Long-term Outcomes in Laparoscopic vs Open Ventral Hernia Repair

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Objective: To investigate whether there was a difference in morbidity, recurrence rate, and length of hospital stay between patients undergoing open or laparoscopic incisional hernia repair.

Design and Setting: Single-institution cohort study. We compared prospectively collected patient cohorts undergoing laparoscopic or open intraperitoneal onlay mesh repair. Statistical analysis was performed by Fisher exact test and analysis of variance.

Patients: Between October 1995 and December 2005, data from 360 consecutive patients who had undergone open or laparoscopic intraperitoneal onlay mesh repair of a ventral hernia were prospectively collected in a database and were supplemented by record review.

Main Outcome Measures: Morbidity, hernia recurrence, and length of hospital stay. Postoperative complications of Clavien grade II or greater were considered major complications.

Results: Intraperitoneal onlay mesh repair was performed in 233 patients by the open approach and in 127 patients using the laparoscopic approach. The groups were similar for sex and body mass index (calculated as the weight in kilograms divided by the height in meters squared); the mean age of the laparoscopic group was 3 years younger; and the mesh was larger in the laparoscopic group. Mean follow-up was 30 and 36 months for the laparoscopic and open groups, respectively; the conversion rate was 4%. Major morbidities were 15% in the open group vs 7% in the laparoscopic group (P = .01). Recurrence rates were 9% in the open group vs 12% in the laparoscopic group (P = .36). Postoperative inpatient admission was more frequent after the open procedure than after the laparoscopic procedure (28% vs 16%, respectively; P < .05).

Conclusions: Outcomes did not differ with respect to recurrence rates after long-term follow-up; however, the lower rate of major morbidity and increased outpatient-based procedure rates favor laparoscopic repair in this study.

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More than 2 million abdominal operations take place yearly in the United States, with an estimated 3% to 20% of those patients ultimately developing a ventral incisional hernia. With 90,000 ventral incisional hernia repairs being performed annually, the question of whether an open or laparoscopic repair should be performed is of growing interest to general surgeons. Data on morbidity and recurrence rates are still inconclusive. The purpose of this study was to compare the outcome of patients undergoing open and laparoscopic intraperitoneal onlay mesh repairs in a single institution during a 10-year period. We hypothesized that there is no difference in the complication rate, severity of complications, long-term recurrence rate, and length of hospital stay between patients undergoing the open or laparoscopic repair.

METHODS

Data from all of the 651 patients who underwent ventral incisional hernia repair between October 1995 and December 2005 at a single institution were prospectively collected. Only patients who had undergone an intraperitoneal onlay mesh repair, either open or laparoscopic, were considered. The techniques of both repairs have been described elsewhere and are briefly outlined here. For the open repair, the hernia sac is dissected free, opened to reduce herniated contents, and resected. The mesh is placed in the intraperitoneal position (Figure 1) and fixated with interrupted suture at a minimum of 2 cm from the fascial edge. For the laparoscopic procedure, the herniated contents are reduced after trocar placement and insufflation and the mesh is fash-
tions do not require pharmacological treatment or intervention; grade II complications include those requiring pharmacological treatment, blood transfusions, or total parenteral nutrition; grade III complications require surgical, radiological, or endoscopic intervention; grade IV complications are life threatening and require intensive care unit management; and grade V complications result in death.

The postoperative occurrence of a seroma was identified by clinical examination. A significant seroma was defined as a seroma that caused pain or discomfort, erythema, or infection. In the laparoscopic group, significant seromas were aspirated. In the open group, drains were placed at operation to prevent the formation of a seroma. No data regarding fixation-related pain were collected. Statistical analysis was performed using Fisher exact test, Wilcoxon rank sum test, and t test with SAS statistical software version 9.3 (SAS Institute, Inc, Cary, NC). The study was judged exempt by the institutional review board.

RESULTS

From October 1995 to December 2005, a total of 651 patients underwent ventral hernia repair at a single institution. Five hundred fourteen patients (79%) underwent an open ventral hernia repair and 137 (21%) underwent a laparoscopic repair. Two hundred eighty-one patients (55%) who underwent the open repair and 10 patients (7%) who underwent the laparoscopic repair were excluded from the analysis because they underwent either an additional procedure (e.g., planned bowel resection) or a nonmesh repair. A total of 233 patients who underwent an open procedure and 127 patients who underwent a laparoscopic procedure were used in the final statistical analysis. Five patients (4%) required conversion from the laparoscopic to the open procedure owing to hemodynamic instability, the inability to obtain visualization, or technical difficulties with the mesh placement.

Table 1 describes the demographic data and comorbidities of the patients included in the analysis. The mean number of prior abdominal operations was 2.71 for the open surgery group and 2.68 for the laparoscopic hernia repair group.
Sixteen patients (7%) in the open repair group and 7 patients (6%) in the laparoscopic repair group had a prior diagnosis of cancer. No data on preoperative albumin levels were collected. The mean BMI as a proxy for obesity-related malnutrition was similar for both groups. Table 2 describes the different types of mesh used for the repairs, with the polypropylene mesh used in the earlier phase of the study in patients with sufficient omentum present. No mesh-related bowel fistula was recorded.

Overall, 43 patients (12%) experienced a Clavien grade II complication or higher. Major complications were significantly more frequent in the open repair group (Table 3). One patient (0.4%) had a postoperative deep vein thrombosis after open ventral hernia repair complicated by *Candida* septicemia and died. One patient in the laparoscopic group manifested sepsis from an unrecognized enterotomy on postoperative day 1 and required reoperation with mesh removal. The patient recovered and underwent open ileostomy takedown and hernia repair 1 year later. Six patients in the open group with mesh experienced infection requiring removal of the mesh. None of the patients in the laparoscopic group had mesh removal for infection. Patients with preexisting pulmonary comorbidities were significantly more likely to have major complications; 27% of patients with pulmonary diseases vs 10% of patients without pulmonary comorbidities had postoperative complications (P < .001). In patients with pulmonary comorbidities, the recurrence rate and complication rate were not correlated with the type of operation performed (laparoscopic vs open). Using a logistic regression model, the occurrence of a complication was associated with the operative method without adjustment for pulmonary disease (P = .04) and remained associated after adjustment for pulmonary disease (P = .03). Additional adjustment for BMI did not alter these conclusions, and BMI did not contribute significantly to the model (P = .71).

Recurrence occurred in 16 patients (13%) in the laparoscopic group and 21 patients (9%) in the open group (P = .36) during a mean follow-up of 30 and 36 months, respectively. The median follow-up was 36 months for the patients with laparoscopic hernia repair and 25 months for patients with open hernia repair. Seventy-five patients (32%) in the open group and 45 patients (36%) in the laparoscopic group had longer than 36 months of follow-up. Recurrence was determined by physical examination and documentation in the record. In addition to reviewing the records, all of the available imaging studies, including computed tomography scans obtained in asymptomatic patients for unrelated diagnoses (eg, cancer follow-up or trauma), were reviewed. Any mention of recurrence in the record or on imaging studies, whether symptomatic or not, was counted as recurrence. Statistical analysis did not reveal any effect related to the type of mesh used on the recurrence rate (ie, polytetrafluoroethylene, polypropylene, or combination meshes) (P = .37).

Further analysis revealed that patients who developed a postoperative abscess had a 4.4-fold risk of recurrence compared with those who did not develop an abscess (P < .001). Patients with a BMI higher than 30 had a 5-fold risk of recurrence compared with patients with normal weight (BMI < 25) (P = .02).

Postoperative inpatient admission was more frequent after the open procedure than after the laparoscopic procedure (28% vs 16%, respectively; P < .05). The

### Table 2. Types of Mesh Used for Hernia Repair

<table>
<thead>
<tr>
<th>Mesh Type</th>
<th>Open (n = 233)</th>
<th>Laparoscopic (n = 127)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTFE</td>
<td>153 (66)</td>
<td>75 (59)</td>
<td>.001</td>
</tr>
<tr>
<td>Polypropylene</td>
<td>31 (13)</td>
<td>42 (33)</td>
<td></td>
</tr>
<tr>
<td>Combination</td>
<td>22 (9)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Not listed</td>
<td>27 (12)</td>
<td>10 (8)</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviation:** PTFE, polytetrafluoroethylene.

### Table 3. Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Open (n = 233)</th>
<th>Laparoscopic (n = 127)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clavien grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥II</td>
<td>34 (15)</td>
<td>9 (7)</td>
<td>.01</td>
</tr>
<tr>
<td>II</td>
<td>21 (9)</td>
<td>6 (5)</td>
<td>NA</td>
</tr>
<tr>
<td>III</td>
<td>12 (5)</td>
<td>3 (2)</td>
<td>NA</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>V</td>
<td>1 (0.4)</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Seroma</td>
<td>18 (8)</td>
<td>21 (16)</td>
<td>.01</td>
</tr>
<tr>
<td>Abscess</td>
<td>15 (6)</td>
<td>3 (2)</td>
<td>.13</td>
</tr>
</tbody>
</table>

**Abbreviation:** NA, not available.

### Table 4. Comparison With Other Reported Studies

<table>
<thead>
<tr>
<th>Source</th>
<th>Study Type</th>
<th>Patients, Total (OVHR/LVHR), No.</th>
<th>Recurrence Rate, %</th>
<th>Complication Rate, %</th>
<th>Follow-up Time, Mean, mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramshaw et al.10 1999</td>
<td>Retrospective review</td>
<td>253 (174/79)</td>
<td>21 OVHR/3 LVHR</td>
<td>26 OVHR/19 LVHR</td>
<td>21</td>
</tr>
<tr>
<td>Carbajo et al.11 1999</td>
<td>Randomized controlled trial</td>
<td>60 (30/30)</td>
<td>7 OVHR/0 LVHR</td>
<td>35 OVHR/6 LVHR</td>
<td>27</td>
</tr>
<tr>
<td>Robbins et al.14 2001</td>
<td>Prospective data retrospective analysis</td>
<td>54 (18/36)</td>
<td>NA</td>
<td>28 OVHR/16 LVHR</td>
<td>NA</td>
</tr>
<tr>
<td>Heniford et al.15 2003</td>
<td>Prospective and retrospective data collection</td>
<td>850 (850/0)</td>
<td>4.7</td>
<td>13.2</td>
<td>20.2</td>
</tr>
<tr>
<td>McGrew et al.16 2003</td>
<td>Prospective cohort study</td>
<td>136 (71/65)</td>
<td>NA</td>
<td>21 OVHR/8 LVHR</td>
<td>1</td>
</tr>
<tr>
<td>Lomanto et al.17 2006</td>
<td>Prospective cohort study</td>
<td>100 (50/50)</td>
<td>10 OVHR/2 LVHR</td>
<td>30 OVHR/24 LVHR</td>
<td>21</td>
</tr>
<tr>
<td>Current study</td>
<td>Prospective data retrospective analysis</td>
<td>360 (233/127)</td>
<td>9 OVHR/13 LVHR</td>
<td>15 OVHR/7 LVHR</td>
<td>36 OVHR/30 LVHR</td>
</tr>
</tbody>
</table>

**Abbreviations:** LVHR, laparoscopic ventral hernia repair; NA, not available; OVHR, open ventral hernia repair.
higher rate of outpatient surgery in the laparoscopic group than in the open group was associated with a shorter mean length of stay (mean ± SD length of stay, 0.9 ± 1.4 days vs 1.4 ± 2.0 days, respectively; P = .01).

The power to detect the observed differences between operation type (open vs laparoscopic) with regard to the prevalence of complications, seroma, and abscess (Table 2) assuming the sample sizes of 233 patients in the open group and 127 patients in the open group, 2-sided tests of the equality of binomial proportions, and a significance level of P < .05 was 53%, 63%, and 35%, respectively.

**COMMENT**

Ventral incisional hernias are common, and controversy still exists as to the best method for surgical repair. To our knowledge, no large randomized, multicenter trial has been completed to date, although 1 systematic review of the best available studies was published in 2004. Until data from ongoing trials are published, smaller trials and cohort studies represent the available evidence. Some of these studies are summarized in Table 4. Our study provides an additional experience with a large patient population and a relatively long follow-up.

The systematic review performed under the auspices of the Royal Australasian College of Surgeons Australian Safety and Efficacy Register of New Interventionsal Procedures–Surgical and other recent studies demonstrated clear differences in the length of hospital stay, the operating room supply cost, and the total hospital cost between laparoscopic and open ventral incisional hernia repair. They found that for the laparoscopic surgery groups, the hospital stay was significantly shorter, the instrument cost was significantly higher, and the overall cost was significantly lower. The complication rates and recurrence rates, however, revealed large variations without a clear difference between the open and laparoscopic methods.

Our study used the Clavien classification of complications to account not only for the occurrence of a complication but also for the severity. Using this classification, our data suggest that more severe complications occurred in patients undergoing open ventral hernia repair, whereas seromas were more frequently noted in patients undergoing laparoscopic repair. The most significant predictor for complications appeared to be preexisting pulmonary disease. When adjusted for pulmonary disease in a logistic regression model, the major complication rates remained significantly different between the 2 operative methods. The study did not have enough statistical power to examine any correlation between mesh type and the complication rate.

Previous studies described obesity as a risk factor for the development of ventral incisional hernias as well as a risk factor for recurrence and complications. Our analysis revealed that patients with a BMI higher than 30 had a risk of recurrence 5 times higher compared with that in patients with a BMI lower than 25. The high BMI combined with a relatively long follow-up may have contributed to our recurrence rates, which were at the upper end of the reported spectrum.

Besides the mean length of stay, we evaluated the frequency with which the ventral hernia repair can be performed as an outpatient procedure. The laparoscopic patient group required significantly fewer inpatient admissions, a finding that may be explained by better pain control or faster recovery from operative trauma, as suggested by others.

In summary, this study confirms that laparoscopic ventral incisional intraperitoneal onlay mesh hernia repair is associated with less severe complications, equivalent recurrence rates, and shorter hospital stays when compared with open repair. It further validates the use of the laparoscopic approach.

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**Author Contributions:** Study concept and design: Bingener and Sirinek. Acquisition of data: Bingener, Buck, and Richards. Analysis and interpretation of data: Bingener, Buck, Michalek, and Schwesinger. Drafting of the manuscript: Bingener and Buck. Critical revision of the manuscript for important intellectual content: Bingener, Richards, Michalek, Schwesinger, and Sirinek. Statistical analysis: Richards and Michalek. Study supervision: Bingener and Sirinek.

**Financial Disclosure:** Dr Bingener has received educational grants from Davol, Inc, Gore, Inc, and US Surgical Corp.

**Previous Presentation:** This study was presented at the 114th Scientific Session of the Western Surgical Association; November 14, 2006, Los Cabos, Mexico. The discussions that follow this article are based on the originally submitted manuscript and not the revised manuscript.

**REFERENCES**


Mark Talamini, MD, San Diego, Calif: The small incisional hernia repairs are pretty straightforward. But, the folks with large complex defects present a huge challenge, as we all know. There aren’t many areas in surgery where the variation across the country is as great as this. The same patient could go to one surgeon and get a primary repair, a second surgeon and get a laparoscopic repair, a third surgeon and get a complex plastic surgical procedure was done, meaning they changed from using permanent mesh to absorbable mesh, then the patient was excluded. So, if the trend regarding minimally invasive surgery continues, hopes there will be fewer and fewer large incisional hernias that need to be repaired. But, this is certainly not a problem that is going to go away. How do you predict we will be repairing these large defects in 10 years, in 2016? Dr Bingener: Relative to follow-up, it would have been nice to have the opportunity to examine everybody yearly and make sure that there was no evidence of recurrence. We didn’t have that luxury. This retrospective analysis of our database and interpretation has inherent limitations.

We worked on the assumption that because the institution that we work in has a large amount of indigent patients who were hospitalized under the auspices of a special county-based insurance system, that they are ours and they won’t go away. We know it was a weakness not to follow the patients prospectively.

We did not assess our outcomes over time, although that would be important and interesting to do. And, I presume that the mesh experience over time would very much fall into the same category.

The presence of pulmonary disease seems to be more important than cardiac assessment. So, I think it is important to look at that. We have not looked at it now, but I think it is very important to assess pulmonary function.

We just did not have enough statistical power to look at the types of mesh and the complication rate, because many surgeons have a gut feeling about this or that mesh being more likely to have a recurrence or more likely to have an infection. We do not use biologic meshes for elective hernia repairs that have that risk. That is one of the things we don’t use. And, it has changed over time, the kinds of mesh we use, because we have seen recurrence. But, we don’t have really good data saying, okay, this mesh is clearly worse and we have to use the other one.

Regarding the future of hernia surgery, we were actually surprised to see the large amount of trocar-site hernias that develop into large hernias even from laparoscopic cholecystectomy. And, I think that is much related to obesity. I think that one of the driving factors of hernias, maybe more than the size of the hernia, is obesity. So, that is one of the things to watch.

Raymond J. Joehl, MD, Chicago, Ill: You excluded patients who had bowel resection. Did you analyze your results based on wound class? How many were clean cases or clean-contaminated cases?

Second, you included incarcerated hernia patients, and I am curious about those who presented for scheduled or elective repair. Did you use bowel preparation in patients having a scheduled or elective repair? Did bowel preparation reduce the risk of wound infection?

Another technical question, did you routinely use transfixation sutures to stabilize the mesh in the laparoscopic hernia group? And in the open group, as Dr Talamini suggested, there are many surgical techniques available to repair ventral hernias. Many general surgeons now use a component part separation technique. Was this technique used as an adjunct in any of your open repairs?

Lastly, have you looked at associated factors that may predict those patients who are likely to recur? Specifically, did you find more recurrences in those hernia repairs that about the pubis or the inguinal ligament or the costal margin? If you included laparoscopic repair of those types of hernias, how did you fix the mesh to bony or cartilaginous landmarks?

Dr Bingener: As far as our exclusion criteria, we included cases that were electively clean cases at the beginning. We did not look specifically if there was any tear or possible extravasation of bowel material during the procedures as far as 1 of the factors for our analysis. If that changed the way the procedure was done, meaning they changed from using permanent mesh to absorbable mesh, then the patient was excluded. So, I presume that the high majority of our patients all had clean ones. We didn’t specifically look at that.
There is a difference in surgeon preferences regarding bowel preparation. There are some surgeons in our group who use bowel preparation on almost every hernia they do, on every large hernia they do, and others who don’t use it at all. We don’t have any factors predicting that this is going to be better or worse.

We used transfixation sutures routinely in all patients. They were usually in the 4 corners, and if the mesh was very large, then some sutures in between the corners.

The component separation technique is being used in our institution. But, we excluded that because we wanted to make sure we had similar hernia repair techniques that we were comparing. We know that we didn’t analyze half of the hernia repairs that were done in our institution, but we wanted to compare apples to apples as much as possible.

And then the question of the location of the hernia, I think, is very important. We didn’t look specifically at that. There are many reports addressing how to do that, drilling holes in the pubis or using fibrin glue to attach it under the costal margin to avoid piercing the rib cage and lungs, anything like that. I am not sure that anybody has good data on saying this is better and this is how you do it. We certainly don’t.

Michael B. Farnell, MD, Rochester, Minn: It appeared from your comments and from your technique slides that your repair results in mesh being in contact with either the omentum or the intestine. I presume some of these patients had a permanent, porous mesh such as Prolene [Ethicon, Inc, Piscataway, NJ] employed. If so, did you experience a problem with fistula formation? If not, would you comment on why not?

Dr Bingener: In intraperitoneal onlay mesh repair, either omentum or bowel will be close by. That is the reason why the large majority, over 50%, had a PTFE [polytetrafluoroethylene]-based mesh and then another 20% PTFE plus a combination of polypropylene. The smaller amount of meshes that were used was polypropylene-based mesh.

We have actually looked in the past at our experience looking for adhesions between polypropylene and PTFE and haven’t found a large amount of difference between the 2 of them. It is not our preference to use, but some surgeons used it because it was cheaper.

We haven’t found fistula formation. Our population is very obese. So, there is a lot of omentum in between the mesh and the intestine and that may be a factor.

Financial Disclosure: Dr Talamini has been a lecturer for Olympus, Inc, a participant in a surgical alumni dinner sponsored by Stryker, Inc, a consultant for Ethicon, Inc, and a participant in a visit to Intuitive Surgical, Inc.