AOD,

Characteristic	*AAA*	*AOD*	P
Age*	71.7 ± 0.5	61.6 ± 0.8	.0001
BMI*	26.6 ± 0.4	25.3 ± 0.5	.049
Male gender (%)	84.2	64.6	.001
White race (%)	91.0	91.5	.57
Smoker (%)	91.6	100	.007
COPD (%)	21.3	26.7	.36
Diabetes (%)	14.7	18.0	.52
Hypertension (%)	72.7	65.4	.24
Previous midline incision (%)	22.4	20.7	.77
Previous abdominal wall hernia (%)	38.4	11.0	.001
Previous inguinal hernia (%)	23.7	6.1	.003

AAA, Abdominal aortic aneurysm; *AOD*, aortoiliac occlusive disease; *BMI*, body mass index; *COPD*, chronic obstructive pulmonary disease.
*Data represent mean ± SEM.

sive disease (AOD) underwent contrast material—enhanced angiography or magnetic resonance angiography. Each participating center chose the type of aortic reconstruction, fascial closure technique, and postoperative care. Patients were followed up at 1 month and at 6-month intervals thereafter, and determination of the presence of a new incision hernia was determined at 6 months or more after the index aortic surgery. Presence or absence of hernia was based only on clinical examination and was always confirmed by attending staff. All data were entered on a standardized data sheet. Information recorded included patient demographic data, cardiopulmonary risk factors (eg, diabetes, hypertension, current or former smoking status, chronic obstructive pulmonary disease [COPD], and body mass index [BMI, kg/m^2]), presence of current or past abdominal wall hernia (AWH; previous or current incisional, inguinal, umbilical, femoral), previous abdominal midline incision, operative blood loss, duration of surgery, type of fascia closure (running, interrupted), suture type (absorbable or nonabsorbable, monofilament or braided), suture size, and postoperative complications (midline wound infection, prolonged intubation [>24 hours], ileus, partial bowel obstruction). Data for groups were summarized as mean ± SEM or as percent. Differences between groups were tested for statistical significance with an unpaired *t* test, X^2 test, or Fisher exact test, as appropriate. Multiple logistic regression analysis was used to control for confounding variables. All analyses were performed with Statistical Analysis Software (SAS Institute, Cary, NC) licensed to Boston University.

RESULTS

Comparison of AAA and AOD groups. The cohort consisted of 259 patients, 177 with AAA and 82 with AOD. All patients underwent midline laparotomy for aortic reconstruction. Mean follow-up for the entire cohort was 32.8 ± 2.3 months, with mean follow-up of 30.8 ± 2.7 months for patients with AAA and 36.8 ± 4.5 months for patients with AOD ($P = .31$). In the AAA group, history of abdominal wall hernia was present in 38.4%, which was significantly greater than the 11% in patients with AOD ($P = .001$). Inguinal hernia was also more frequent in the AAA group compared with the AOD group (23.7% vs 6.1%; $P = .003$). Patients with AAA were significantly older, more likely to be male, and had a higher BMI compared with patients with AOD. There was no difference in incidence of previous midline incision (Table I).Frequency of postoperative incision hernia formation was 28.2% in the AAA group, which was significantly greater than the 11% observed in the AOD group ($P = .002$). In general, in patients undergoing aneurysm revascularization, operative time was shorter, there was more blood loss, and No. 1 sutures were used more frequently for fascia closure, compared with patients with AOD. Wound infection rate, prolonged intubation, and return of normal bowel function were similar in both groups (Table II).

Factors that influenced postoperative incision hernia. We initially compared data for patients with postoperative hernia versus patients without hernia, to identify possible risk factors for hernia formation that might act as confounding factors (Tables III and IV). Past or current abdominal wall hernia was associated with increased risk for development of postoperative incision hernia ($P = .002$), and increased BMI was associated with borderline increased risk ($P = .09$). Age, gender, smoking status, previous midline incision, and cardiopulmonary risk factors were not significant. Suture closure technique appeared to influence risk for postoperative incision hernia, as did braided and nonabsorbable sutures, and prolonged ileus or partial small bowel obstruction. Blood loss, wound infection, duration of surgery, and prolonged intubation did not influence subsequent development of incision hernia (Table IV).

Multivariate logistic regression analysis. Various models of multivariate analysis were performed to examine AAA as a risk factor for previous hernia and postoperative hernia formation, after adjusting for possible confounding variables including age, risk factors, and difference in wound closure technique. Adjusting for age, we found that

Table II. Comparison of operative and postoperative events and incisional hernia formation in patients with AAA or AOD

Characteristic	*AAA*	*AOD*	P
Operative time (min)*	211.4 ± 10.2	247.8 ± 13.9	.044
Estimated blood loss (mL)*	1492.6 ± 152.1	992.8 ± 100.6	.007
Cell saver (mL)*	679.8 ± 55.3	302.0 ± 57.8	.0001
Suture			
Running suture (%)	100	98.6	.13
Monofilament suture (%)	93.6	90.3	.37
Nonabsorbable suture (%)	74.1	75.3	.84
No. 1 suture† (%)	85.7	59.7	.001
Wound infection (%)	3.7	5.6	.50
Prolonged intubation (%)	16.6	13.9	.60
Ileus or partial small bowel obstruction (%)	9.0	3.7	.22
Postoperative oral nutrition (d)	4.2 ± 0.2	4.0 ± 0.3	.64
Postoperative incision hernia	28.2	11.0	.002

AAA, Abdominal aortic aneurysm; *AOD*, aortoiliac disease.
*Data represent mean ± SEM.
†No. 2 suture was used in the remainder of patients with AAA or AOD.

Table III. Patient factors and influence on postoperative incision hernia

	Postoperative incision hernia		
Characteristic	*Present*	*Absent*	P
Age (y)*	69.6 ± 1.0	68.2 ± 0.6	.29
BMI*	27.1 ± 0.6	25.9 ± 0.3	.088
Male gender (%)	84.7	76	.15
White race (%)	91.5	91.0	.43
Smoker (%)	96.5	93.7	.41
Previous midline incision (%)	20.0	22.3	.71
Previous abdominal wall hernia (%)	45.8	25.0	.002
Diabetes (%)	11.9	16.9	.35
Hypertension (%)	77.2	68.4	.20
COPD	27.3	21.7	.39

BMI, Body mass index; *COPD*, chronic obstructive pulmonary disease.
*Data represent mean ± SEM.

patients with AAA are at increased risk for abdominal wall hernia (OR, 5.5; $P = .0001$), and this holds true when femoral hernia is excluded (n = 1); furthermore, patients with AAA also are at increased risk for inguinal hernia (OR, 5.0; $P = .002$). We performed an analysis to determine whether presence of a previous incision hernia influenced development of postoperative incision hernia. After adjusting for age, patients with a previous incision hernia before aortic surgery were at increased risk for postoperative incision hernia (OR, 4.8; $P = .003$). Adjusting for age and previous incision hernia, AAA was an independent risk factor for development of postoperative incision hernia (OR, 3.2; $P = .01$). The OR associated with increased risk for incision hernia formation was 4.0 ($P = .20$) for smoking status and 6.6 ($P = .020$) for closing the fascia with braided (non-monofilament) suture. After adjusting for age, BMI, smoking status, COPD, diabetes, suture type, ileus, or partial small bowel obstruction, patients operated on because of AAA had an almost ninefold increased risk (OR, 8.8; $P = .0049$) for postoperative incision hernia formation, compared with patients who underwent aortic surgery because of occlusive disease.

DISCUSSION

Incidence of incision hernia is substantially greater in patients undergoing aneurysm surgery (28.2%) compared with patients undergoing surgery because of AOD (11%). These results are consistent with previously published reports, with incision hernia rate of 10% to 37% in patients with aneurysm and 3% to 17% in patients with occlusive disease.[1,3,4,7,8] Because the present study was prospective and multicenter, the data may be considered representative of the patient population undergoing laparotomy for aortic procedures and of risk for incision hernia. More important, this study confirms that a strong independent relationship exists between AAA and incision hernia formation after midline laparotomy.

Previous studies have documented a higher rate of inguinal hernia in patients with aneurysm disease, ranging from 19% to 41%, compared with 5% to 20% in patients

Table IV. Closure technique and perioperative factors, and influence on postoperative incision hernia

Characteristic	*Postoperative incision hernia*		P
	Present	*Absent*	
Suture			
Running (%)	100	99.5	.61
Monofilament (%)	84.1	94.6	.017
Nonabsorbable (%)	89.4	70.8	.009
Suture size†	—	—	.17
Wound infection (%)	6.2	3.8	.45
Prolonged intubation (%)	14.0	16.2	.70
Ileus or partial small bowel obstruction (%)	10.2	6.5	.044
Operative time (min)*	235.0 ± 22.9	219.3 ± 8.7	.52
Estimated blood loss (mL)*	1733.0 ± 248.7	1249.0 ± 123.5	.088
Cell saver (mL)*	682.4 ± 76.7	558.2 ± 52.6	.18
Postoperative oral nutrition (d)*	4.2 ± 0.4	4.1 ± 0.2	.97

*Data represent mean ± SEM.
†Analysis of suture size (No. 1 or No. 2) was not significant.

with AOD.[1,5,12] Our findings were consistent with published results; 23.7% patients with aneurysm had a previous or current inguinal hernia, compared with only 6% of patients with AOD. Predisposition for AAA formation is associated with fourfold increased risk in patients who smoke who have inguinal hernia.[14] A systemic proteolytic effect has been suggested in patients with AAA and formation of inguinal hernia.[13,15]

A number of variables in the current study had significant importance in postoperative incision hernia formation. Compared with monofilament or absorbable suture, braided suture or nonabsorbable suture had a significant influence on postoperative incision hernia formation. A recent meta-analysis concluded that the ideal suture for abdominal fascia closure should consist of running nonabsorbable monofilament suture. In the same study, subgroup analysis showed no difference in incision hernia formation with either absorbable or nonabsorbable suture.[16] Also, a suture length to wound length ratio greater than 4 reduces incidence of incision hernia[11]; however, this was not determined or controlled for in our study. With univariate analysis comparing the presence or absence of incision hernia, our data suggest that use of monofilament absorbable suture is associated with less frequency of postoperative incision hernia formation. Our study did not control for either institution or surgeon preference for suture type. Therefore firm conclusions as to which suture material is superior for fascia closure cannot be determined from our findings and requires a randomized study. However, the data support that, even after controlling for suture size and type, presence of AAA is a significant independent factor for incision hernia development.

A significant finding was that a history of abdominal wall hernia was strongly associated with postoperative incision hernia development. It is not known whether a genetic predisposition for incision hernia exists, but the literature suggests that systemic proteolytic effect,[15] increased proteolytic activity in the aneurysmal aorta and abdominal wall in patients with inguinal hernia,[17] and inherent defects in synthesis and turnover of type III collagen in both aneurysmal aorta and inguinal hernia[18-20] may be important in development and association of aortic aneurysm and abdominal wall hernia formation.

Postoperative ileus or partial small bowel obstruction is associated with increased risk for incision hernia formation, but was insignificant at multivariate analysis. A similar finding has been previously reported.[4] Currently we can only speculate that increased abdominal pressure, coupled with stronger systemic factors, may have an effect on incision hernia. In addition, we did not find that increased blood loss, either estimated or with cell saver measurement, had any effect on incision hernia development, which is consistent with findings of one published study[7] but inconsistent with those of another.[11] Wound infection is a risk for incision hernia formation after aortic surgery.[11] We did not find that wound infection contributed to postoperative incision hernia, consistent with previously published studies.[4,7] The variability is probably reflected in how wound infection is classified. Wound infection can have a wide range of distribution, from skin and subcutaneous cellulitis to deep space and fascia. Various studies will find different results according to how wound infection is described.

The high incidence of postoperative incision hernia in patients with AAA is likely multifactorial. Our multivariate analysis clearly established that AAA is an independent variable with an almost ninefold increase in incision hernia development, even after correcting for other risk factors associated with incision hernia. In a randomized trial of primary abdominal incision hernia repaired with either suture or mesh, patients who had undergone previous surgery because of AAA were at significant risk for recurrence.[21] The relationship of collagen metabolism between abdominal wall hernia and aneurysm disease has been studied.[19,20] A recent study that evaluated skin fibroblasts cultured from patients with incision or recurrent incision hernia demonstrated increased transcription of type III

procollagen and decreased ratio of type I to type III procollagen.[22] Although defects in collagen metabolism are central to the pathogenesis of aneurysm, inguinal hernia, and incision hernia, further molecular studies are required to assess both the aortic tissue and abdominal fascia before hernia formation, to establish a causal systemic relationship. In addition, clinical studies are required to determine possible technical and perioperative factors that may be modified to reduce the incidence of incision hernia formation after aortic aneurysm surgery.

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