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A Comparative Analysis Between Laparoscopic and Open Ventral Hernia Repair at a Tertiary Care Center

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Abstract

Laparoscopic ventral hernia repair reportedly yields lower postoperative complications than open repair. We hypothesized that patients undergoing laparoscopic repair would have lower postoperative infectious outcomes. Also, certain preoperative patient characteristics and preoperative hernia characteristics are hypothesized to increase complication risk in both groups. All ventral hernia repairs performed at University of Virginia from January 2004 to January 2006 were reviewed. Primary outcomes included wound healing complications and hernia recurrence. Categorical data were analyzed with χ^2 and Fisher's exact tests. Continuous variables were evaluated with independent *t* tests and Mann-Whitney U tests. Multivariable logistic regression was performed. A total of 268 repairs (110 open, 158 laparoscopic) were evaluated. Patient and hernia characteristics were similar between groups, though the percents of wound contamination (5.4% vs 0.6%; $P = 0.02$) and simultaneous surgery (7.2% vs 0%; $P = 0.001$) were greater in the open procedures. Univariate analysis also revealed that open cases had a greater incidence of postoperative superficial surgical site infection (SSI) (30.0% vs 10.7%; $P < 0.0001$). Multivariable analysis revealed that both diabetes and open repair were associated with an increased risk of superficial SSI ($P = 0.019$; odds ratio = 3.512; 95% confidence interval = 1.229–10.037 and $P = 0.001$; odds ratio = 4.6; 95% confidence interval = 1.9–11.2, respectively). Laparoscopic ventral hernia repair yielded lower rates of postoperative superficial SSI than open surgery. Other pre-operative patient characteristics and preoperative hernia characteristics, with the exception of diabetes, were not found to be associated with an increased risk of postoperative complications.

A ventral hernia is described as being any evisceration of the intra-abdominal or preperitoneal contents through a fascial defect of the abdominal wall, which may or may not result in loss of abdominal domain and/or abdominal visceral disproportion.^{1, 2}

Ventral hernia repair is one of the most commonly performed procedures in the United States by general surgeons.³ The first described repairs of the ventral hernia were open, simple suture, and primary closure. Over time, closure techniques have become more sophisticated and now include tension free mesh repair and separation of components. In 1993, LeBlanc and Booth⁴ described the first laparoscopic incisional hernia repair.

Multiple studies comparing laparoscopic and open techniques have shown that the laparoscopic approach yields a decrease in postoperative pain and hospital stay, as well as a faster return to activity.^{3, 5–7} However, less clear data is available regarding incidence of

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wound infections, and recurrence rates with some studies proclaiming a clear benefit with the laparoscopic approach and others stating that there is no difference.^{3, 5–13}

A recent poll of 204 practicing surgeons was taken among both academic and urban hospitals. Approximately 85 to 96 per cent performed basic laparoscopic procedures on a routine basis; however, more than 90 per cent reported that they do not perform laparoscopic hernia repair. Out of that group, 81 per cent stated that they would not start performing laparoscopic hernia repair for reasons including lack of improved results, risk of enterotomy, operative time, cost, and experience.¹⁴

As a result of this disparity, in defining the optimal surgical approach, we evaluated our patient population at the University of Virginia and compared outcomes from both laparoscopic and open ventral hernia repairs over a 2-year time period. As a secondary goal we also looked at preoperative patient characteristics and comorbidities between the two groups. We hypothesized that University of Virginia patients undergoing laparoscopic repair would have lower postoperative infectious outcomes, including both superficial (cellulitis and superficial skin dehiscence) and deep surgical site infections. Also, preoperative patient characteristics [diabetes, smoking, greater body mass index (BMI), wound contamination] along with preoperative hernia characteristics (fascial defect size, number of previous hernia repairs) were hypothesized to increase complication risk in both groups.

Methods

Institutional review board approval was obtained before retrospective review of the data was initiated. A retrospective analysis of a prospectively maintained database was performed of all patients seen at the University of Virginia Health System who underwent open and/or laparoscopic ventral hernia repair from January 2004 to January 2006. The database was a compilation of the work of over 28 surgeons at our institution ranging from general to plastic to transplant surgery. Demographic information, preoperative comorbidities and risk factors, and postoperative outcomes for all patients were collected.

Pre-operative patient demographics, comorbidities, and risk factors evaluated included: age, BMI, tobacco abuse, diabetes, steroid use, previous abdominal surgery, previous ventral hernia repair, fascial defect size, concomitant surgery (*i.e.*, simultaneous bowel transection), and concurrent wound contamination (*i.e.*, presence of ostomy, fistula, intraoperative enteric spillage, and preoperative cellulitis). These were chosen largely based upon a report by Neumayer et al.¹⁵ In this report, Neumayer et al.¹⁵ goes on to list 14 variables, which have been independently linked with increased risk of surgical site infection.

Primary surgical outcomes evaluated included: seroma, hematoma, hernia recurrence, superficial surgical site infection, deep surgical site infection, organ space surgical site infection, all abscesses, all short term complications (defined as any complication that occurred within 30 days of initial hernia repair), and all long term complications (defined as any complication that occurred after 30 days of the initial hernia repair). Statistical significance was defined as a *P* value of less than 0.05. Categorical data was analyzed with univariate statistics models including χ^2 analysis and/or Fisher's exact test. Continuous variables were analyzed with independent *t* tests and/or Mann-Whitney U tests. These models were used to compare and contrast laparoscopic *versus* open ventral hernia repair with regards to preoperative patient demographics, comorbidities, and risk factors, as well as postoperative complications. Multivariate logistic regression models were then generated to estimate risk of postoperative surgical complications as a function of preoperative patient characteristics, comorbidities, and surgical approach.

Pre-operatively, all patients were encouraged to quit smoking 4 weeks in advance of their surgery; however, smoking cessation data was neither collected nor monitored during this study. Operative technique consisted of either laparoscopic or open ventral hernia repair. The decision to perform either repair was based upon patient's body habitus, preoperative presence of infection, preoperative abdominal surgeries including prior ventral hernia repairs, intraoperative complications, and surgeon preference.

For the laparoscopic repair, intraperitoneal access was gained using either the open Hasson technique or the Veress needle technique. Once pneumoperitoneum was achieved, three to four trocars were placed usually consisting of one 10-mm port and two to three 5-mm ports. A piece of mesh was then chosen and cut to allow for a 3 to 5-cm overlap around the fascial defect. The mesh was then introduced into the peritoneal cavity and anchored to the abdominal wall using a combination of transfascial sutures and circumferential tacks placed in a double ring fashion.

For the open repair an incision was performed directly over the hernia site. Using electrocautery the hernia and surrounding fascia was appropriately exposed. The hernia sac was then reduced and, depending on the fascial defect size, closed either primarily with non-absorbable sutures (60/110) or using mesh (50/110). When mesh was chosen, it was primarily placed in an underlay fashion 78 per cent (39/50) of the time. Other options included onlay (20%; 10/50) or inlay (2% 1/50). The mesh was typically secured to the fascia using Prolene sutures in either a running, simple interrupted, or horizontal mattress fashion.

The type of mesh used for repair primarily consisted of dual mesh (Gore, Flagstaff, AZ), Gortex (Gore, Flagstaff, AZ), Sepramesh (Bard, Warwick, RI), Prolene, vicryl, porcine xenograft, ultrapro mesh (Ethicon, Cincinnati, OH), permachol (Covidien, Mansfield, MA), and Proceed (Ethicon, Cincinnati, OH). These were chosen largely based on surgeon preference.

Postoperatively, upon discharge from the hospital, all patients were encouraged to refrain from smoking, wear their abdominal binders at all times when not lying down, use a pillow to brace their abdomens when coughing, and to refrain from engaging in strenuous labor for a period of at least 4 to 6 weeks (to include lifting anything over 10 pounds). All patients were seen in follow-up at 4 weeks postoperatively and then on an as-needed basis. They were all evaluated postoperatively by physical exam and when necessary (*i.e.*, complication), by additional imaging (*i.e.*, CT scan or ultrasound) to assess the integrity of their repair.

Results

A total of 268 patients underwent ventral hernia repairs at our institution between January 2004 and January 2006. Of these, 114 were male and 154 were female. The etiologies of the ventral hernias were as follows: umbilical (33/268), recurrent umbilical (14/268), midepigastria (22/268), recurrent midepigastria (3/268), incisional (121/268), recurrent incisional (52/268), parastomal (4/268), and spigelian (5/268), and the rest were simply recorded as "ventral hernia" (14/268). The theme most commonly shared amongst all primary ventral hernias was obesity. The mean age was 52.5 ± 15.4 years. The mean fascial defect size was 130.27 ± 199.07 cm². Multiple modalities were used to measure the defect size and included: preoperative measurement in the outpatient clinic, radiographic measurement, intraoperative measurement, and mesh size. Amongst our study population, 37 per cent ($n = 101$) were smokers, 16 per cent ($n = 43$) had diabetes, 4 per cent ($n = 11$) were on chronic steroids, 38 per cent ($n = 102$) had a history of previous hernia repairs, 84

per cent ($n = 225$) had a history of previous abdominal surgery, 92 per cent ($n = 247$) had a BMI $> 25 \text{ kg/m}^2$, 3 per cent ($n = 8$) were found to have wound contamination intraoperatively, and 3 per cent ($n = 8$) underwent simultaneous surgery during their initial hernia repair (*i.e.*, bowel transection).

Of the 268 patients, 110 (41%) underwent open ventral hernia repair and 158 (59%) underwent laparoscopic ventral hernia repair. The two groups were comparable with regards to: age, incidence of diabetes, BMI, number of previous ventral hernia repairs, number of previous abdominal surgeries, presence of tobacco abuse, presence of steroid use, and fascial defect size. However, there was a significant difference between the two groups in incidence of (pre/intraoperative) wound contamination (5.4%; $n = 6$ open *vs* 0.6%; $n = 1$ laparoscopic; $P = 0.020$) and presence of simultaneous surgery (*i.e.*, bowel transection) (7.2%; $n = 8$ open *vs* 0.0%; $n = 0$ laparoscopic; $P = 0.001$) (Table 1).

Post-operative complications between groups were comparable with regards to: hematomas, seromas, need for reoperation, number of overall surgical site infections, number of deep surgical site infections, number of intra-abdominal abscesses, all short-term complications (defined as complications occurring within 30 days after initial hernia repair), and all long-term complications (defined as complications occurring 30 days after initial hernia repair). However, there was a significant difference between the two groups in superficial surgical site infection (30.0%; $n = 33$ open *vs* 10.7%; $n = 16$ laparoscopic; $P < 0.0001$) (Table 2). All 49 infectious complications [25 open (14 had mesh), 18 laparoscopic (all had mesh), and six laparoscopic converted to open (5 had mesh)] were initially treated with antibiotics. Of the 25 open repair patients, four (2 with mesh) had cellulitis treated with antibiotics alone, 15 (8 with mesh) had skin dehiscence, six (4 with mesh) had an abscess, 20 (10 with mesh) were treated with serial debridements, six (5 with mesh) were reoperated on, and six either required readmission or prolonged primary hospitalization. Of the 18 laparoscopic repair patients, six had cellulitis treated with antibiotics alone, four had skin dehiscence, seven had an abscess, nine were treated with serial debridements, eight were reoperated on, and eight either required readmission or prolonged primary hospitalization. Of the six laparoscopic conversion to open repair, one (1 with mesh) had cellulitis treated with antibiotics alone, one (1 with mesh) had skin dehiscence, five (3 with mesh) had an abscess, two (1 with mesh) were treated with serial debridements, two (2 with mesh) required reoperation, and two either required readmission or prolonged primary hospitalization.

Of the 268 patients, hernia recurrence data was available for only 42 per cent. This gave us a mean follow-up of 39.5 ± 23.2 months with a range of 6 to 83 months. Current literature recommends that to truly evaluate hernia recurrence, patients should ideally be followed for over 2 years. In total, there were 71 recurrences. On average these were noted to occur 23 ± 18.07 months after the repair. Thirty-eight were associated with the laparoscopic repair. Twenty-five were associated with open repair (14 of which had been repaired with mesh). Eight were associated with laparoscopic converted to open repair (6 of which had been repaired with mesh). Of those 71 recurrences, 42 required reoperation.

Results from the multivariate logistic regression revealed that both diabetes and surgical approach (open) were associated with a significant increased risk of superficial surgical site infection ($P = 0.019$; odds ratio = 3.5; 95% confidence interval = 1.2–10.04 and $P = 0.001$; odds ratio = 4.6; 95% confidence interval = 1.9–11.2, respectively). All other patient risk factors and comorbidities were not found to be associated with an increased risk of postoperative complications (Table 3).

Discussion

A recent analysis found many previously reported preoperative patient comorbidities confer increased risk of surgical site infection: diabetes, steroid use, alcoholism, recent radiotherapy, low preoperative albumin, operation on the gastrointestinal tract, emergency surgery, higher American Society of Anesthesiologists class, and wound classifications other than clean.¹⁵

Our study demonstrated that the incidence of postoperative superficial surgical site infection was significantly higher in the open approach compared with the laparoscopic approach to ventral hernia repair. Also, diabetes was significantly associated with an increased incidence of superficial surgical site infection; however, other preoperative patient characteristics and comorbidities were not.

More recently, a National Surgical Quality Improvement Program analysis⁸ and a multicenter Veterans Affairs hospital analysis¹⁶ found that open surgical technique, not patient comorbidities or hernia characteristics, was associated with the formation of postoperative surgical site infection. By and large our study supports these findings. As previously cited in the literature, the higher association of open ventral hernia repair with surgical site infection is most likely attributed to the inherent need for creation of a larger incision, development of skin flaps with potential de-vascularization, larger blood loss, and increased exposure of tissues to the environment.^{3, 16}

Regarding hernia recurrence, a recent retrospective analysis followed 331 patients over a 5-year period and compared the actual hernia recurrence rates of laparoscopic *versus* open techniques. This study was one of the first to follow patients beyond the typically referenced 2 to 3-year follow-up period. Their study found similar recurrence rates between both the open (11% at 1 year and 28% at 5 years) and laparoscopic (15% at 1 year and 29% at 5 years) ventral hernia repair groups.¹² Similarly, our study did not demonstrate a significant difference between the laparoscopic technique (22% recurrence) and open ventral hernia repair (27% recurrence) with regards to hernia recurrence.

Finally, patient comorbidities and hernia characteristics were similar between the two groups (open *vs* lap) analyzed in the present study with the exception of wound contamination both pre and intraoperatively. The usual criteria, at our institution, for selecting the open instead of the laparoscopic approach include presence of infected mesh, multiple prior abdominal surgeries, and morbid obesity. During further review of the data, many of the contaminated cases in our series stemmed from prior ventral hernia repairs taken back for infected mesh removal. Only one of 23 open cases with postop cellulitis also had preop cellulitis.

Limitations

Study limitations are as follows. This was a retrospective analysis of a database compiled by multiple surgeons from multiple departments (*i.e.*, general surgery, plastics, transplant, etc). As a result, some of the data have not been recorded consistently. Also, as this is a single center study, generalizing the results to other patients is potentially limited. Finally, the literature often reports a 2-year follow-up as the minimum time interval for which to evaluate hernia recurrence.^{9, 11–13} All of our patients had at least a 4-week postoperative visit; however the majority were not seen back if they did not encounter a complication. This problem was addressed by excluding all patients with less than 6 months of documented follow-up (resulting in a mean follow-up of 39.5 ± 23.2 months).

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Table 1

Univariable Analysis of Preoperative Risk Factors in Open and Laparoscopic Groups

Preoperative Risk Factor	Open (% of Patients or Mean $\pm$ SD)	Laparoscopic (% of Patients or Mean $\pm$ SD)	P value
Diabetes mellitus *	18.2	15.2	0.615
Wound contamination *	5.4	0.6	0.020
BMI ≥ 35 kg/m ² *	93.1	90.6	0.772
Previous ventral hernia repair *	37.3	39.2	0.799
Previous abdominal surgery *	84.5	83.5	0.867
Smoker *	31.8	40.5	0.159
Simultaneous surgery (bowel transected) *	7.2	0	0.001
Steroid use *	3.6	4.4	1.0
BMI (kg/m ²) †	35.4 $\pm$ 10	34.7 $\pm$ 8.4	0.677
Age (years) †	52.1 $\pm$ 16	52.3 $\pm$ 14.7	0.948
Fascial defect size (cm ²) †	98.5 $\pm$ 156	147.4 $\pm$ 217.9	0.170
Number of previous ventral hernia repairs †	1.78 $\pm$ 1.2	1.77 $\pm$ 1.1	0.979
Number of previous abdominal surgeries †	2.2 $\pm$ 1.7	2.3 $\pm$ 2.0	0.626

* For analysis of statistical significance, the Fisher's exact test or χ^2 was used to assess the difference in proportions.

† The Mann-Whitney *U* test was used to assess the statistical significance of the difference in means.

SD, standard deviation.

Table 2

Univariable Analysis of Categorical Surgical Outcomes in Open versus Laparoscopic Groups

Surgical Outcome	Open (% of Patients)	Laparoscopic (% of Patients)	P value
Superficial SSI	30.0	10.7	<0.0001
Reoperation	21.8	16.4	0.270
All abscesses	7.2	2.5	0.065
Deep SSI	5.4	2.5	0.214
Organ space SSI	1.8	0.6	0.364
All short-term complications (grouped)	4.5	1.3	0.127
All long-term complications (grouped)	56.3	46.8	0.137
Hematoma	0.9	0	0.410
Seroma	1.8	0.6	0.570
Hernia recurrence	27.2	21.5	0.309

* All calculations for Table 2 were performed using Fisher's exact test/ χ^2 .

SSI, surgical site infection.

Table 3**Multivariable Logistic Regression for Superficial Surgical Site Infection**

Risk Factor	P value	Odds Ratio	95% Confidence Interval
Surgical approach	0.001	4.6	1.9–11.2
Smoking	0.225	0.545	0.204–1.453
Diabetes	0.019	3.512	1.229–10.037
Previous ventral hernia repair	0.462	0.709	0.283–1.776
Wound contamination	0.147	5.372	0.553–52.232
Simultaneous surgery	0.999	5.978E8	0.0-NA
BMI > 25 kg/m ²	0.308	3.313	0.331–33.195

NA, not applicable.