



## Identification of risk factors for 30-day postoperative complications in patients undergoing primary ventral hernia repair: a prospective cohort study of 2,374 patients

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### ABSTRACT

**Background.** Primary ventral hernia is a common condition. Surgical repair is associated with complications, but no clear predictive risk factors have been identified. The European Hernia Society classification offers a structured framework to describe hernias and to analyze postoperative complications. Given this structured nature, the European Hernia Society classification might prove useful for preoperative patient or treatment classification. The objective of this study was to investigate the European Hernia Society classification as a predictor for complications within 30 days after primary ventral hernia surgery.

**Methods.** A registry-based, prospective cohort study was performed, including all patients undergoing primary ventral hernia surgery between September 1, 2011 and February 29, 2016. Univariate analyses and multivariable logistic regression analysis were performed to identify risk factors for postoperative complications.

**Results.** A total of 2,374 patients were included, of whom 105 (4.4%) patients had  $\geq 1$  complications, either a wound, surgical, or medical complication. Factors associated with complications in univariate analyses ( $P < .10$ ) and clinically relevant factors were included into the multivariable analyses. In the multivariable analyses, age, body mass index, and the duration of the operation were independent risk factors. The diameter of the hernia was not an independent risk factor.

**Conclusion.** Primary ventral hernia repair is associated with a 4.4% rate of complications. No correlation was found between the European Hernia Society classification and postoperative complications. Age, body mass index, and duration of the operation were correlated with postoperative complications. Therefore, age and body mass index should be used in the preoperative risk assessment.

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Ventral hernia repair is a common surgical procedure, with >300,000 repairs being performed each year in the United States alone.<sup>1</sup> Of these hernia repairs,  $\approx 75\%$  are performed for primary ventral hernias (mainly epigastric and umbilical hernias).<sup>2</sup>

Primary ventral hernias can vary in type and size. To categorize these hernias, the European Hernia Society (EHS) classification was developed and published in 2009.<sup>3</sup> One of the aims of this classification was to use a uniform method of describing hernias in both scientific and clinical communication.

The classification is based partly on the estimated risk of complications and recurrences. Although published several years ago, the EHS classification has not been externally validated thoroughly.

Recently, Kokotovic et al<sup>4</sup> demonstrated that 11.2% of all patients undergoing primary ventral hernia repair developed short-term or long-term postoperative complications and that these complications were correlated with the readmission rate of the patients. This finding shows the importance of identifying risk factors for postoperative complications. Recognizing these risk factors could lead potentially to preoperative interventions or individual patient risk-assessment.

The objective of this study was to evaluate the EHS classification among other factors, as a potential predictive tool for postoperative complications after primary ventral hernia repair by using a French, large-scale database.

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## Methods

### Study design

A registry-based, prospective cohort study was performed. All adults undergoing primary ventral hernia surgery in the French Hernia-Club registry between September 1, 2011, and February 29, 2016, were included. The Hernia-Club registry is approved by the French "Commission Nationale de l'Informatique et des Libertés" (CNIL; registration number 1993959v0). Because the study is a registry-based study, and patient data reanonymized, participant consent and approval by the institutional review board were not required in accordance to French and Dutch national ethical standards.

STROBE (Strengthening the Reporting of Observational studies in Epidemiology) and the European Registry of Abdominal Wall Hernias (EuraHS) recommendations were used for this study.<sup>5,6</sup>

### Hernia-club registry

The Hernia-Club registry is a collaborative, prospective, anonymized online database of all abdominal wall hernia operations performed by 42 French surgeons specialised in abdominal wall surgery. Each participating surgeon must accept and sign the Charter of Quality, which states that: "all input must be registered in a consecutive, unselected and exhaustive manner and in real time." Participants consent to random peer review of original medical charts. A total of 164 parameters are collected prospectively from screening, pre-, peri-, and postoperative periods. All parameters are collected by a blinded clinical research associate, independent of the individual participating surgeon. The collected parameters in this database are fully compatible with the EHS classification of primary and incisional abdominal wall hernias<sup>3</sup> and the European Registry of Abdominal Wall Hernias (EuraHS) international online platform.<sup>7</sup>

### Data collection

Data extracted from the registry included patient age, sex, and other patient characteristics (body mass index (BMI), smoking habits,

diabetes mellitus, corticosteroid use, preoperative radio- or chemotherapy, history of aneurysm of the abdominal aorta, connective tissue disorders, anticoagulants use or coagulopathies, previous history of hernias, American Society of Anesthesiologists score); hernia characteristics (location, width, length, EHS class, primary or recurrent hernia), and operative characteristics (open or laparoscopic, emergency surgery, use of mesh and technique of mesh placement, duration of operation, and Altemeier wound class<sup>8</sup>).

### Outcome

The primary outcome measure was the number of patients with  $\geq 1$  postoperative complications within 30 days postoperatively. Postoperative complications were graded using the Clavien-Dindo grading system.<sup>9</sup>

### Statistics

SPSS 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, version 21.0. IBM Corp, Armonk) was used for all statistical analyses. To test normal distribution of continuous variables, Levene's test for equality of variances was used. Continuous variables are presented as means with standard deviations (SDs). Categorical variables are presented as numbers with percentages. Mann-Whitney *U* (continuous data) and  $\chi^2$  tests (categorical data) were used to compare risk factors for complications after primary hernia surgery. In case of small groups ( $n < 5$ ), Fisher exact test was used. To prevent bias, multiple imputations were performed to compensate for missing data. Potential risk factors that were related to postoperative complications in the univariate analysis ( $P < .10$ ) and clinically relevant factors were included in the multivariable regression analysis.

## Results

A total of 2,374 patients with a primary ventral hernia who underwent operative repair were included. Baseline patient characteristics are presented in Table 1. Patients with postoperative complications were older ( $62.4 \pm 15.0$  year vs  $55.2 \pm 14.5$ ,

**Table 1**  
Baseline characteristics.

Characteristic	No complication (n = 2,186)	Missing (%)	Any complication (n = 105)	Missing (%)	P value
Age, y (SD)	55.21 (14.54)	8 (0.4)	62.43 (15.00)	0 (0)	<.001
Male sex (%)	1,335 (61)	0	62 (59)	0 (0)	.678
BMI, kg/m <sup>2</sup> (SD)	27.58 (6.97)	0	30.21 (8.70)	0 (0)	<.001
Smoking (%)	493 (23)	50 (2.3)	19 (18)	0 (0)	.235
Diabetes mellitus (%)	131 (6.0)	24 (1.1)	10 (9.5)	1 (1.0)	.143
Corticosteroid use (%)	74 (3.4)	24 (1.1)	6 (5.7)	1 (1.0)	.205
AAA (%)	6 (0.3)	17 (0.8)	0 (0)	0 (0)	1.000
Connective tissue disorder (%)	1 (0)	17 (0.8)	0 (0)	0 (0)	1.000
Anticoagulants use or coagulopathy (%)	174 (8.0)	24 (1.1)	18 (17)	1 (1.0)	.001
Presence of ascites (%)	19 (0.9)	20 (0.9)	1 (1.0)	0	.614
History of abdominal wall hernia (%)					
Inguinal hernia (%)	201 (9.2)		17 (16)		.019
Ventral hernia (%)	79 (3.6)		2 (1.9)		.585
Incisional hernia (%)	17 (0.8)		3 (2.9)		.062
Other abdominal wall hernia (%)	8 (0.4)		0 (0)		1.000
Missing (%)	17 (0.8)		0 (0)		
Hiatal hernia (%)	15 (0.7)	17 (0.8)	1 (1.0)	0	.532
Family history of hernia (%)	100 (4.6)	17 (0.8)	1 (1.0)	0	.087
Previous abdominal surgery (%)	554 (26)	17 (0.8)	29 (28)	2 (1.9)	.553
ASA Class					<.001
I-II (%)	1842 (84)		71 (68)		
III-IV (%)	325 (15)		33 (31)		
Missing (%)	19 (0.9)		1 (1.0)		

Data are means (SD) or n (%).

SD, standard deviation; AAA, aneurysm of the abdominal aorta; ASA, American Society of Anesthesiologists.

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