Recurrence after elective incisional hernia repair is more frequent than you think: an international prospective cohort from the French Society of Surgery (AFC)

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Original article

Conflicts of Interest: None

Funding: this work received grants from French Society of Surgery (AFC) and the Agence Nationale de la Recherche (Labex LipSTIC, ANR -11-LABX-0021)

ABSTRACT

Background. There are little reliable data regarding the rate of recurrence after incisional hernia repair (IHR). The French Society of Surgery (AFC) has endorsed a cohort aiming to prospectively assess the frequency of recurrence after IHR and to identify the risk factors.

Methods. Consecutive patients undergoing IHR in the participating centers were included in the prospective AFC cohort over a 6-month period. Patients were followed up with a CT-scan at 1 year and a clinical assessment by the surgeon at 2 years. We collected patient characteristics, medical history, and information regarding hernias and the surgical technique for the analysis of recurrence.

Results. A total of 1075 patients undergoing IHR were included in 61 participating centers. The median follow-up was 24.0 days [IQR: 14.0-25.3]. The follow-up rates were 83.0% and 68.5% at 1 and 2 years, respectively. The recurrence rates were 18.1% at 1 year and 27.7% at 2 years. In multivariate analysis, risk factors associated with 1-year recurrence were a history of hernia (OR = 1.51, 95% CI = 1.01-2.27, p = 0.045), a concomitant digestive surgery (OR = 1.81, 95% CI = 1.09-3.01, p = 0.022) and the occurrence of early surgical site complications (OR = 2.06, 95% CI = 1.15-3.69, p = 0.015). Recurrence risk factors at 2 years were a history of hernia (OR = 1.57, 95% CI = 1.05-2.35, p = 0.028), a lateral hernia (OR = 1.84, 95% CI = 1.19-2.86, p = 0.007), a concomitant digestive surgery (OR = 1.97, 95% CI = 1.20-3.22, p = 0.007) and the occurrence of early surgical site complications (OR = 1,90, 95% CI = 1.06-3.38, p = 0.030). The use of surgical mesh was strongly associated with a lower risk of recurrence at 2 years (p<0.001).

Conclusion. After incisional hernia repair, the 2-year recurrence rate is as high as 27.7%. History of hernia, lateral hernia, concomitant digestive surgery, the onset of surgical site complications and the absence of mesh are strong risk factors for recurrence.

INTRODUCTION

The incidence of incisional hernia after laparotomy is as high as 20% according to the current literature[1], and incisional hernia repair (IHR) is one of the most common operations performed by general surgeons[2,3]. There is a lack of evidence regarding the best surgical techniques for long-lasting incisional hernia repair. Many studies have focused on immediate postoperative outcomes or have recorded longer follow-up but in a limited number of patients[4–6]. In recent years, some collaborative national registries have started to report population-based results, but recurrence is defined and assessed according to the usual practices of each center [7,8]. Unfortunately, it is well-known that the incidence of recurrence depends on how it is assessed[9].

The French Society of Surgery (*Association Française de Chirurgie*, AFC) has promoted a cohort among its affiliated members with the aim of describing the management of incisional hernia in French-speaking countries. There is a particular focus on recurrence and the risk factors leading to recurrence.

The main endpoint of the study was the 1-year recurrence rate (determined with abdominal CT scan). The secondary endpoints were postoperative morbidity, the 2-year recurrence rate and the risk factors for recurrence.

METHODS

Study design

All members of the AFC in France, Belgium, Switzerland, Morocco, Algeria and Tunisia were invited to include patients in this cohort if they agreed to include all consecutive patients operated for IHR over a 6-month period and to follow each patient for 2 years (with a mandatory CT scan at 1 year and a physical exam at 2 years). A prospective, international, cohort was thus created, involving 105 surgeons in 63 participating centers. Consecutive patients undergoing IHR were included between October 1st, 2015 and March 31st, 2016. Inclusion criteria were: patients aged 18 years and older, undergoing elective incisional hernia repair with or without a concomitant surgical procedure. Exclusion criteria were: primary, groin or perineal hernias, patients in which any factor suggested that 2 years of follow-up could not be achieved. Patients provided written informed non-opposition to their anonymous inclusion in a database according to French current law. The database was declared to the French regulatory authorities (CCTIRS (n°13571) and CNIL (n°913493)).

All aspects regarding the surgical technique were left to each surgeon's judgement in order to reflect the current practices in French-speaking countries. No particular instructions were given on surgical indications, preoperative work-up or perioperative management. Regardless of each center's follow-up practices, the present study required a clinical examination by a surgeon and an abdominal CT scan at the 1-year visit and a clinical examination performed by a surgeon with an optional CT scan at the 2-year visit.

Data recorded

Data recorded in the online database (www.club-hernie.com) included patient characteristics (age, sex, body mass index), previous medical history (comorbidities and previous hernia), hernia characteristics (location, size, number of recurrences, symptoms) and specific preparation in case of giant hernias (defined as all hernias > 10 cm in width), and surgical technique (type of mesh if any, location, fixation, concomitant surgical procedures, wound contamination according to the CDC wound class[10] and the VHWG classification[11], and drains). Postoperative complications were analyzed with the Clavien-Dindo classification[12]. Data regarding length of stay, immediate postoperative complications and reoperation were collected. The results of the clinical examination and imaging at 1 and 2 years of follow-up were recorded.

Statistical analysis

Categorical variables were described using frequencies, and continuous variables were described using means (± standard deviation, SD) when normally distributed or medians and interquartile ranges otherwise. Bivariate analyses were performed using the chi-squared test (or Fisher's exact test) and Student-t test (or Wilcoxon test), as appropriate.

First, to explore the relationships between patients or hernia characteristics and the type of surgical technique (use of mesh and its position, open vs laparoscopic approach), logistic regression models, stratified by center, were used to estimate odds ratios (OR) and 95% confidence intervals (95%CI). The variables associated with the type of surgical technique in bivariate analyses with a p-value< 0.25 were included in the multivariate model. Continuous data such as the size of the hernia, the interval between the initial laparotomy and the onset of inguinal hernia (IH), or the duration of surgery were categorized according to the tertiles of their distribution.

Secondly, factors associated with the risk of recurrence at 1 and 2 years of follow-up were sought. Logistic regressions stratified by center were also fitted using the same strategy as above to fulfil this objective. Patients and hernia characteristics, as well as surgical technique (use of mesh if any and its position, open vs laparoscopic approach) and postoperative course were considered. A backward stepwise selection strategy was then applied to identify the characteristics that were associated with the risk of recurrence.

In order to identify possible variations in practices according to centers (or geographical areas), the analyses were then performed without stratification on the center. If a modification of the effect of the surgical technique on the risk of recurrence was observed, geographical areas (and interaction with surgical technique) were fitted in the model.

All p-values were based on two-tailed statistical tests and p-value<0.05 was considered statistically significant. Analyses were performed with SAS® software, version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Population characteristics

During the 6-month recruitment phase, 1301 patients operated for IHR were potentially eligible. After checking for eligibility, missing criteria, and duplicates, 1075 patients were finally included and analysed (flowchart of the study in Figure 1).

There were 584 women (50.7%), mean age was 63.3 ± 13.8 years, and mean body mass index (BMI) was 29.4 ± 6.3 kg/m² (76.2% overweight or obese patients) (Table 1). Regarding comorbidities increasing surgical site occurrences, 30.0% of patients had diabetes, immunosuppression or anticoagulation therapy, and 18.5% were active smokers. Regarding their perioperative risk, 24.6% were classified as ASA 3 and 1.2% ASA 4. Almost a half of patients (49.1%) had undergone a previous surgery for IHR, 30% at the same location (recurrent IHR) and 19% in different locations.

Incisional hernia characteristics

The median delay between index surgery (leading to the treated IH) and the onset of IH was 24 months (IQR: 12-60). The index surgery was a gastrointestinal surgery for 527 patients (49.5%), a parietal surgery for 261 (24.5%), and a gynaecological procedure for 152 (14.3%). The remaining surgeries were distributed between urology, vascular surgery, cardio-thoracic, orthopaedic and plastic surgery. Regarding the clinical presentation, 203 patients (19.1%) were asymptomatic while 858 (80.9%) had symptoms such as discomfort or pain (72.6%), or episodes of reducible incarceration (8.3%).

Hernias were located more frequently on the midline (906 defects, 85.7%) than on the lateral part of the abdomen (233 defects, 24.0%); 104 patients (9.8%) presented with several defects (Table 1). The median dimensions of the defects were 5 cm in width (IQR: 3-8) and 6 cm in length (IQR: 4-10); according to EHS classification for incisional hernias [13], 45.4% were W1, 37.8% were W2, and 16.7% were W3. The skin was normal in 799 patients (76.0%), thinned without trophic disturbances in 175 patients (16.7%) and presenting trophic disorders or obvious contamination in the remaining patients.

The currently treated IH was a recurrence in 26.7% of patients. The previous attempted repair consisted in a suture without mesh in 72 patients (27.8%), an intraperitoneal mesh in 88 (34.0%), a sublay mesh in 88 (34.0%), a bridge or inlay mesh in 7 (2.7%) and an onlay mesh in 4 patients (1.5%).

The preoperative assessment included an abdominal CT in 588 patients (55.6%), either requested by the referring physician (11.8%) or by the surgeon (43.8%). This CT showed unexpected features and/or changed the strategy in 35 patients (7.4% of patients whose results were available).

Giant incisional hernias

In the cohort, 93 patients (9.2%) presented with a giant incisional hernia (width > 10 cm). Among the patients with a giant IH, 19 (45.2%) had a loss of domain, 23 (57.5%) underwent preoperative respiratory physiotherapy, 16 (39.0%) had cutaneous preparation and 7 (18.4%) had a specific nutritional management. Among the patients with loss of domain, 13 (68.4%) had a

preoperative therapeutic pneumoperitoneum according to Goñi-Moreno's technique [14] for a period of 13.8 ± 3.8 days.

Degree of contamination of the surgical field

According to Altemeier's classification[10], surgery was clean, clean contaminated, contaminated, or dirty in 968 (90.5%), 70 (6.5%), 20 (1.9%), or 12 cases (1.1%), respectively. In 50 cases (4.7%), an enterotomy was reported. A simultaneous cholecystectomy was performed in 17 patients (1.6%) and another surgery was associated in 105 patients (9.9%). Antibiotic prophylaxis was administered in 88.1% of patients.

Techniques used

Open surgery was performed in 928 patients (87.5%) and laparoscopic surgery in 132 (12.5%). In multivariate analysis, the higher EHS-W classification for incisional hernia, the more frequently the surgeon opted for an open approach (OR = 2.18 for W2 vs W1, 95% CI = 1.30-3.66, p = 0.003, and OR = 7.35 for W3 vs W1, 95% CI = 1.59-33.97, p = 0.011).

Primary repair without surgical mesh was performed in 115 patients (10.9%). This was a deliberate choice (small defect in solid aponeurosis) in 42 cases (37.2 %) and a cautious choice due to a contaminated wound in 46 cases (40.7%). In multivariate analysis, the size of the hernia was related with the use of mesh for repair (OR = 4.42 for incisional hernias whose width classified in W3 vs W1, 95% CI = 1.60-12.19, p =0.004). Primary suture repair was preferred for patients with higher ASA classification (OR = 13.34 for ASA 4 vs ASA 1, 95% CI = 1.91-93.03, p = 0.009; OR=2.51 for ASA 2 vs ASA 1, 95% CI= 1.10-5.73; p=0.029), for those presenting a longer interval between the "case index surgery" and the onset of IH (OR = 4.21 for intervals in the 3rd tertile vs the 1st tertile, 95% CI = 1.80-9.83, p = 0.001), and when a concomitant digestive procedure was performed at the time of IHR (OR = 6.16, 95% CI = 3.16-12.02, p < 0.001).

Mesh was used in 970 patients (90.7%) (Table 2): sublay position in 506 patients (52.8%), intraperitoneal position in 425 (44.4%) (including 118 (28.0%) operated on by laparoscopy and 304 (72.0%) by open approach), onlay in 20 patients (2.1%), inlay position or bridging in 7 cases (0.7%). In multivariate analysis, the higher BMI (OR = 1.04, 95% CI = 1.01-1.07, p = 0.007), and a longer delay between index surgery and the onset of IH (OR = 1.69 for intervals in the 2nd tertile vs the 1st tertile, 95% CI = 1.03-2.76, p = 0.038) were associated with the use of mesh in intraperitoneal position rather than in sublay position. Sublay position was prioritized for higher EHS-W classification for IH (OR = 1.61 for W2 vs W1, 95% CI = 1.07-2.44, p = 0.023), and for repair with several defects (OR = 1.99, 95% CI = 1.05-3.81, p = 0.036).

Synthetic mesh was used in 775 patients (93.9%), biologic in 26 patients (3.2%; 17 reticulated and 9 non-reticulated), biosynthetic in 24 patients (2.9%). The median dimensions of the mesh were 15 cm in width (IQR: 10-20), 15 cm in length (IQR: 12-25), and 177 cm² in area (IQR: 94-353)). The median duration of surgery (skin to skin) was 87 minutes (IQR: 57-123).

Postoperative outcomes

Abdominal binders were prescribed in 756 patients (71.9%) for a median duration of 30 days (IQR: 30-45). Non-specific complications occurred in 112 patients (10.7%) and surgical site

occurrences in 118 patients (11.3%). Postoperative morbidity is presented in Table 3. A reoperation was performed in 43 patients (4.2%). The median length of stay was 5 days (IQR: 3-7). IHR repair was successfully performed as day case surgery in 115 (11.3%) of patients.

Follow-up and recurrence

The median follow-up was 24.0 months [IQR: 14.0-25.3]. Twenty four (2.8%) patients died from causes unrelated to IHR. The 1-year follow-up was attended by 892 (83.0%) patients. Among the 802 patients who received a CT scan (74.6% of the cohort, 89.9% of the followed patients), 142 had a radiologic recurrence (17.7% of those having the CT-scan). When clinical and radiologic data were collected at the 1-year visit, 157 patients (18.1%; 95% CI = 15.6-20.7) had a recurrence.

The 2-year control was attended by 736 patients (80.2% of those followed-up at 1 year, 68.5% of the entire cohort). At this time, 200 patients had a recurrence (27.7% of patients followed at 2 years, 95% CI = 24.4-30.9).

Risk factors for recurrence

In bivariate analysis, the factors associated with 1-year recurrence were BMI, ASA score, lateral incisional hernia location, a concomitant surgery, a wound contamination, a history of recurrence and the use of surgical mesh (Table 4). In multivariate analysis, the factors associated with 1-year recurrence were a history of hernia (OR = 1.51, 95% CI = 1.01-2.27, p = 0.045), a concomitant surgery (OR = 1.81, 95% CI = 1.09-3.01, p = 0.022) and the occurrence of early surgical site complications (OR = 2.06, 95% CI = 1.15-3.69, p = 0.015). Concerning the impact of the surgical technique, the use of a mesh was associated with a significant decrease in recurrence (OR = 0.14, 95% CI = 0.07-0.26, p <0.001). The other surgical techniques (mesh position and type of approach) had no impact on 1-year recurrence.

In bivariate analysis, the factors associated with 2-year recurrence, which was a history of smoking, were added to the 1-year risk factors (except a wound contamination, Table 5). The EHS-W classification for incisional hernia was at the limit of significance (p = 0.057). In multivariate analysis, the factors associated at 2 years were a history of hernia (OR = 1.57, 95% CI = 1.05-2.35, p =0.028), a lateral incisional hernia (OR = 1.84, 95% CI = 1.19-2.86; p = 0.007), a concomitant surgery (OR = 1.97, 95% CI = 1.20-3.22, p = 0.007) and the occurrence of early surgical site complications (OR = 1.90, 95% CI = 1.06-3.38, p = 0.030). Mesh use was a strong protector against recurrence at 2 years after adjustment for other risk factors (OR = 0.12, 95% CI = 0.06-0.25, p < 0.001). No national, regional or institutional effect was found as significant.

DISCUSSION

This international cohort study showed that recurrence rates after IHR were 18.1% and 27.7% at 1 and 2 years of follow-up, respectively, following scheduled, systematic assessments to screen for recurrence. This large cohort of patients from several French-speaking countries underwent IHR within a single 6-month period. These patients, treated in specialized centers as well as in county hospitals and private clinics and followed for 2 years, accurately depict real-life practices and management of IHR. Although this was not a registry, the data provided are similar to that of a population-based study. Patient and hernia characteristics were similar to those reported in other large cohorts in the literature [7,8].

Most patients were operated on because they presented with hernia-related symptoms, but 19% were asymptomatic. In a recent publication, Wolf et al. found that asymptomatic IH required surgery in 39% of cases, 14% of which were in an emergency setting [15]. The cost-effectiveness analysis favored the treatment of asymptomatic IH except in high-risk patients.

The proportion of patients operated on by laparoscopy in our cohort (12%) may seem low, but it is similar to that reported in the Spanish EVEREG Registry [8]. There is growing evidence of a higher risk of recurrence and visceral complications with the traditional laparoscopic approach using intraperitoneal mesh [16]. In the PROLOVE trial which compared laparoscopy and laparotomy in terms of comfort and quality of life, the recurrence rate was higher for laparoscopy though the difference did not reach significance [17].

The use of surgical mesh was associated with a significant decrease in recurrences. Mesh remains the gold standard for IHR despite the concerns raised recently by Kokotovic et al. regarding the long-term effects of synthetic mesh [18,19]. Concerning the position of the mesh, the sublay technique remains the reference [20]. In our series, sublay was the most frequent technique, but it was closely followed by the intraperitoneal position. Recurrences were more frequent with the intraperitoneal position, but the difference did not reach significance in the multivariate analysis. This result could be explained by the fact that intraperitoneal mesh was used for smaller midline incisional hernias which were at lower risk of recurrence. Recent technical advances have shown the feasibility of mesh repair in the sublay position with a mini-invasive or a robotic approach [21,22]. These approaches may combine the advantage of the laparoscopic approach and the sublay position of the mesh[23].

The recurrence rate in this cohort could be considered as high (18.1% at 1 year and 27.7% at 2 years), but it is consistent with the results obtained from other population-based studies and registries. This is the effect of exhaustive follow-up. Accordingly, the Spanish Registry (EVEREG) found a 1-year recurrence rate of 20.7% in a series of 4500 patients [8]. After long term follow-up, the recurrence rate may be as high as 64% at 140 months for a first incisional hernia and even 73% in case of recurrence [20]. In our cohort, there was a considerable increase in the recurrence rate between 1 year and 2 years of follow-up. Such an increase is consistent with the current literature: the German HERNIAMED registry found recurrence rates of 35% and 56% at 1 year and 2 years, respectively, and the authors concluded that a follow-up as long as 10 years could be necessary to detect at least 92% of recurrences [9].

The risk factors for 1-year recurrence were a previous history of IH, concomitant surgery, the occurrence of surgical site complications, and the absence of mesh repair. The risk factors for 2-year recurrence were the same with the addition of IH in a lateral position. All efforts should be made to perform optimal IHR at the first attempt in order to avoid a vicious circle of complications and recurrence [20].

Complex abdominal-wall repair made up approximately 10% of our cohort. These patients often suffer from comorbidities and require complex strategies including specific perioperative management. They should thus be managed in specialized centers that can provide a multidisciplinary approach [24,25].

Some of the strengths of our study may also be limits. The number and variety of recruiting centers makes our cohort quite heterogeneous. It accurately reflects the reality of the field and current variations in practice. However, subgroups analyses were difficult, and we could not conclude on specific points regarding the best surgical technique as a result of the limited subgroups. Patients lost to follow-up, though scarce, could have induced an underestimation of the recurrence rate. Furthermore, the recurrence rate would probably have increased with a mandatory CT scan at 2 years and longer follow-up, as suggested by the Herniamed registry [9].

To conclude, IHR is an operation frequently performed by surgeons in French-speaking countries. Considering the high 1-year and 2-year recurrence rates and the fact that recurrence itself is a risk factor for failed repair, every effort must be made to attempt an optimal repair at the outset. This includes a repair with surgical mesh, careful prevention of surgical site occurrences, avoiding simultaneous surgical procedures whenever possible, and considering a more specialized approach in case of complex hernia repair.

ACKNOWLEDGEMENTS

The authors thank Pr Denis Collet, past President of the AFC (Association Française de Chirurgie) for his commitment and support during this study, and also the current President, Pr Patrick Pessaux, for his encouragements and help in the later phases of the work. The Club Hernie was involved at all levels in this work with his members recruiting patients and their online database at our disposal to create a specific labelled cohort.

We thank all the team of the Center for Clinical Research, Clinical Epidemiology Unit of Dijon (Inserm CIC 1432), and M. Cyril Boisson (LabeX LipSTIC, ANR-11-LABX-0021), for their dedication and the many hours spent on data monitoring and statistical analysis.

The authors thank Suzanne Rankin from the Dijon University Hospital for editing and proofreading the manuscript.

Funding: This work received grants from the French Society of Surgery (AFC) and the Agence Nationale de la Recherche (Labex LipSTIC, ANR -11-LABX-0021)

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Figure 1: Flowchart

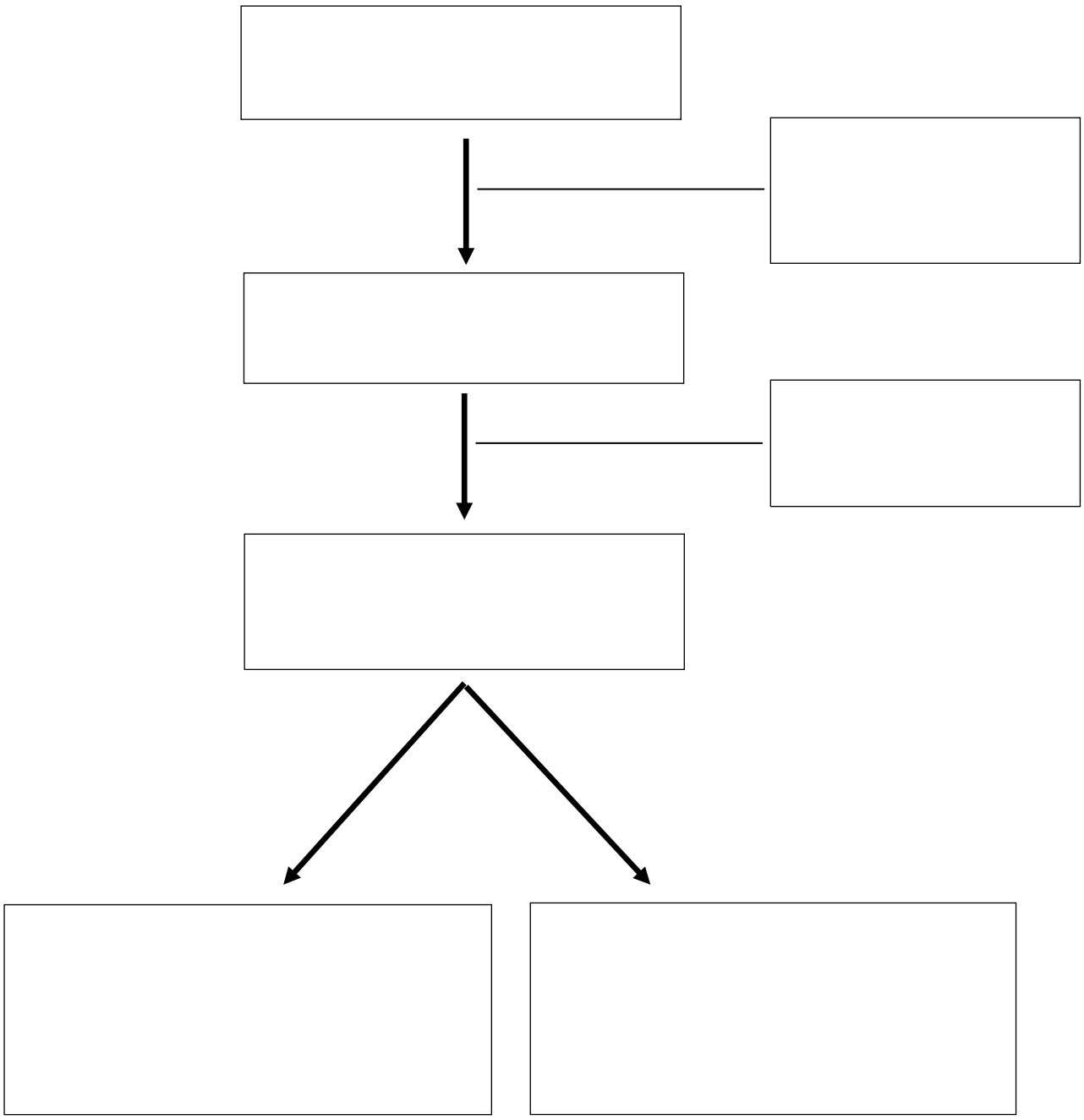

Table 1: Demographics data (AFC cohort 2015-2016)

Total (n=1075)					
Patient			**Incisional hernia characteristics**		
Age (Years)		63.3 ± 13.8	Median location (%)		
Gender (%)	Female	545 50.7)		No	151 (14.3)
	Male	530 (49.3)		Yes	906 (85.7)
*BMI (kg/m²)		29.4 ± 6.3	Lateral location (%)		
Professional activity (%)	Unemployed	534 (62.2)		No	737 (76)
	Administrative work	132 (15.4)		Yes	233 (24)
	Physical work	113 (13.2)	EHS-W classification (%)		
Physical activity (%)				W1	459 (45.4)
	None	622 (67.8)		W2	382 (37.8)
	Sporadic	208 (22.7)		W3	169 (16.7)
	Regular	88 (9.6)	Recurrent incisional hernia (%)		
Past IH history (%)				No	762 (73.3)
	No	542 (50.9)		Yes	277 (26.7)
	Yes	508 (47.7)	Giant incisional hernia (%)		
Smoking (%)				No	917 (90.8)
	No	779 (81.5)		Yes	93 (9.2)
	Yes	177 (18.5)	Concomitant surgery (%)		
Factors influencing abdominal pressure (%)				No	893 (83.8)
	No	687 (65.2)		Yes	172 (16.2)
	Yes	366 (34.8)			
Factors influencing wound healing (%)					

	No	740 (70)
	Yes	317 (30)
ASA classification (%)		
	ASA1	263 (24.6)
	ASA2	529 (49.5)
	ASA3	263 (24.6)
	ASA4	13 (1.2)

Table 2: Mesh position according to incisional hernia and patient characteristics (AFC cohort 2015-2016))

		Mesh position		
		Sublay (n=506)	Intrapéritoneal (n=425)	P**
Patient				
*Age (années)		62.8 ± 13.5	63.2 ± 14.0	0.701
Gender (%)	Female	256 (55.2)	208 (44.8)	0.616
	Male	250 (53.5)	217 (46.5)	
*BMI (kg/m²)		28.8 ± 5.7	30.1 ± 6.6	**0.001**
Professional activity (%)	Unemployed	242 (53.3)	212 (46.7)	0.915
	Administrative work	61 (54)	52 (46)	
	Physical work	96 (55.2)	78 (44.8)	
Physical activity (%)				0.235
	None	305 (57)	230 (43)	
	Sporadic	95 (55.2)	77 (44.8)	
	Regular	37 (46.8)	42 (53.2)	
Past IH history (%)				0.962
	No	252 (54.3)	212 (45.7)	
	Yes	250 (54.5)	209 (45.5)	
Smoking (%)				0.859
	No	364 (54.1)	309 (45.9)	
	Yes	81 (53.3)	71 (46.7)	
Factors influencing abdominal pressure (%)				0.602
	No	331 (54.9)	272 (45.1)	
	Yes	164 (53.1)	145 (46.9)	
Factors influencing wound healing (%)				0.865
	No	352 (54.2)	297 (45.8)	
	Yes	147 (54.9)	121 (45.1)	
ASA classification (%)				**0.002**
	ASA1	147 (62.3)	89 (37.7)	
	ASA2	229 (50)	229 (50)	
	ASA3	122 (54)	104 (46)	
	ASA4	6 (100)	0 (0)	
Incisional hernia				
Median location (%)				**0.009**
	No	85 (64.4)	47 (35.6)	
	Yes	410 (52.2)	376 (47.8)	
Lateral location (%)				**0.032**
	No	339 (52.6)	305 (47.4)	
	Yes	122 (61.3)	77 (38.7)	
EHS-W classification (%)				**0.032**
	W1	202 (50.5)	198 (49.5)	
	W2	197 (60.2)	130 (39.8)	
	W3	85 (54.8)	70 (45.2)	
Recurrent incisional hernia (%)				0.839
	No	364 (54.2)	308 (45.8)	
	Yes	128 (54.9)	105 (45.1)	
Giant incisional hernia (%)				0.706

	No	439 (55.1)	358 (44.9)	
	Yes	45 (52.9)	40 (47.1)	
Concomitant surgery (%)				0.974
	No	431 (54.4)	362 (45.6)	
	Yes	71 (54.2)	60 (45.8)	

*expressed as mean ± SD

** chi-squared test or Student test

Table 3: Postoperative complications according to Dindo-Clavien classification

Classification	Number of patients (%)
0	738 (77.1)
I	125 (13.1)
II	41 (4.3)
IIIa	10 (1.0)
IIIb	31 (3.2)
IVa	9 (0.9)
V	3 (0.3)

Table 4: Bivariate analysis of the relationship between patient characteristics, surgical procedures and complications and the occurrence of a recurrence at 1 year (AFC cohort 2015-2016)

		No recurrence at 1 year FU (n=710)	Recurrence at 1 year FU (n=157)	P**
Patient				
Age (Years)		62.8 ± 13.9	64.8 ± 12.8	0.100
Gender (%)	Female	368 (83.4)	73 (16.6)	0.226
	Male	342 (80.3)	84 (19.7)	
*BMI (kg/m²)		29.0 ± 6.0	31.0 ± 7.3	**<0.001**
Professional activity (%)				0.132
	Unemployed	350 (81)	82 (19)	
	Administrative work	91 (89.2)	11 (10.8)	
	Physical work	125 (83.9)	24 (16.1)	
Physical activity (%)				0.245
	None	418 (82.9)	86 (17.1)	
	Sporadic	131 (77.5)	38 (22.5)	
	Regular	59 (84.3)	11 (15.7)	
Incisional hernia history (%)				0.306
	No	359 (83.3)	72 (16.7)	
	Yes	345 (80.6)	83 (19.4)	
Smoker (%)				0.148
	No	528 (83.3)	106 (16.7)	
	Yes	115 (78.2)	32 (21.8)	
Factors influencing abdominal pressure (%)				0.752
	No	451 (82)	99 (18)	
	Yes	245 (81.1)	57 (18.9)	
Factors influencing wound healing (%)				**0.040**
	No	494 (83.7)	96 (16.3)	
	Yes	204 (77.9)	58 (22.1)	
Classification ASA (%)				**<0.001**
	ASA1	183 (87.1)	27 (12.9)	
	ASA2	361 (83.8)	70 (16.2)	
	ASA3	158 (74.9)	53 (25.1)	
	ASA4	4 (44.4)	5 (55.6)	
Incisional hernia characteristics				
Median location (%)				0.741
	No	103 (81.1)	24 (18.9)	
	Yes	596 (82.3)	128 (17.7)	
Lateral location (%)				**0.020**
	No	507 (84.5)	93 (15.5)	
	Yes	153 (77.3)	45 (22.7)	
EHS-W classification (%)				0.180
	W1	307 (85)	54 (15)	
	W2	255 (79.9)	64 (20.1)	
	W3	115 (80.4)	28 (19.6)	
Recurrent incisional hernia (%)				**0.040**
	No	514 (83.6)	101 (16.4)	
	Yes	179 (77.5)	52 (22.5)	
Concomitant surgery (%)				**0.022**

	No	598 (83.3)	120 (16.7)	
	Yes	106 (75.2)	35 (24.8)	
Surgery performed				
Approach (%)				0.425
	Laparocopy	84 (79.2)	22 (20.8)	
	Open	619 (82.4)	132 (17.6)	
Mesh used (%)				**<0.001**
	No	40 (49.4)	41 (50.6)	
	Yes	669 (85.3)	115 (14.7)	
Mesh location (%)				0.098
	underlay	272 (82.2)	59 (17.8)	
	sublay	370 (88.5)	48 (11.5)	
	Inlay (bridge)	6 (85.7)	1 (14.3)	
	onlay	13 (81.3)	3 (18.8)	
Intraoperative and early complications				
*Operative time (minutes)		84 [59-122]	90 [56-135]	0.347
Abdominal compression belt (%)				0.352
	No	180 (80)	45 (20)	
	Yes	519 (82.8)	108 (17.2)	
Medical complications (%)				0.347
	No	623 (82)	137 (18)	
	Yes	74 (86)	12 (14)	
Surgical Site Occurrence (%)				0.063
	No	627 (83.3)	126 (16.7)	
	Yes	71 (75.5)	23 (24.5)	
Dindo-Clavien classification (%)				0.844
	No complication	502 (83.3)	101 (16.7)	
	I	83 (79.8)	21 (20.2)	
	II	30 (83.3)	6 (16.7)	
	III	26 (78.8)	7 (21.2)	
	IV	6 (75)	2 (25)	
Reintervention (%)				0.432
	No	662 (82.3)	142 (17.7)	
	Yes	27 (77.1)	8 (22.9)	

*expressed as mean ± SD or median [IQR]

** chi-squared test or Student test (or Wilcoxon test)

Table 5: Bivariate analysis of the relationship between patient characteristics, surgical procedures and complications and the occurrence of a recurrence at 2 years (AFC cohort 2015-2016)

		No recurrence at 2 years FU (n=523)	Recurrence at 2 years FU (n=200)	P**
Patient				
Age (Years)		63.0 ± 13.9	64.2 ± 13.1	0.308
Gender (%)	Female	269 (74.3)	93 (25.7)	0.235
	Male	254 (70.4)	107 (29.6)	
BMI (kg/m²)		29.0 ± 6.1	30.8 ± 7.0	**<0.001**
Professional activity (%)				0.102
	Unemployed	265 (71.4)	106 (28.6)	
	Administrative work	68 (82.9)	14 (17.1)	
	Physical work	86 (73.5)	31 (26.5)	
Physical activity (%)				0.444
	None	318 (72.8)	119 (27.2)	
	Sporadic	98 (69)	44 (31)	
	Regular	39 (78)	11 (22)	
Incisional hernia history (%)				0.648
	No	252 (73.3)	92 (26.7)	
	Yes	269 (71.7)	106 (28.3)	
Smoker (%)				**0.021**
	No	399 (75.1)	132 (24.9)	
	Yes	75 (64.7)	41 (35.3)	
Factors influencing abdominal pressure (%)				0.361
	No	339 (73.2)	124 (26.8)	
	Yes	175 (70)	75 (30)	
Factors influencing wound healing (%)				0.253
	No	353 (73.5)	127 (26.5)	
	Yes	159 (69.4)	70 (30.6)	
Classification ASA (%)				**<0.001**
	ASA1	140 (79.5)	36 (20.5)	
	ASA2	258 (74.6)	88 (25.4)	
	ASA3	121 (64.4)	67 (35.6)	
	ASA4	3 (33.3)	6 (66.7)	
Incisional hernia characteristics				
Median location (%)				0.578
	No	82 (70.7)	34 (29.3)	
	Yes	437 (73.2)	160 (26.8)	
Lateral location (%)				**0.002**
	No	376 (76.6)	115 (23.4)	
	Yes	116 (64.4)	64 (35.6)	
EHS-W classification (%)				0.057
	W1	226 (77.7)	65 (22.3)	
	W2	187 (69.8)	81 (30.2)	
	W3	86 (68.8)	39 (31.2)	
Recurrent incisional hernia (%)				**0.010**
	No	385 (75)	128 (25)	
	Yes	126 (65.3)	67 (34.7)	

Concomitant surgery (%)				**0.009**
	No	449 (74.5)	154 (25.5)	
	Yes	72 (62.6)	43 (37.4)	
Surgery performed				
Approach (%)				0.642
	Laparocopy	54 (70.1)	23 (29.9)	
	Open	462 (72.6)	174 (27.4)	
Mesh used (%)				**<0.001**
	No	23 (33.3)	46 (66.7)	
	Yes	500 (76.7)	152 (23.3)	
Mesh location (%)				0.269
	underlay	197 (73.5)	71 (26.5)	
	sublay	285 (79.8)	72 (20.2)	
	Inlay (bridge)	4 (80)	1 (20)	
	onlay	9 (69.2)	4 (30.8)	
Intraoperative and early complications				
*Operative time (minutes)		90 [59-125]	90 [60-150]	0.151
Abdominal compression belt (%)				0.561
	No	122 (70.9)	50 (29.1)	
	Yes	396 (73.2)	145 (26.8)	
Medical complications (%)				0.719
	No	466 (73)	172 (27)	
	Yes	49 (71)	20 (29)	
Surgical Site Occurrence (%)				0.118
	No	457 (73.8)	162 (26.2)	
	Yes	58 (65.9)	30 (34.1)	
Dindo-Clavien classification (%)				0.437
	No complication	376 (74.6)	128 (25.4)	
	I	62 (67.4)	30 (32.6)	
	II	25 (73.5)	9 (26.5)	
	III	20 (71.4)	8 (28.6)	
	IV	3 (50)	3 (50)	
Reintervention (%)				0.611
	No	491 (72.8)	183 (27.2)	
	Yes	22 (68.8)	10 (31.3)	

*expressed as mean ± SD or median [IQR]

** chi-squared test or Student test (or Wilcoxon test)