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Laparoscopic repair of primary and incisional ventral hernias: the differences must be acknowledged

A prospective cohort analysis of 1,088 consecutive patients

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Abstract
Background Interpretation of the outcome after laparoscopic repair (LR) of ventral hernias presented in the literature often is based on pooled data of primary ventral hernias (PVH) and incisional ventral hernias (IVH). This prospective cohort study was performed to investigate whether this pooling of data is justified.
Methods The data of 1,088 consecutive patients who underwent LR of PVH or IVH were prospectively collected and reviewed for baseline characteristics, operative findings, and postoperative complications classified as Clavien grade 3 or higher.
Results The PVH group consisted of 662 patients, and the IVH group comprised 426 patients. The mean Association of American Anesthesiologists classification was higher in IVH group (1.92 vs 1.68; $P \leq 0.001$), as was rate of conversion to open surgery (7 vs 0.5 %; $P < 0.001$). The IVH group required more adhesiolysis (76 vs 0.9 %; $P < 0.001$), a longer procedure (73 vs 42 min; $P < 0.001$), and a longer hospital stay (4.53 vs 2.43 days; $P < 0.001$). The recurrence rate was higher in the IVH group (5.81 vs 1.37 %; $P < 0.001$), as was total complication rate (18.69 vs 4.55 %; $P < 0.001$).
Conclusions This study showed significant differences in baseline characteristics and operative findings between patients undergoing PVH repair and those undergoing IVH repair. Continued pooling of data on LR of IVH and PVH combined, commonly found in the current literature, seems incorrect.

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Primary ventral hernia (PVH) and incisional ventral hernia (IVH) of the abdominal wall are considered to be separate entities due to a different etiopathology, and the European Hernia Society has formulated separate classification systems for these two entities [1]. Interestingly, the outcome and results of laparoscopic repair (LR) of PVH and IVH have consistently been pooled together in case series and randomized clinical trials (RCTs) [2–9]. Even recent systematic reviews and metaanalysis comparing laparoscopic and open hernia repair have included RCTs that analyzed a mix of PVH and IVH in the LR group [10–12].

In this prospective cohort study, we compared baseline characteristics, operative findings, and short- and long-term outcomes after LR of PVH and IVH to investigate whether this pooling of PVH and IVH data is justified.

Materials and methods

All the patients who underwent laparoscopy for a ventral hernia between January 2000 and September 2012 were included in this study. The patients with PVH were routinely scheduled for LR. The patients with IVH were scheduled for LR unless they had contraindications such as abdominal wall fistulas, loss of domain, an abdomen deemed not accessible for laparoscopy, or a preference for an open correction.

All patient characteristics, operation data, and complications were prospectively registered in an electronic database at the moment of presentation. The primary outcome measures were the postoperative complications classified as Clavien grade 3 or higher (Table 1) [13] and

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Table 1 Classification of surgical complications according to Dindo–Clavien

Grade	Definitions
Grade 1	Any deviation from the normal postoperative course without the need for pharmacologic treatment or surgical, endoscopic, or radiologic interventions
	Allowed therapeutic regimens are drugs as antiemetics, antipyretics, analgesics, diuretics, electrolytes, and physiotherapy. This grade also includes wound infections opened at the bedside.
Grade 2	Complication requiring pharmacologic treatment with drugs other than those allowed for grade 1 complications
	Blood transfusions and total parenteral nutrition are also included.
Grade 3	Complication requiring surgical, endoscopic, or radiologic intervention
Grade 3a	Intervention not requiring general anesthesia
Grade 3b	Intervention requiring general anesthesia
Grade 4	Life-threatening complication requiring IC or ICU management
Grade 4a	Single-organ dysfunction (including dialysis)
Grade 4b	Multi-organ dysfunction
Grade 5	Death of the patient

IC intensive care, *ICU* intensive care unit

the recurrence rate. The secondary outcome measures were differences in baseline characteristics, American Society of Anesthesiologists (ASA) grade [14], intraoperative findings such as incidence and duration of adhesiolysis, conversion rate, size of hernia defect, size of mesh used, length of procedure (LOP), and length of hospital stay (LOS).

Adhesiolysis was defined as any manipulation needed to prepare the abdominal working area and abdominal wall for adequate mesh placement. De-insertion of the ligamentum teres hepatis and removal of fat from the hernia sac in cases of epigastric and umbilical hernia were not scored as adhesiolysis. Adhesiolysis requiring more than 30 min was scored as an extensive adhesiolysis.

Operative technique

All procedures were performed by of one of two senior surgeons (Johan Raymakers and Srdjan Rakic) or under their supervision. Pneumoperitoneum was routinely obtained using a Veress needle (insertion at "Palmer's point") unless the surgeon considered use of an open introduction necessary due to safety reasons. Adhesiolysis was performed when required. The ligamentum teres hepatis and fatty tissue were removed from the abdominal wall in preparation for placement of a mesh.

All the patients underwent LR using a 1-mm-thick expanded polytetrafluoroethylene mesh (DualMesh, WL Gore and Associates, Flagstaff, AZ, USA) tailored to overlap all hernia margins at least 3 cm. No effort was made to approximate the edges of the hernia opening. The mesh was fixed either by a double crown of tacks (ProTack; TycoUSS, Norwalk, CT, USA) or with a single circle of tacks along the periphery of the mesh combined with transabdominal sutures placed equidistant along the perimeter of the mesh. The method of fixation was determined by the surgeon for all but 199 patients who were part of randomization for another study [6].

All the patients were scheduled to return for a follow-up examination 2, 6, and 12 weeks after discharge and then thereafter when they had any type of LR-related problem. Nearly all the patients included in this study (98.4 %) were patients belonging to the adherence area of the hospital. It can be assumed that practically all these patients would return to our hospital for subsequent medical treatment, including treatment of problems related to LR of their hernias.

Data analysis

The analysis was performed on an intention-to-treat basis. For the purpose of this study, the patients were divided into two groups. Group 1 consisted of IVH, and group 2 consisted of PVH. Repair of IVH included both primary and recurrent incisional hernias as well as all recurrent PVHs. Repair of PVH included umbilical, epigastric, lumbar, and Spigelian hernias.

The data were collected in an Excel database. Statistical analyses were performed using the Statistical Package for Social Sciences for Windows, version 15.0 (SPSS Inc., Chicago, IL, USA). Categorical variables were compared by the Chi square test, and continuous variables were compared using the independent-samples t test. A P value lower than 0.05 was considered statistically significant.

Results

The study enrolled 1,088 patients, 426 in the IVH group and 662 in the PVH group. The baseline characteristics of the two groups are presented in Table 2.

The operative findings are compared in Table 3, with consistent differences demonstrated between the two groups. Of the 30 conversions to open repair in the IVH group, 14 were due to bowel injury during either open introduction or subsequent adhesiolysis, and 16 were due to adhesions deemed not safe for laparoscopic lysis. Of the three converted procedures in the PVH group, one was due to bowel injury during adhesiolysis, and two were due to severe adhesions.

The postoperative complications of the two groups and pooled data are compared in Table 4.

Table 2 Demographic data according to hernia group

	IVH group ($n = 426$)	PVH group ($n = 662$)	P value
Mean age at operation (years)	54.99 ± 13.85	51.27 ± 13.47	<0.001
Gender: *n* (%)			
Male	195 (45.77)	460 (69.49)	<0.001
Female	231 (54.22)	202 (30.51)	
Mean ASA classification	1.92 ± 0.72	1.68 ± 0.70	<0.001
Hernia location: *n* (%)	Midline: 255 (59.86)	Umbilical: 456 (68.88)	
	Trocar site: 68 (15.96)	Epigastric: 170 (25.68)	
	Subcostal: 36 (8.45)	Spigelian: 35 (5.29)	
	Lumbar: 18 (4.23)	Lumbar: 1 (0.15)	
	Transverse: 19 (4.46)		
	Pfannenstiel: 7 (1.69)		
	McBurney: 23 (5.56)		

IVH incisional ventral hernia, *PVH* primary ventral hernia, *ASA* American Society of Anaesthesiologists

Adhesiolysis occurred almost exclusively in the IVH group, with 38 % of 153 patients requiring extensive adhesiolysis. Extensive adhesiolysis was correlated with a greater number of complications classified as Clavien grade 3 or higher (33 %) compared with 12 % in the nonextensive adhesiolysis group ($P < 0.001$).

Discussion

Adult ventral hernias are defects in the abdominal wall that develop spontaneously (PVH) or as a complication of prior abdominal surgery (IVH). The latter represents a wide spectrum of either single or multiple defects that can appear at any site where an incision was made and with an extreme range in size from minimal defects to giant defects with complete loss of domain. Even if only a small segment of an incisional scar appears to be insufficient, the remainder of the scar, comprising collagenous tissue of inferior quality [15], should not be considered "entirely sufficient" and must also be corrected to prevent later development of herniation [16]. In contrast, PVHs are mostly small solitary defects originating at typical locations (e.g., epigastric or umbilical) and surrounded by healthy intact abdominal wall. As a rule, due to apparent differences in etiopathology, the literature on open repair maintains a distinct separation between PHV and IVH.

The first LR of ventral hernia of the abdominal wall was described by LeBlanc and Booth [17] in 1993. This new technique has slowly but surely gained popularity, and, probably to increase the number of patients included for analyses, the first large series pooled outcomes and results of PVH and IVH together [2, 17–19]. Although differences between LR of PVH and IVH were reported as early as 1999 [20], pooling has remained a habit to date.

The results of this study demonstrate apparent differences in the baseline characteristics between the two types of ventral abdominal wall hernias. Although statistically significant, these differences do not pose as clinically significant and by themselves do not pose a strong argument against "pooling." A greater prevalence of female patients

Table 3 Operative findings of the pooled data according to hernia group

	Pooled data ($n = 1{,}088$) *n* (%)[a]	IVH group ($n = 426$) *n* (%)	PVH group ($n = 662$) *n* (%)	P value[b]
Open introduction	159 (15.07)	143 (36.11)	16 (2.43)	<0.001
Mean no. of trocars	2.86 ± 0.78	3.16 ± 0.73	2.40 ± 0.61	<0.001
Adhesiolysis	307 (29.10)	301 (76.01)	6 (0.91)	<0.001
Conversion to open procedure	33 (3.03)	30 (7.04)	3 (0.45)	<0.001
Mean hernia size (cm^2)	9.86 ± 22.36	23.04 ± 33.00	2.41 ± 3.77	<0.001
Mesh size (cm^2)[c]	213.16 ± 154.35	322.94 ± 199.00	148.79 ± 58.26	<0.001
Double-crown fixation[c]	728 (69.00)	276 (69.70)	452 (68.59)	0.724
Median no. of tacks[c]	34.58 ± 21.28	52.15 ± 26.46	28.13 ± 14.54	<0.001
Length of procedure (min)[c]	53.73 ± 33.70	72.56 ± 42.79	42.27 ± 19.14	<0.001
Hospital stay (days)[c]	3.33 ± 3.99	4.53 ± 5.79	2.43 ± 1.00	<0.001

IVH incisional ventral hernia, *PVH* primary ventral hernia

[a] Pooled data are combined data of IVH and PVH

[b] Comparison of the IVH and PVH groups

[c] Converted patients are excluded

Table 4 *Early* (≤30 days after surgery) and *late* (>30 days after surgery) postoperative complications according to hernia group

	Pooled data (n = 1,055) n (%)[a]	IVH group (n = 396) n (%)	PVH group (n = 659) n (%)	P value[b]
Early complications				
Bleeding	4 (0.38)	2 (0.51)	2 (0.30)	0.604
Prolonged ileus	10 (0.95)	5 (1.26)	5 (0.76)	0.308
Wound infection	1 (0.09)	1 (0.25)	0 (0.00)	0.196
Mortality (not specific to LR)	3 (0.28)	3 (0.76)	0 (0.00)	0.025
Unrecognized bowel lesion (diagnosed postoperatively)	3 (0.28)	3 (0.76)	0 (0.00)	0.025
Late complications				
Pain followed by reoperation (removal of fixation)	8 (0.76)	4 (1.01)	4 (0.61)	0.463
Bulging of mesh	13 (1.23)	8 (2.02)	5 (0.76)	0.071
Trocar-site hernia	15 (1.42)	12 (3.03)	3 (0.46)	0.001
Recurrent hernia	32 (3.03)	23 (5.81)	9 (1.37)	<0.001
Clinically relevant chronic seroma	5 (0.47)	3 (0.76)	2 (0.30)	0.297
Total complications, Clavien grade ≥3	104 (9.86)	74 (18.69)	30 (4.55)	<0.001

Converted patients are excluded

IVH incisional ventral hernia, *PVH* primary ventral hernia, *LR* laparoscopic repair

[a] Pooled data are combined data of IVH and PVH

[b] Comparison of the IVH and PVH groups

in the IVH group, for reasons not completely clear, has been noted previously [21, 22].

The operative findings of the current study, however, clearly indicate that LR of IVH is a much more complex procedure than LR of PVH in every aspect and at every stage of the operation. Access to the abdomen of IVH patients is more difficult and carries a potential risk for bowel lesion. Adhesions, exceptional in PVH patients with no previous abdominal surgery, are common in patients with IVH. All the bowel lesions and conversions in the current series were in one way or another related to adhesions. When the presented data are pooled, a conversion rate of 3 % can be misleading, masking a striking 14-fold difference between the IVH group (7 %) and the PVH group (0.5 %).

The presence of adhesions and features of their lysis seem to be critical in determining the complexity and risks of a procedure [23]. Extensive adhesiolysis was required exclusively in the IVH group and correlated with a higher percentage of complications than nonextensive adhesiolysis in the same group. The IVH group with nonextensive adhesiolysis had significantly more complications than the PVH group, in which adhesions were very rare.

Interestingly, a recent study on a similar issue [22] reported that 73 % of the PVH patients required lysis of adhesions, compared with only 0.9 % reported in the current study. The most likely explanation for this enormous difference could be that we did not encode de-insertion of the ligamentum teres hepatis, nearly always required for adequate application of the mesh over the hernia defect, as adhesiolysis.

After completion of adhesiolysis, the most complex part of LR, a much safer and more technical part of the procedure takes place: introduction, positioning, and fixation of the mesh. Not surprisingly, patients with IVH had larger hernia defects, requiring larger meshes and more tackers for fixation. All this together with eventual adhesiolysis contributed to a longer LOP than in the PVH group.

The mean hospital stay in this series (3.33 days) was somewhat higher than that reported in the literature (2.3–3.0 days) [2–4], possibly because at our institution LR of ventral hernias is not performed as day-care surgery, as is customary in some other institutions. A longer LOS in the IVH group is in accordance with previous studies [22, 24]. A number of factors potentially contribute to a longer LOS including differences in age and ASA grade, conversion rate, LOP, use of larger meshes and more tackers, and certainly, a higher incidence of postoperative complications.

The complication rate (Clavien grade ≥3) of 18.69 % for IVH in this study is comparable with complication rates reported in other studies (16.4–31.5 %) [25–27] and significantly higher than the rate (4.55 %) for the PVH group. A number of factors may have contributed to this dissimilarity including differences in age and ASA grade, use of more and larger trocars, adhesiolysis and overall

procedural complexity, larger hernias, use of both larger meshes and more fixation, LOP, and higher recurrence rate. Similar to the conversion rate, a pooled complication rate of 9.86 % was not representative for either the IVH group, with a twofold higher complication rate, or the PVH group, with a complication rate of less than half the pooled rate. Interestingly, Kurian et al. [22] found no significant difference in overall morbidity between the two groups (23 % for IVH vs 16 % for PVH).

A recurrence rate more than four times higher in the IVH group also can be overlooked if only pooled data are presented. Besides a larger hernia size in the IVH group, a disregard for the principle of treating the whole incision and not only a hernia defect certainly plays an important role [16].

The results of the current study demonstrate important differences in all aspects related to LR of IVH and PVH, from patient characteristics to complexity and risks of procedure to intra- and postoperative complications to late outcome. Surgeons in their "learning curve" of acquiring skills for performance of LR must be aware of these differences and respect them. Using "pooled data" evidently leads to inexact preoperative counseling of patients and may seriously call into question the correctness of the acquired informed consent. Clearly, the practice of pooling these two entities together should come to an end.

Disclosures Vincent M. A. Stirler, Ernst J. P. Schoenmaeckers, Robbert J. de Haas, Johan T. F. J. Raymakers, and Srdjan Rakic have no conflicts of interest or financial ties to disclose.

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