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ORIGINAL ARTICLE

Observational Study

Long term recurrence, pain and patient satisfaction after ventral hernia mesh repair

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Abstract

AIM: To compare long term outcomes of laparoscopic and open ventral hernia mesh repair with respect to recurrence, pain and satisfaction.

METHODS: We conducted a single-centre follow-up study of 194 consecutive patients after laparoscopic and open ventral hernia mesh repair between March 2000 and June 2010. Of these, 27 patients (13.9%) died and 12 (6.2%) failed to attend their follow-up appointment. One hundred and fifty-three (78.9%) patients attended for follow-up and two patients (1.0%) were interviewed by telephone. Of those who attended the follow-up appointment, 82 (52.9%) patients had received laparoscopic ventral hernia mesh repair (LVHR) while 73 (47.1%) patients had undergone open ventral hernia mesh repair (OVHR), including 11 conversions. The follow-up study included analyses of medical records, clinical interviews, examination of hernia recurrence and assessment of pain using a 100 mm visual analogue scale (VAS) ruler anchored by

word descriptors. Overall patient satisfaction was also determined. Patients with signs of recurrence were examined by magnetic resonance imaging or computed tomography scan.

RESULTS: Median time from hernia mesh repair to follow-up was 48 and 52 mo after LVHR and OVHR respectively. Overall recurrence rates were 17.1% after LVHR and 23.3% after OVHR. Recurrence after LVHR was associated with higher body mass index. Smoking was associated with recurrence after OVHR. Chronic pain (VAS > 30 mm) was reported by 23.5% in the laparoscopic cohort and by 27.8% in the open surgery cohort. Recurrence and late complications were predictors of chronic pain after LVHR. Smoking was associated with chronic pain after OVHR. Sixty point five percent were satisfied with the outcome after LVHR and 49.3% after OVHR. Predictors for satisfaction were absence of chronic pain and recurrence. Old age and short time to follow-up also predicted satisfaction after LVHR.

CONCLUSION: LVHR and OVHR give similar long term results for recurrence, pain and overall satisfaction. Chronic pain is frequent and is therefore important for explaining dissatisfaction.

Key words: Female; Ventral/surgery; Herniorrhaphy/methods; Laparoscopy; Male; Pain; Patient satisfaction; Postoperative complications/epidemiology; Recurrence; Hernia

Core tip: This is an observational and retrospective study of laparoscopic and open ventral mesh repair involving both incisional and non-incisional hernias. The principal outcome measures were recurrence, abdominal pain and satisfaction. Of the original cohort of 194 patients, 153 patients (78.9%) were examined individually with a mean follow-up period of 51 mo. Our results demonstrate an overall recurrence rate of 16.1% and we discuss the potential reasons. Excluding clinical recurrence, 13.7% suffered from chronic pain and 55.3% were satisfied with the outcome. Laparoscopic and open ventral mesh repair are comparable with respect to outcome measures.

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INTRODUCTION

Benefits and pitfalls[1] have been documented for both the mesh-reinforced open and laparoscopic approaches to incisional and ventral hernioplasty. Most papers suggest that laparoscopic ventral hernia mesh repair (LVHR) results in a shorter hospital stay, fewer wound complications and better cosmetic results compared to open ventral hernia mesh repair (OVHR)[2]. Favourable outcome of hernia surgery is often measured by the absence of recurrence and pain[3]. Chronic pain due to sensations of stiffness and foreign body reaction to the mesh, are adverse effects of mesh implantation[4,5]. Recurrence rates after LVHR and OVHR vary considerably and are related to surgical methods and skills, patient characteristics and length of follow-up[6]. The recurrence rate appears to reach peak incidence level after two years, with only small additional recurrences appearing later on[7].

The purpose of the present follow-up study was to compare laparoscopic and open mesh repair for incisional and non-incisional hernias in terms of complications, recurrence, pain and patient satisfaction with the outcome. As the study is of explorative character, no adjustments were made for multiple hypothesis testing.

MATERIALS AND METHODS

We conducted a follow-up study of all patients undergoing mesh repair for incisional and non-incisional hernia at Akershus University Hospital, Norway between March 2000 and June 2010. Follow-up examinations were carried out by one surgeon and one study nurse. Data from medical records and clinical examinations were recorded. The recorded hernia operation is referred to as the index mesh repair.

We enrolled 194 consecutive patients, of whom 94 had been treated with laparoscopic mesh repair and 100 with open mesh repair including 11 conversions. Of these, 27 patients had died and 12 patients failed to attend their follow-up appointment without providing an explanation. There was no significant difference between the patient characteristics of eligible and non-eligible patients. One hundred and fifty-three patients attended their follow-up appointment and two patients were interviewed by telephone. Of the patients who attended their follow-up appointment, 82 (52.9%) had received a laparoscopic mesh repair while 73 (47.1%) patients had undergone open mesh repair, including 11 conversions from laparoscopic surgery due to intestinal injuries or technical problems (Figure 1). These 11 patients are included under open surgical procedures in tables and text, *i.e.,* as per protocol. The patients were examined at various points after surgery as presented in Table 1. Median follow-up was 48 mo (9-88 mo) after LVHR and 52 mo (12-115 mo) after OVHR. Comorbidity was classified according to Charlson[8].

Postoperative complications were classified according to Dindo *et al*[9]. Postoperative complications were recorded as minor (Clavien Ⅰ + Ⅲa) or major (Clavien Ⅲb + Ⅳ).

Late complications (> 30 d after surgery) were recorded using medical records.

Pain was assessed by a 100 mm visual analogue

Table 1 Patient and hernia characteristics (n = 155)

Characteristics	Laparoscopic	Open	*P* value
Age (yr), mean ± SD	56.5 ± 14.9	57.2 ± 11.6	0.76
Gender: Male	34 (41.5)	34 (46.6)	0.52
BMI (kg/m^2), mean ± SD	30.7 ± 6.2	29.7 ± 5.3	0.29
ASA class			0.64
I	13 (15.9)	13 (17.8)	
II	62 (75.6)	55 (75.3)	
III	7 (8.5)	5 (6.8)	
Charlson index score			0.41
Score 0	25 (30.5)	16 (21.9)	
Score 1	14 (17.1)	19 (26.0)	
Score 2	16 (19.5)	19 (26.0)	
Score 3	16 (19.5)	12 (16.4)	
Score 4, 5, 6	11 (13.4)	7 (9.6)	
Type of co-morbidity			0.64
Hypertension/congestive heart disease	23 (28.0)	19 (26.0)	
[3]COPD	16 (19.5)	12 (16.4)	
Diabetes	5 (6.1)	5 (6.1)	
Neurological disease	2 (2.4)	1 (1.4)	
Multimorbid	0	3 (4.1)	
Miscellaneous	8 (9.8)	10 (13.7)	
Smoking	28 (34.1)	26 (35.6)	0.85
Hernia type			0.96
Incisional	66 (80.5)	59 (80.8)	
Non-incisonal	16 (19.5)	14 (19.2)	
Recurrent hernia	15 (18.3)	13 (17.8)	0.94
Hernia area (cm^2) ± SD	57.5 ± 56.9	44.9 ± 52.9	0.17
[1]Incsional hernia			0.41
Small/medium < 70 cm^2	44 (67.7)	41 (74.5)	
Large ⩾ 70 cm^2	21 (32.3)	14 (25.5)	
[2]Non-incisonal hernia			0.003
Small/medium < 13 cm^2	6 (40.0)	13 (92.9)	0.06
Large ⩾ 13 cm^2	9 (60.0)	1 (7.1)	
Hernia location			0.40
Midline	74(90)	67 (92)	
Others	8 (10)	6 (8)	
Mesh size (cm^2), mean ± SD	235.1 ± 113.4	184.5 ± 124.3	0.03
Follow up (mo), median, range	48 (9-88)	52 (12-115)	0.006

[1]Missing value in laparoscopic group, 4 patients: Missing values in open group; [2]Missing value; laparoscopic group; [3]Chronic obstructive pulmonary disease. Data are numbers with percentages in brackets unless otherwise indicated.

scale (VAS) ruler anchored by word descriptors at each end to calculate the patient's impression of pain[10]. Chronic pain was defined as pain above 30 mm in the last 30 d[11]. During the examination, we asked about maximum abdominal wall pain in the last 30 d, and maximum abdominal wall pain associated with sedentary and moderate physical activities like climbing stairs, outdoor walking, gardening. The clinical examination focused on pain by palpating the abdominal wall in nine areas (Figure 2). Duration of surgery was divided into two categories by the median in each surgical group.

Hernia characteristics

We adopted the classification by Muysoms *et al*[12] which distinguishes between non- incisional and incisional hernias and which classifies recurrent hernias of any origin as incisional. Hernia area was calculated by the formula: p/4 × A × B, where A and B are the two diagonals. Due to small numbers of patients in the small-sized non-incisional and incisional categories, we constructed a small and medium sized hernia group and a large sized hernia group in both categories. Incisional hernia size was categorised into ordinal variables as small/medium sized (< 70 cm^2) and large sized hernias (⩾ 70 cm^2). Non-incisional hernia size was categorised into ordinal variables as small/medium sized (< 13 cm^2) and large sized hernias (⩾ 13 cm^2) (Table 1). Hernia locations were defined by sectoral mapping of the abdominal wall[13].

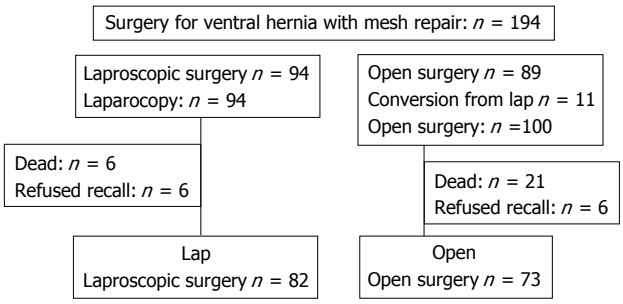

Figure 1 Consort diagram.

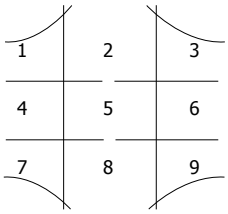

Figure 2 Sectoral map of the abdominal wall.

Operative technique

The types of surgical approach and mesh selected were based on the surgeon's preferences and experience. In laparoscopic mesh repair, the access to the abdominal cavity was established with open introduction of a 12 mm trocar. Capnoperitoneum was established with a pressure of 12 mmHg. Two or three additional abdominal trocars, 5 or 10 mm, were positioned on the surgeon's side or on the contralateral side if appropriate. Adhesions were detached with scissors and occasionally with LigaSure® or ultracision. Fatty tissue on the inner abdominal wall was removed. The hernia sac was not routinely removed. The defect was measured. The mesh was introduced through the 12 mm trocar and placed over the defect with a minimum of 5 cm hernia overlap using tacks or transfacial non-absorbable sutures according to the surgeon's preferences. The mesh did not necessarily cover the entire scar with a 5 cm overlap.

In open mesh repair, the incision was made over the hernia thus exposing the hernia content. The hernia sac was removed if possible. The peritoneum or posterior rectus sheet was dissected from the rectus muscle. The posterior sheet was not routinely closed with running absorbable sutures. The mesh was anchored in a retromuscular position with running non-resorbable trans-

Table 2 Perioperative characteristics (n = 155)

	Laparoscopic	Open	*P* value
Operative time, min, mean ± SD	117 ± 54	92 ± 44	0.002
Emergency hernia operation	0	12 (16.4)	
Preoperative antibiotics	30 (36.6)	33 (45.8)	0.24
Postoperative antibiotics	12 (14.6)	17 (23.3)	0.17
Postoperative stay, d, median (IQR)	2 (1-3)	2 (1-4)	0.67
No. of trocars, median (range)	3 (3-6)	-	-
No. of tackers	28 (10-70)	-	-
Mesh types			
Polypropylene	0	27 (38.0)	
Marlex	0	7 (9.9)	
Bard composix	20 (25.0)	5 (7.0)	
Parietex composite	39 (48.8)	9 (12.7)	
Proceed	7 (8.8)	1 (1.4)	
TiMESH	2 (2.5)	1 (1.4)	
Unknown	0	6 (8.5)	
Unknown	0	6 (8.5)	

Data are numbers with percentages in brackets unless otherwise indicated. IQR: Interquartile range.

facial sutures and seeking to achieve a 5 cm overlap. The anterior rectus sheet was not routinely closed. Neither intraperitoneal onlay mesh technique with Kugel patch nor mesh plug repair was applied. For small umbilical and epigastric hernias, the mesh was placed as described, but with minor modifications. Drains were used as per the surgeon's preferences. Adhesions were graded according to Mazuji *et al*[14]. In the OVHR cohort, the adhesion score could not be established due to deficient reporting.

For the purpose of examining the association between intraperitoneal adhesions and complications, the grading was dichotomised into adhesions involving, or not involving, the intestine.

Recurrence

Clinical recurrence was determined at follow-up by physical examination and was defined as a detectable gap in the abdominal wall with or without bulging of viscera. Patients with signs of clinical recurrence were intentionally examined by magnetic resonance imaging or computed tomography scan. There were three false positive cases, two after OVHR and one after LVHR. Four patients with clinical recurrence, did not attend for radiology examination. Information received of ventral hernia mesh repair after the index operation was registered as recurrence. Overall recurrence was therefore defined as clinical recurrence, corrected for false positive cases together with information of ventral hernia mesh repair after the index operation.

Statistical analysis

The analysis was performed on a per protocol basis. Data in text and tables are given as mean ± SD, median (minimum-maximum) and frequency (percentage), as appropriate. For postoperative stay, we have chosen interquartile range instead of standard deviation due to some instances of extreme values[15]. Categorical variables were compared by the χ^2-test and the Fisher exact test as appropriate. Comparison of continuous variables was performed using Student's *t*-test. Non-parametric variables were handled and comparisons of median values were performed using the Mann-Whitney *U*-test and the Median test. Variables associated with postoperative complications, hernia recurrence, pain and overall satisfaction at the $P < 0.1$ level in bivariate analyses, were included in multivariate logistic regression models. The results were presented as odds ratios (ORs) with a 95%CI estimated by a multivariate model unless otherwise stated. All tests were two-tailed with a significance level of 0.05. The analyses were performed using the SPSS version 22 (SPSS Inc., Chicago, IL United States).

RESULTS

Patient and hernia characteristics are presented in Table 1. The groups were similar with regard to age, gender, body mass index (BMI), comorbidity and smoking habits. Thirty-four point eight percent of the patients were smokers, 18.1% had chronic obstructive pulmonary disease (COPD) or asthma and 27.1% had hypertension and/or congestive heart disease. The observation time after open surgery was longer than after laparoscopic surgery. Laparoscopic surgery was more time-consuming compared to open hernia mesh repair (P = 0.002) (Table 2). There were 18 (22.0%) minor and seven (8.5%) major complications after LVHR and 22 (30.1%) minor and eight (11.0%) major complications after OVHR (P = 0.39) (Table 3). Six patients had two types of complications. Prolonged operative time was associated with an increased rate of minor complications after LVHR (P = 0.02), but not after OVHR (P = 0.28). Wound infection (P = 0.05, OR = 2.74, 95%CI: 0.99-7.65) and seroma (P = 0.01, OR = 3.65, 95%CI: 1.25-10.72) were more pronounced after OVHR. In the LVHR cohort, operative time > 108 min. was a predictor for postoperative complications in the crude model (OR = 3.96, 95%CI: 1.44-10.9). The presence of intraperitoneal adhesions involving the intestine (OR = 3.0, 95%CI: 1.1-8.2) or incisional hernias (OR = 8.4, 95%CI: 1.0-67.9) was a predictor for postoperative complications only in the crude model. In the OVHR cohort, large incisional hernias were not associated with postoperative complications in general (OR = 1.71, 95%CI: 0.46-6.32). In multivariate analysis only prolonged operative time was a predictor of postoperative complications ($P < 0.03$, OR = 1.02, 95%CI: 1.00-1.04) (Table 3). The need for postsurgical intervention was not different between the two groups (P = 0.58).

Recurrence

We discriminated between clinical recurrence and overall recurrence at follow-up. Ten patients had surgery for recurrence in the follow-up period, six of these had no recurrence at follow-up. The frequency of recurrence judged clinically, was 10 (12.2%) after LVHR and 15 (20.5%) after OVHR. Information received of hernia

Table 3 Perioperative, postoperative and late complications

	Laparoscopic	Open	*P* value
Postoperative complications - grading			0.39
Minor (Ⅰ - Ⅲa)	18 (22.0)	22 (30.1)	
Major (Ⅲb-Ⅳ)	7 (8.5)	8 (11.0)	
Postoperative complications - type			0.17
Wound infection	6 (7.3)	13 (17.8)	0.05
Seroma	5 (6.1)	14 (19.2)	0.02
Deep infection	1 (1.2)	1 (1.4)	
Pneumonia	2 (2.4)	1 (1.4)	
Unclassified infection	3 (3.7)	4 (5.5)	
Subcutaneous bleeding	4 (4.9)	2 (2.7)	
Substantial pain	6 (7.3)	3 (4.1)	
Others	2 (2.4)	2 (2.7)	
Intraoperative complications - type			0.14
Enterotomy	0	4 (5.5)	
Colotomy	1 (1.2)	0	
Late complications - type			0.24
Subileus/ileus	3 (3.7)	0	
Deep infection	1 (1.2)	2 (2.7)	
Substantial pain	4 (4.9)	3 (4.1)	
Hematoma	0	1 (1.4)	
Seroma	4 (4.9)	2 (2.7)	
Wound infection	1 (1.2)	4 (5.5)	
Others	-	2 (2.7)	

Data are numbers with precentages in brackets unless otherwise indicated.

surgery for recurrence after the index mesh repair, confirmed an overall recurrence rate of 14 (17.1%) after LVHR and 17 (23.3%) after OVHR (*P* = 0.33) (Table 4). In univariate analysis, hernia size, BMI, numbers of trocars and length of postoperative stay were associated with recurrence (Table 5). Variables thought of as confounders, namely gender, age, BMI and COPD, were adjusted for in multivariate analysis. There was no difference between incisional and non-incisional hernias with respect to recurrence. In the multivariate model, BMI, number of trocars and length of postoperative stay were independent predictors of recurrence (Table 6). In the OVHR cohort, univariate analysis showed that smoking, postoperative complications in general and length of postoperative stay were factors associated with recurrence (Table 7). In multivariate analysis, only smoking (OR = 4.18, 95%CI: 1.22-14.38) was an independent predictor of recurrence in the crude and adjusted model (Table 8). Gender, BMI and COPD did not change the associations. Wound infection and seroma were not factors associated with recurrence.

Pain

There was no difference in reported pain or pain on palpation between the two surgical groups, calculated with the adjustment factors of clinical recurrence, age, BMI, gender, chronic obstructive pulmonary disease (Table 9). Clinical recurrence was associated with maximum reported pain in both surgical cohorts, but only after LVHR during sedentary (OR = 5.78, 95%CI: 1.11-30.05) and physical activity (OR = 14.22, 95%CI: 1.75-116.05). Adjusting for clinical recurrence, BMI, age and COPD, it was found that after LVHR, female gender was associated with maximum reported pain (OR = 7.37, 95%CI: 1.36-39.85). In addition, young age and low BMI were factors associated with pain during sedentary and physical activity (Table 10). In the OVHR cohort, there was no association between pain and gender, age and BMI, but with hernia recurrence (OR = 18.04, 95%CI: 1.80-181.09) ($P < 0.05$). Among subjects without clinical recurrence, 13 patients (18.3%) *vs* eight patients (15.4%) experienced chronic pain in the LVHR and OVHR cohorts respectively (*P* = 0.53). In multivariate regression analysis, clinical recurrence (OR = 11.67, 95%CI: 2.00-68.24) and history of late complications (OR = 5.47, 95%CI: 1.11-27.09) were factors associated with chronic pain in the LVHR group (Table 11). Together with female gender, age, COPD and smoking (adjustment factors), these covariates could explain 41% of the variance on the dependent variable.

In the OVHR cohort smoking was associated with chronic pain in the crude model (OR = 3.85, 95%CI: 1.24-11.99) but not in the adjusted model (OR = 3.81, 95%CI: 0.95-15.34) (Table 12). In the whole model, clinical recurrence, female gender, postoperative complications, late complications and admission time, could only explain 30.7% of the variance on the dependent variable.

Patient satisfaction

Satisfaction among patients after hernia surgery was established by "yes/no" responses to whether they experienced abdominal wall pain or discomfort. Of 152 patients reporting their symptoms, 49 patients (60.5%) were satisfied with LVHR and 35 patients (49.3%) were satisfied with OVHR (*P* = 0.17). Absence of chronic pain (OR = 7.4, 95%CI: 1.43-38.46), age over 60 years (OR = 7.16, 95%CI: 1.37-37.42) at hernia surgery and shorter time to follow-up (OR = 1.83, 95%CI: 1.11-3.05) was associated with satisfaction after LVHR (Table 13). Absence of clinical recurrence was associated with satisfaction only in the crude model (OR = 7.81, 95%CI: 1.54-40.00). These covariates, including female gender and late complications, could explain 55.7% of the variance on the dependent variable. In the OVHR cohort, no clinical recurrence (OR = 20.00, 95%CI: 2.15-200.00) and absence of chronic pain (OR = 5.56, 95%CI: 1.24-25.00) were associated with satisfaction (Table 14). Covariates, including admission time and late complications, could explain 45.7% of the variance on the dependent variable.

DISCUSSION

In the present study, patients who had undergone open mesh repair experienced a higher frequency of wound complications compared to the laparoscopic group, thus supporting previous studies[2]. The higher frequency of enterotomy in the open surgery group is due to perioperative bowel injuries during laparoscopy, and conversion to open surgery. There were, however, no differences between the two groups witch regard

Table 4 Overall recurrence after hernia surgery

	Recurrence LVHR		Recurrence OVHR		*P* value
	No	Yes	No	Yes	
Clinical recurrence[1]	72 (87.8)	10 (12.2)	58 (79.5)	15 (20.5)	
Hernia surgery after index mesh repair[2]	-	4 (4.9)	-	2 (2.7)	
Overall recurrence	14 (17.1)		17 (23.3)		0.33

[1]Correction for 3 false positive recurrences; [2]No detectable recurrence at follow up. Percentages are given in brackets. OVHR: Open mesh repair; LVHR: Laparoscopic mesh repair.

Table 5 Predictors for overall recurrence after laparoscopic mesh repair univariate analysis

	Yes	No	*P* value
Gender male/female	7/7	27/41	0.48
Age at hernia surgery; yr; mean ± SD	52 ± 14	57 ± 15	0.24
Period of follow-up, mo ± SD	46 ± 15	46 ± 17	0.94
Charlson index			0.79
0	6 (24.0)	19 (76.0)	
1	2 (14.3)	12 (85.7)	
2	2 (12.5)	14 (87.5)	
3	3 (18.8)	13 (81.3)	
4, 5, 6	1 (9.1)	10 (90.9)	
COPD	3 (18.8)	13 (81.3)	0.84
Smoking	5 (17.9)	23 (82.1)	0.89
BMI (kg/m^2); mean ± SD	34 ± 6	30 ± 6.0	0.05
BMI (kg/m^2); (%) 18.5-24.9	1 (8.3)	11 (92.7)	0.38
BMI (kg/m^2); (%) 25.0-29.9	3 (12.0)	22 (88.0)	
BMI (kg/m^2); (%) 30.0-39.9	10 (22.2)	35 (77.8)	
Hernia type			0.59
Incisional	12 (18.2)	54 (81.8)	
Non-incisional	2 (12.5)	14 (87.5)	
Recurrent hernia	2 (13.3)	13 (86.7)	0.67
Hernia area, cm^2, mean ± SD	80 ± 58	53 ± 56	0.11
Hernia area, both types < 58 cm^2	5 (9.8)	46 (90.2)	0.04
Hernia area, both types ⩾ 58 cm^2	8 (27.6)	21 (72.4)	
Incisional hernia area < 70 cm^2, *n*[1]	6 (13.6)	38 (86.4)	0.15
Incisional hernia area ⩾ 70 cm^2, *n*	6 (28.6)	15 (71.4)	
Non-incisonal hernia area < 13 cm^2, *n*	0	6	0.40
Non-incisonal hernia area ⩾ 13 cm^2, *n*	1 (11.1)	8 (88.9)	
No. of trocars, median, (range)	4 (3-6)	3 (3-5)	< 0.001
Operative time, min, mean ± SD	142 ± 63	112 ± 51	0.07
Postoperative stay, d, mean ± SD	4 ± 4	2 ± 1	0.001
Preop antibiotics	8 (26.7)	22 (73.3)	0.08
Surgeons experience			0.69
Less experient	7 (15.6)	38 (84.4)	
Experient	7 (18.9)	30 (81.1)	
Mesh			0.47
Goretex	3 (25.0)	9 (75.0)	
Parietex	7 (17.5)	33 (82.5)	
Bard	3 (15.0)	17 (85.0)	
Other	0	9	
Postoperative complications	5 (20.0)	20 (80.0)	0.64
Postoperative antibiotics	3 (25.0)	9 (75.0)	0.43
Late complications	2 (15.4)	11 (84.6)	0.86
Hernia belt	11 (22.0)	39 (78.0)	0.14

[1]Missing value with recurrence; missing value without recurrence. Data are numbers with percentages in brackets unless otherwise indicated. COPD: Chronic obstructive pulmonary disease.

Table 6 Predictors for overall recurrence after laparoscopic mesh repair multivariate analysis adjusted model

	OR (95%CI)	*P* value
Hernia area[1]	5.55 (0.74; 41.47)	0.095
No. of trocars	4.32 (1.55; 12.05)	0.005
Operative time[2]	0.32 (0.03; 2.94)	0.313
BMI	1.21 (1.05; 1.41)	0.010
Postoperative stay	1.79 (1.10; 2.89)	0.018
Preop antibiotics	0.74 (0.12; 4.57)	0.742

[1]Hernia area < 58 cm^2 small, reference category > 58 cm^2 large; [2]Operative time < 108 min reference category. BMI: Body mass index; OR: Odds ratio.

Table 7 Predictors for overall recurrence after open mesh repair-univariate analysis

	Yes	No	*P* value
Gender male/female	9/8	25/31	0.55
Age at hernia surgery, yr, mean ± SD	57 ± 11	57 ± 12	1.0
Period of follow-up, mo ± SD	56 ± 26	57 ± 30	0.91
Charlson index			0.86
0	3 (18.8)	13 (81.3)	
1	6 (31.6)	13 (68.4)	
2	4 (21.1)	15 (78.9)	
3	3 (25.0)	9 (75.0)	
4, 5, 6	1 (14.3)	6 (85.7)	
COPD	3 (25.0)	9 (75.0)	0.88
Smoking	10 (38.5)	16 (61.5)	0.02
BMI, kg/m^2, mean ± SD	31 ± 6.0	29 ± 5.1	0.25
BMI (kg/m^2) (%)18.5-24.9	2 (20.0)	8 (80.0)	0.80
BMI (kg/m^2) (%) 25.0-29.9	5 (19.2)	21 (80.8)	
BMI (kg/m^2) (%) 30.0-39.9	10 (27.8)	26 (72.2)	
Emergency operation	3 (25.0)	9 (75.0)	1.0
Hernia type			1.0
Incisional	14 (23.7)	45 (76.3)	
Non-incisional	3 (21.4)	11 (78.6)	
Recurrent hernia	2 (15.4)	11 (84.6)	0.72
Hernia area, cm^2, mean ± SD	39 ± 56	47 ± 52	0.60
[1]Incisonal hernia area < 70 cm^2	11 (26.8)	30 (73.2)	0.48
Incisonal hernia area ⩾ 70 cm^2	2 (14.3)	12 (85.7)	
Non-incisonal hernia area < 13 cm^2	2 (15.4)	11 (84.6)	0.21
Non-incisonal hernia area ⩾ 13 cm^2	1	0	
Mesh area, cm^2, mean ± SD	186 ± 112	184 ± 131	0.97
Operative time, min, mean ± SD	97 ± 65	90 ± 36	0.56
Preop antibiotics	8 (24.2)	25 (75.8)	0.70
Surgeons experience			0.98
Less experient	6 (23.1)	20 (76.9)	
Modest experient	11 (23.4)	36 (76.6)	
Mesh			0.63
Goretex	4 (26.7)	11 (73.3)	
Polypropylene	5 (19.2)	21 (80.8)	
Unknown	0	6	
Other	5 (23.8)	16 (76.2)	
Postoperative complications	11 (36.7)	19 (63.3)	0.02
Seroma	5 (35.7)	9 (64.3)	0.22
Wound infection	4 (30.8)	9 (69.2)	0.48
Postoperative antibiotics	7 (52.9)	10 (47.1)	0.05
Late complications	5 (35.7)	9 (64.3)	0.22
Postoperative stay, d, mean ± SD	8 ± 19	2 ± 2	0.02
Hernia belt	5 (15.6)	27 (84.4)	0.54

[1]1 missing value with recurrence; 3 missing values without recurrence. COPD: Chronic obstructive pulmonary disease.

to overall postoperative complication rates and postoperative stay, which is somewhat surprising.

In the present study, the overall recurrence rates were 17.1% after laparoscopic mesh repair and 23.3% after open mesh repair (*P* = 0.33). The median time from

Table 8 Predictors for overall recurrence after open mesh repair-multivariate analysis adjusted model

	OR (95%CI)	*P* value
Smoking	4.18 (1.22; 14.38)	0.002
Postoperative complications	2.36 (0.49; 11.45)	0.287
Postoperative antibiotics	1.36 (0.25; 7.43)	0.722
Postoperative stay	1.18 (0.89; 1.57)	0.254

OR: Odds ratio.

hernia surgery to follow-up was only four months longer in the open mesh repair group and would probably have no impact on recurrence. Even though our recurrence rates were high after both LVHR and OVHR, the mean follow-up time was longer than in many other studies. The great variation of follow-up time among different studies could affect recurrence rates. There are also other factors to consider: Our study involved mandatory examination of all patients. Patients who report no symptoms of recurrence in mailed questionnaires can easily be misdiagnosed. Finally, we need to consider that relatively small numbers of patients are followed-up in some of the previously conducted studies[16].

A Cochrane review reported a recurrence rate of only 4.2% after open hernia mesh repair (15/326), but the follow-up time was relatively short (< 2 years in four of nine studies included)[1]. The review included both incisional and ventral hernia. Lauscher *et al*[17] reported a recurrence rate of 13.3% in 90 patients 18 mo after open incisional hernia mesh repair.

Comparing laparoscopic (n = 119) and open (n = 106) hernia mesh repair, a retrospective study from the Cleveland clinic, showed a 5-year recurrence rate of 28% in the open mesh repair group and 29% in the laparoscopic mesh repair group. There were both incisional and non-incisional hernias included[18]. Eker *et al*[16] reported recurrence rates of 14% and 18% after open and laparoscopic incisonal hernia repairs. They conducted a large randomized controlled multicentre trial with a mean follow-up period of 35 mo. Of 194 patients in our study, 146 (75%) completed the follow-up. There are very few studies with a follow-up longer than 5 years. It is suggested that the threshold for recurrence is 5 years after ventral hernia surgery[18].

The mechanisms underlying recurrence could be due to infection, lateral detachment of the mesh, inadequate mesh fixation, inadequate overlap and mesh shrinkage[19]. Schoenmacker reported a 7.5% shrinkage rate and no difference in recurrence after comparing one group with double crown of tacks to another group with tacks and sutures[20]. Another retrospective study reported a shrinkage rate of 6.7% after LVHR and the use of ePTFE (Dualmesh) with double crown fixation and sutures evaluated by CT scans[21]. In our laparoscopic group, there was no association between mesh/hernia area ratio and overall recurrence (P = 0.45). Smoking was a predictor for overall recurrence after OVHR both in the crude and the adjusted model. There was no association between smoking and overall recurrence after LVHR. The finding that smoking is a risk factor for developing incisional hernia after laparotomy is in accordance with Sorensen and others[22]. Smoking has also been found to be a risk factor for recurrence, after both open suture repair[23] and laparoscopic hernia mesh repair[24].

The rate of seroma was higher after OVHR, but was not associated with overall recurrence. For laparoscopic mesh repairs, increasing the number of trocars was associated with overall recurrence. Large hernia areas (> 58 cm^2) had more recurrences (P = 0.095), an observation which agrees with those of others[16]. After OVHR, postoperative complications in general were associated with overall recurrence only in the crude model.

Pain

We did not find any difference in abdominal pain between the cohorts. Clinical recurrence was a causative and predictive factor for pain after both LVHR and OVHR. Other factors also modulate the notion of pain, but could only be confirmed after LVHR. In our study it was found, that after adjusting for recurrence, female gender, low BMI and young age were all factors associated with higher levels of reported pain. This gender difference across different diseases, has recently been reported[25].

The use of tacks *vs* sutures or the number of tacks used, had no implication on abdominal wall pain in the laparoscopic group. Muysoms *et al*[26] reported more patients with abdominal wall pain (VAS > 10 mm) after sutures and tacks (31.4%) compared to tacks in a double circle shape (8.3%). This was registered three months after LVHR. Wassenaar *et al*[27] found no correlation between number of tacks and pain three months after LVHR.

The terms mild, moderate and severe pain have been discussed in several publications[10,19,28]. The cut-off value for differentiating between moderate and severe pain can differ among studies, but seems to be fairly consistent, particularly on the intercept between mild and moderate pain. This is also the case for the numerical rating scale[10]. Liang *et al*[30] looked at the relationship between chronic pain and other clinical characteristics in 122 patients after LVHR and found that 17.2% of the patients experienced chronic abdominal pain 24 mo after hernia surgery. He assessed patient experience on a 10-point numerical scale. Unfortunately, he did not specify the cut-off value on the numerical rating scale; only the patients' own rating. Eriksen *et al*[31] reported that less than 10% had VAS pain scores > 5 six months after LVHR. Setting the cut-off value at 10 mm on the VAS, we found that 39.5% reported pain after LVHR and 43.1% after OVHR. The difference between our results and those reported by others, is their lack of precise criteria for the definition of chronic pain. Furthermore, there is great variation in the time from operation to clinical follow-up in many studies. Excluding recurrence, 13 patients (18.3%) and eight patients (15.4%) reported chronic pain after LVHR and

Table 9 Predictors for abdominal wall pain measured on the visual analogue scale in relation to type of hernia surgery

	Laparoscopic *n* = 81	Open *n* = 72	OR[1] (95%CI)	*P* value
Maximum pain reported, mean ± SD	16.7 (20.8)	18.6 (20.8)	1.40 (0.42-4.68)	0.58
Maximum pain on palpation, mean ± SD	12.9 (20.2)	12.1 (20.2)	0.78 (0.26-2.32)	0.66
Pain on average, mean ± SD	3.3 (10.3)	2.4 (6.4)	0.85 (0.49-1.47)	0.56
Pain during sedentary activities, mean ± SD	6.5 (17.9)	4.0 (15.4)	0.61 (0.31-1.22)	0.16
Pain during work activities, mean ± SD	9.8 (17.9)	7.7 (15.4)	0.68 (0.24-1.89)	0.46

[1]Referes LVHR. Factors adjusted for: Clinical recurrence, age categories, BMI categories, gender, COPD. LVHR: Laparoscopic mesh repair; COPD: Chronic obstructive pulmonary disease; BMI: Body mass index.

Table 10 Predictors for pain after laparoscopic mesh repair and open mesh repair

	Maximum pain OR (95%CI)[2]	Average pain OR (95%CI)[3]	Pain, sedentary OR (95%CI)	Pain, work OR (95%CI)
[1]	LVHR	LVHR	LVHR	
Gender	7.37[2] (1.4-39.9)	NA	NA	NA
Age	19.77[3] (3.4-115.5)	NA	3.71[3] (1.1-12.6)	7.04[3] (1.5-33.0)
BMI	14.56[4] (2.4-90.0)	5.03[4] (1.4-18.3)	7.24[4] (1.5-35.1)	9.73[4] (1.3-73.0)
COPD	NA	NA	NA	NA
Clinical recurrence excluded				
LVHR	32.04 (2.82-363.22)	NA	5.78 (1.11-30.05)	14.22 (1.75-116.05)
OVHR	18.04 (1.80-181.1)	NA	NA	NA

[1]Referes to LVHR when OVHR is excluded; [2]Referes male; [3]Referes age > 60; [4]Referes BMI > 30; Only significant values ($P < 0.05$) are presented. (1) Pain after LVHR and OVHR relative to gender, age, BMI, COPD. Adjusted for recurrence; and (2) pain after LVHR and OVHR relative to no clinical recurrence Factors adjusted for: Gender age, BMI, COPD, clinical recurrence. OVHR: Open mesh repair; LVHR: Laparoscopic mesh repair; COPD: Chronic obstructive pulmonary disease; BMI: Body mass index.

Table 11 Predictors for chronic pain after laparoscopic mesh repair-multivariate analysis (*n* = 81)

	OR (95%CI)	*P* value
Clinical recurrence	11.67 (2.00-68.24)	0.006
Late complications	5.47 (1.1-27.09)	0.037
Gender (referes female)	0.42 (0.10-1.98)	0.274
Age > 60 yr	0.23 (0.03-1.51)	0.125
COPD	2.39 (0.52-11.10)	0.265
Smoking	1.38 (0.37-5.11)	0.629

COPD: Chronic obstructive pulmonary disease; OR: Odds ratio.

Table 12 Predictors for chronic pain after open mesh repair-multivariate analysis (*n* = 71)

	OR (95%CI)	*P* value
Clinical recurrence	1.20 (0.24-6.06)	0.828
Smoking (crude model)	3.86 (1.24-12.00)	0.020
Smoking (adjusted model)	3.81 (0.95-15.33)	0.060
Hernia size > 70 cm^2	0.84 (0.13-5.53)	0.852
Gender (ref female)	0.30 (0.07-1.35)	0.116
Postoperative complications	3.59 (0.76-16.88)	0.106
Late complications	1.16 (0.20-6.87)	0.869
Postoperative stay	1.08 (0.75-1.57)	0.668

OR: Odds ratio.

Table 13 Predictors for satisfaction after laparoscopic mesh repair-multivariate analysis (*n* = 79)

	OR (95%CI)	*P* value
Chronic pain[1]	0.14 (0.03-0.70)	0.017
Age > 60 yr	7.16 (1.37-37.42)	0.020
Gender (ref female)	2.69 (0.72-10.05)	0.142
Time to follow up	0.55 (0.33-0.90)	0.019
Clinical recurrence (crude model)	0.13 (0.03-0.65)	0.013
Clinical recurrence (adjusted model)	0.13 (0.02-1.11)	0.062
Late complications	0.39 (0.07-2.23)	0.289

[1]Chronic pain at hard labour activities. OR: Odds ratio.

Table 14 Predictors for satisfaction after open mesh repair-multivariate analysis (*n* = 71)

	OR (95%CI)	*P* value
Chronic pain[1]	0.18 (0.04; 0.81)	0.025
Age > 60 yr	0.05 (0.01; 0.47)	0.008
Gender (ref female)	0.26 (0.05; 1.37)	0.111
Time to follow up	0.71 (0.49; 1.03)	0.073

[1]Chronic pain at hard labour activities. OR: Odds ratio.

OVHR respectively.

Satisfaction

Percent of 60.5 the patients were satisfied after LVHR and 49.3% after OVHR. Excluding clinical recurrence, 66.2% and 60.7% were satisfied after laparoscopic and open hernia surgery respectively, there being no other significant difference. Factors other than recurrence will therefore have an influence on patient satisfaction.

The equality of long term satisfaction rates between LVHR and OVHR has been confirmed by others[32]. Liang *et al*[30] used a 10-point numerical scale to assess satisfaction after laparoscopic ventral hernia repair. He set the cut-off value for satisfaction to $\geqslant 7$. In his study, 74.5% of patients were satisfied with the outcome. Chronic pain and recurrence were associated with reduced overall satisfaction.

In our study, absence of chronic pain was the most important factor for satisfaction after LVHR. Old age at hernia surgery also predicted satisfaction, while clinical recurrence was predictive only in the crude model. Longer follow-up was associated with discontent in our study and could be due to increased rate of recurrence, though this is not proven.

Chronic pain and clinical recurrence was associated with discontent after OVHR.

Eriksen *et al*[31] also found that pain was associated with dissatisfaction after laparoscopic ventral hernia repair ($P < 0.001$). They had however no recurrences. Gronnier *et al*[11] found that almost 83% were satisfied more than 2 years after open hernia mesh repair. A recurrence rate of 6.1% at the repair site could explain the higher rate of satisfaction compared to our results (20.5% recurrence rate/49.3% satisfaction rate).

There are obvious limitations to our study. The study population is relatively small and our retrospective analysis on the basis of medical records and the heterogeneity of ventral hernia type and location, calls for careful interpretation of results. The study does however also benefit from some clear advantages: Nearly 79% of the original cohort attended for examination at follow-up. Also, the study was conducted at a single institution with an established examination protocol, and interviews were conducted by a single experienced doctor.

In conclusion, there was no difference in long term recurrence, pain and overall patient satisfaction after open and laparoscopic mesh repair. We demonstrated a relatively high frequency of hernia recurrences. We could also demonstrate that the two techniques had different predisposing factors for recurrence. High BMI was the most important cause of recurrence after LVHR, while smoking was the most important factor after OVHR. Hernia recurrence is associated with more pain, but pain without recurrence is also quite frequent. The absence of chronic pain is the most important factor for patient satisfaction after ventral hernia surgery.

COMMENTS

Background

No precise data on the incidence and prevalence of non-incisional and incisional hernias are available, but the reported incidence rates for incisional hernia after laparotomy are between 9% and 20%; this represents one of the most common complications after abdominal surgery. Non-incisional and incisional hernias are treated with surgery for cosmetic reasons, but mainly to relieve pain and discomfort, prevent respiratory or skin problems and resolve incarceration or strangulation. The surgical and patient reported outcomes vary according to surgical skills and method, type and size of hernia, type of mesh and the length of follow-up. Patient characteristics are also important.

Research frontiers

The ultimate goal in ventral hernia surgery is to improve and restore the patients' quality of life. This is achievable with emphasis on the patients' reported outcomes. Surgical approach, mesh considerations and surgical outcome will benefit from well designed studies with sufficiently long follow-up and examination of all participants.

Innovations and breakthroughs

This is the first report from Norway that compares the outcome of laparoscopic and open ventral hernia mesh repair. It is a retrospective observational study with a mixture of non-incisional and incisional hernias, but the authors were able to examine nearly 80% of the original cohort and 92% of those that were still alive at long-term follow up.

Applications

The results presented in this study confirm that laparoscopic and open mesh repair involve complications and pitfalls that put significant demands on surgical skills. The recurrence rate could most likely be lowered in the hands of experts. The selection of patients for open or laparoscopic repair could also benefit from surgical skills of a high standard and better knowledge of the many aspects of hernia disease.

Terminology

The term ventral hernia often refers to a primary hernia which has not been caused by earlier surgery. The authors use the term to refer to both incisional and non-incisional hernias located in the anterior abdominal wall.

Peer-review

This single-centre study has undergone peer-review by colleagues with a science background both at preparation stage and during the follow-up examinations. The results were discussed and revised internally throughout this process.

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