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Anterior Lumbar Interbody Fusion With and Without Previous Abdominal Surgery: Analysis of 5,356 Cases

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Abstract

Purpose: To evaluate the impact of previous abdominal surgery on intraoperative injuries during anterior lumbar interbody fusion (ALIF) and determine whether anatomical risk stratification better predicts intraoperative morbidity than prior surgery alone.

Methods: A retrospective consecutive cohort study included 5,356 adults who underwent ALIF between April 2019 and May 2025. Patients were stratified into two groups: with previous abdominal surgery (n=2,725) and without previous abdominal surgery (n=2,631). Prior procedures were further classified as low, moderate, or high risk according to their anatomical relevance to the anterior ALIF access corridor. The primary outcome was any intraoperative injury. Multivariable logistic regression and 1:1 propensity score matching were performed to improve group comparability and reduce the influence of potential confounding.

Results: Among patients with and without previous abdominal surgery, intraoperative injuries occurred in 95 of 2,725 (3.5%) and 78 of 2,631 (2.96%) patients, respectively (p=0.0963). In the adjusted model, previous abdominal surgery was not independently associated with intraoperative injury (OR 1.42, 95% CI 0.98-2.04; p=0.061), whereas high-risk prior procedures were associated with higher injury odds (OR 1.99, 95% CI 1.07-3.71; p=0.030). The number of previous abdominal surgeries was not independently associated with injury. After propensity score matching, intraoperative injuries occurred in 4.4% of patients with previous abdominal surgery and 3.1% of those without previous surgery (p=0.093).

Conclusion: Previous abdominal surgery alone was not associated with a significant increase in intraoperative injury during ALIF. Prior procedures with greater anatomical relevance to the anterior access corridor were associated with higher injury risk.

INTRODUCTION

Anterior lumbar interbody fusion (ALIF) is an established surgical technique for the treatment of degenerative lumbar spine pathologies, offering recognized biomechanical advantages compared to posterior approaches [1, 2]. The technique provides direct access to the disc space, allowing complete discectomy, restoration of disc height, and effective correction of sagittal alignment through the insertion of larger lordotic implants [3, 4].

Despite the recognized benefits, ALIF presents a specific complication profile, predominantly related to the access approach. The more common retroperitoneal approach places the surgeon near critical vascular structures, with vascular complications (particularly venous injuries) being the most frequently reported adverse events [5–8]. Conversely, the transperitoneal approach (less frequent) may increase the risk of intestinal injury and adhesion formation[5].

The presence of previous abdominal surgery constitutes a point of controversy in the literature, being frequently cited as a relative contraindication due to the theoretical risk of intraoperative complications

[9, 10]. Adhesions and anatomical distortion resulting from previous interventions may obscure anatomical landmarks and hinder retroperitoneal dissection, theoretically increasing the risk of vascular and visceral injuries [11].

However, data on the impact of previous abdominal surgery on intraoperative injuries during ALIF remain inconsistent. Retrospective studies have reported conflicting findings, with some identifying significant associations between previous surgery and intraoperative complications [6, 12] and others finding no statistically significant differences [13, 14]. Large-cohort analyses are therefore needed to clarify this question [11, 15].

METHODS

Study Design and Ethical Approval

We conducted a comparative retrospective consecutive cohort study to assess the association between previous abdominal surgery and intraoperative injuries in patients undergoing ALIF. The study was approved by the Research Ethics Committee and followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for observational studies [15]. Informed consent was waived because of the retrospective design and use of anonymized data.

Population and Patient Selection

Data were retrospectively collected from the institutional database of the Aécio Dias Spine Access Institute (IAAD) from April 2019 to May 2025. The cohort included all consecutive adult patients who underwent ALIF during the study period. Previous abdominal surgery was identified using a dedicated database field.

Inclusion and Exclusion

Patients ≥ 18 years old who underwent ALIF during the study period were included. Surgeries performed outside the established period were excluded.

Demographic and Clinical Variables Analyzed

Analyzed variables included demographic data (age, sex, and categorized body mass index), history of previous spine surgery, operative level distribution, number of operated levels, ALIF type, and specific type of previous abdominal surgery. Previous abdominal procedures were recorded individually and further classified, at the patient level, according to their anatomical relevance to the anterior ALIF access corridor based on the available literature [14, 16–25]. Procedures considered low risk included cesarean section, cholecystectomy, and bariatric surgery, as these were associated predominantly with

intraperitoneal or upper abdominal adhesions and were considered less likely to affect the lower retroperitoneal corridor used for ALIF [16–19, 22]. Procedures considered moderate risk included appendectomy, abdominoplasty, and hernia repair, as these may alter abdominal wall or adjacent intra-abdominal planes without consistently involving deep pelvic or retroperitoneal dissection [20, 21]. Procedures considered high risk included hysterectomy, prostatectomy, and previous ALIF, as these involve pelvic, retroperitoneal, or prior anterior spinal dissection with greater potential to produce fibrosis, adhesions, or anatomical distortion along the lower abdominal and retroperitoneal access corridor [23–25]. In patients with more than one previous abdominal procedure, classification was based on the procedure with the highest anatomical risk. The number of previous abdominal surgeries was also recorded and categorized as 0, 1, 2, or ≥ 3.

Outcomes Analyzed

The primary outcome was any intraoperative injury at the patient level. Secondary outcomes included specific intraoperative injuries (arterial, venous, and epigastric), operative time (skin incision to closure), and intraoperative bleeding (aspirated volume plus gauze weighing).

Statistical Analysis

Analyses were conducted in Python (v3.11.0) using statistical libraries. Significance was set at $p < 0.05$, with 95% confidence intervals (CI) when applicable. Categorical variables were expressed as counts and percentages, and continuous variables as mean ± standard deviation or median (interquartile range), according to distribution. Group comparisons used chi-square or Fisher's exact tests for categorical variables, and Student's t-test or Mann-Whitney test for continuous variables, as appropriate.

Descriptive subgroup analyses were performed according to the anatomical risk classification of previous abdominal surgery (none, low, moderate, and high) and separately according to the number of previous abdominal surgeries (0, 1, 2, and ≥ 3). Multivariable logistic regression models were then used to evaluate the association between previous abdominal surgery and the primary outcome after adjustment for potential confounders, including age, sex, BMI, previous spine surgery, operative level distribution, number of operated levels, and ALIF type. Additional logistic regression models were performed using anatomical risk stratification and number of previous abdominal surgeries as exposure variables.

A sensitivity analysis using 1:1 propensity score matching (nearest neighbor, caliper 0.2) was performed to improve comparability between patients with and without previous abdominal surgery and reduce potential confounding. Matching variables included age, sex, BMI, previous spine surgery, number of operated levels, operative level distribution, and ALIF type. Covariate balance after matching was assessed using standardized mean differences.

RESULTS

A total of 5,356 patients underwent ALIF during the study period: 2,725 with previous abdominal surgery and 2,631 without previous abdominal surgery. Patients with previous abdominal surgery were older, more frequently female, and more often represented in higher BMI categories, whereas previous spine surgery was similarly distributed between groups (Table 1).

Table 1
Baseline demographic and clinical characteristics of patients with and without previous abdominal surgery

General characteristics	With Previous Surgery	Without Previous Surgery	p-valor	Total
Number of Patients, n	2725	2631	-	5356
Mean age, y (standard deviation)	51.9 (12.28)	47.3 (12.12)	< 0.001	49.6 (12.42)
Age range, y	18–93	18–91	-	18–93
Median age, y	50	46	-	48
Sex (male/female), n	608 / 2117	1928 / 703	< 0.001	2536 / 2820
BMI				
x < 25, n (%)	292 (10.7)	273 (10.3)	< 0.001	565 (10.5)
25 ≤ x < 30, n (%)	1279 (46.9)	1457 (55.3)		2736 (51.0)
30 ≤ x < 35, n (%)	916 (33.6)	679 (25.8)		1595 (29.7)
35 ≤ x < 40, n (%)	189 (6.9)	173 (6.5)		362 (6.7)
x > 40, n (%)	49 (1.7)	49 (1.8)		98 (1.8)
Previous spine surgery				
Yes, n (%)	1334 (52.0)	1232 (48.0)	0.0854	2566 (48.0)
No, n (%)	1391 (49.9)	1399 (50.1)		2790 (52.0)

Description: Values are presented as number of patients, mean (standard deviation), median, range, or n (%), as appropriate. BMI was analyzed in predefined categories. P-values compare patients with previous abdominal surgery versus those without previous abdominal surgery. BMI, body mass index.

Among patients with previous abdominal surgery, 3,440 prior abdominal procedures were identified. Cesarean section, abdominoplasty, and cholecystectomy were the most frequent procedures. Most patients had undergone one previous abdominal surgery and were classified in the low-risk category

(Table 2). The distribution of operated levels and the number of fused levels were similar between groups, whereas ALIF construct type differed significantly (Table 3).

Table 2
Distribution, number, and anatomical risk stratification of previous abdominal procedures in patients with prior abdominal surgery

Previous abdominal surgery	**With Previous Surgery**
Cesarean section, n (%)	1620 (47.0)
Cholecystectomy, n (%)	326 (9.5)
Abdominoplasty, n (%)	530 (15.4)
Appendectomy, n (%)	303 (8.7)
Hernia repair, n (%)	278 (8.0)
Hysterectomy, n (%)	187 (5.4)
ALIF, n (%)	35 (1.0)
Prostatectomy, n (%)	14 (0.41)
Bariatric, n (%)	147 (4.3)
Total, n	3440
Number of abdominal surgery	
1, n (%)	1817 (66.7)
2, n (%)	671 (24.62)
3 or more, n (%)	237 (8.7)
Risk Stratification	
Low, n (%)	1582 (57.7)
Moderate, n (%)	880 (32.2)
High n (%)	263 (9.6)

Description: Values are presented as n (%). Percentages for specific previous abdominal procedures were calculated based on the total number of previous abdominal procedures, whereas the distributions for number of abdominal surgeries and risk stratification were calculated at the patient level among individuals with previous abdominal surgery. Because some patients underwent more than one prior abdominal procedure, the total number of procedures exceeds the total number of patients. Risk stratification was defined according to the presumed anatomical relevance of prior surgery to the

anterior access corridor used for anterior lumbar interbody fusion (ALIF). ALIF, anterior lumbar interbody fusion.

Table 3
Operative level distribution, number of fused levels, and ALIF construct type in patients with and without previous abdominal surgery

Level	With Previous Surgery	Without Previous Surgery	p-valor	Total
L5-S1, n (%)	1033 (37.9)	1049 (39.8)	0.2384	2082 (38.9)
L4-L5, n (%)	496 (18.2)	395 (15.0)		891 (16.6)
L4-L5-S1, n (%)	822 (30.1)	824 (31.3)		1646 (30.7)
L3-L4, n (%)	39 (1.4)	38 (1.4)		77 (14.3)
L3-L4-L5, n (%)	111 (4.0)	118 (4.5)		229 (4.3)
L3-L4-L5-S1, n (%)	187 (6.8)	174 (6.6)		361 (6.7)
L2-L3, n (%)	3 (0.11)	2 (0.08)		5 (0.9)
L2-L3-L4, n (%)	4 (0.15)	4 (0.15)		8 (1.5)
L2-L3-L4-L5, n (%)	15 (0.55)	12 (0.46)		27 (5.0)
L2-L3-L4-L5-S1, n (%)	15 (0.55)	15 (0.57)		30 (5.6)
Total operated levels, n	2725	2631	-	5356
Number of levels				
1 Level, n (%)	1571 (57.6)	1484 (56.4)	0.6751	3055 (57.0)
2 levels n (%)	937 (34.4)	946 (36.0)		1883 (35.2)
3 or more levels n (%)	217 (7.9)	201 (7.6)		418 (7.8)
ALIF type				
Stand-Alone, n (%)	1364 (48.7)	1437 (51.3)	0.0015	2801 (52.2)
With posterior supplementation, n (%)	1361 (53.2)	1194 (46.7)		2555 (47.7)

Description: Values are presented as n (%), unless otherwise specified. P-values compare patients with previous abdominal surgery versus those without previous abdominal surgery. ALIF, anterior lumbar

interbody fusion. Stand-alone indicates ALIF performed without posterior instrumentation.

At least one intraoperative injury occurred in 95 of 2,725 patients with previous abdominal surgery (3.5%) and 78 of 2,631 patients without previous abdominal surgery (2.96%; p = 0.0963). Epigastric injury occurred in 19 (0.7%) versus 9 (0.3%) patients (p = 0.1069), arterial injury in 10 (0.4%) versus 8 (0.3%) patients (p = 0.7184), and venous injury in 68 (2.5%) versus 61 (2.3%) patients (p = 0.7391). Operative time was 101.7 ± 36.5 versus 99.3 ± 35.5 minutes (p = 0.8567), and blood loss was 77.0 ± 98.6 versus 69.3 ± 82.7 mL (p = 0.6421) (Table 4).

Table 4
Intraoperative injuries, repair methods, operative time, and blood loss in patients with and without previous abdominal surgery

Intraoperative injury	**With Previous Surgery**	**Without Previous Surgery**	**p-valor**	**Total**
Total patients with injuries, n (%)	95 (3.5)	78 (2.96)	0.0963	173 (3.1)
Patients with epigastric injury, n (%)	19 (0.7)	9 (0.3)	0.1069	28 (0.5)
Patients with arterial injury, n (%)	10 (0.4)	8 (0.3)	0.7184	18 (0.3)
Patients with venous injury, n (%)	68 (2.5)	61 (2.3)	0.7391	129 (2.7)
Injury repair				
Eletrocauter, n (%)	6 (5.2)	4 (5.6)	-	10 (5.1)
Suture, n (%)	25 (21.3)	8 (11.2)	-	32 (16.5)
Barrier hemostatic, n (%)	86 (73.5)	66 (91.6)	-	152 (78.4)
Operative time, min (SD)	101.7 (36.5)	99.3 (35.5)	0.8567	100.6 (36.0)
Bleeding, mL (SD)	77.0 (98.6)	69.3 (82.7)	0.6421	72.9 (95.2)

Description: Values are presented as n (%) or mean (standard deviation), as appropriate. P-values compare patients with previous abdominal surgery versus those without previous abdominal surgery. “Total patients with injuries” refer to the number of patients who sustained at least one intraoperative injury. “Patients with epigastric injury,” “patients with arterial injury,” and “patients with venous injury” refers to the number of patients with at least one injury of that type. Injury repair methods are presented according to the total number of repaired injuries. Among patients with previous abdominal surgery, arterial injuries involved the aorta (n = 1), iliac arteries (n = 6), left iliac artery (n = 6), and right iliac artery (n = 2), whereas venous injuries involved the left iliac vein (n = 60), right iliac vein (n = 8), vena cava (n =

3), and iliolumbar vein (n = 12). Among patients without previous abdominal surgery, arterial injuries involved the aorta (n = 2) and left iliac artery (n = 6), whereas venous injuries involved the left iliac vein (n = 41), right iliac vein (n = 7), vena cava (n = 9), and iliolumbar vein (n = 4). The number of injured vascular structures exceeds the number of patients with arterial or venous injury because more than one vascular structure could be injured in the same patient. SD, standard deviation.

Across anatomical risk strata, at least one intraoperative injury occurred in 51 of 1,582 low-risk patients (3.2%), 29 of 880 moderate-risk patients (3.3%), 15 of 263 high-risk patients (5.7%), and 78 of 2,631 patients without previous abdominal surgery (2.96%). According to the number of prior operations, injury rates were 3.5% after one surgery, 3.9% after two surgeries, and 2.5% after three or more surgeries, without a clear numerical gradient (Tables 5 and 6).

Table 5
Intraoperative injuries, operative time, and blood loss according to anatomical risk stratification of previous abdominal surgery

Intraoperative injury	**Low Risk**	**Moderate Risk**	**High Risk**	**Without Previous Surgery**
Total patients with injuries, n (%)	51 (3.2)	29 (3.3)	15 (5.7)	78 (2.96)
Patients with epigastric injury, n (%)	9 (0.6)	6 (0.7)	4 (1.5)	9 (0.3)
Patients with arterial injury, n (%)	3 (0.2)	1 (0.1)	6 (2.3)	8 (0.3)
Patients with venous injury, n (%)	39 (2.5)	22 (2.5)	7 (2.7)	61 (2.3)
Operative time, min (SD)	101.1 (32.5)	101.7 (30.4)	105.2 (36.8)	99.3 (35.5)
Bleeding, mL (SD)	76.5 (90.4)	76.6 (95.7)	86.2 (113.0)	69.3 (82.7)

Description: Values are presented as n (%) or mean (standard deviation), as appropriate. Risk stratification was based on the presumed anatomical relevance of previous abdominal surgery to the anterior access corridor used for anterior lumbar interbody fusion. SD, standard deviation.

Table 6
Intraoperative injuries, operative time, and blood loss according to the number of previous abdominal surgeries

Intraoperative injury	1 surgery	2 surgeries	3 or more surgeries	Without Previous Surgery
Total patients with injuries, n (%)	63 (3.5)	26 (3.9)	6 (2.5)	78 (2.96)
Patients with epigastric injury, n (%)	11 (0.6)	7 (1.0)	1 (0.4)	9 (0.3)
Patients with arterial injury, n (%)	4 (0.2)	4 (0.6)	2 (0.8)	8 (0.3)
Patients with venous injury, n (%)	48 (2.6)	17 (2.5)	3 (1.3)	61 (2.3)
Operative time, min (SD)	101.6 (33.0)	101.6 (31.4)	103.1 (29.2)	99.3 (35.5)
Bleeding, mL (SD)	77.4 (93.3)	76.6 (95.6)	80.7 (100.6)	69.3 (82.7)

Description: Values are presented as n (%) or mean (standard deviation), as appropriate. Patients with previous abdominal surgery were stratified according to the number of prior abdominal procedures as one, two, or three or more surgeries, and were compared with patients without previous abdominal surgery. SD, standard deviation.

In the adjusted logistic regression model, previous abdominal surgery as a binary exposure was not independently associated with intraoperative injury (OR 1.42, 95% CI 0.98–2.04; p = 0.061). Increasing age was independently associated with injury (OR 1.03 per year, 95% CI 1.02–1.04; p < 0.001), as were male sex (OR 1.60, 95% CI 1.12–2.28; p = 0.010) and a greater number of operated levels (OR 1.33, 95% CI 1.07–1.65; p = 0.009). Previous spine surgery (OR 1.26, 95% CI 0.92–1.72; p = 0.154) and stand-alone ALIF (OR 0.99, 95% CI 0.72–1.37; p = 0.963) were not independently associated with injury.

When prior procedures were stratified by anatomical risk, only the high-risk subgroup was independently associated with intraoperative injury compared with patients without previous abdominal surgery (OR 1.99, 95% CI 1.07–3.71; p = 0.030). The low-risk subgroup (OR 1.46, 95% CI 0.95–2.24; p = 0.087) and moderate-risk subgroup (OR 1.25, 95% CI 0.79–1.96; p = 0.349) were not significantly associated with injury. The number of previous abdominal surgeries was also not independently associated with injury: one prior surgery (OR 1.42, 95% CI 0.96–2.08; p = 0.076), two prior surgeries (OR 1.57, 95% CI 0.94–2.60; p = 0.085), and three or more prior surgeries (OR 0.96, 95% CI 0.38–2.39; p = 0.919).

Propensity score matching produced 1,308 pairs matched for age, sex, BMI, previous spine surgery, number of operated levels, ALIF type, and operated level. Covariate balance was adequate, with standardized mean differences below 0.10. In the matched cohort, intraoperative injuries occurred in 4.4% of patients with previous abdominal surgery and 3.1% of those without previous surgery (p = 0.093).

DISCUSSION

Previous abdominal surgery, when analyzed as a binary exposure, was not associated with a statistically significant increase in overall intraoperative injury during ALIF. The result was similar after propensity score matching. Although prior abdominal surgery is often considered a marker of greater technical difficulty during anterior lumbar exposure, published evidence indicates that risk may vary according to the anatomical region involved [1–3, 6, 7].

After stratification by anatomical risk, the high-risk subgroup had higher odds of intraoperative injury in the adjusted model, whereas the low- and moderate-risk subgroups did not. The relationship between the prior procedure and the anterior retroperitoneal corridor may therefore be more informative than the presence of prior abdominal surgery alone. The number of previous abdominal procedures was not independently associated with the primary outcome.

Cesarean section was classified as a low-risk procedure because it is generally performed through a low transverse incision with intraperitoneal access, without retroperitoneal dissection. Adhesions resulting from this procedure tend to remain confined to the intraperitoneal pelvic compartment rather than the retroperitoneal space used during ALIF [16, 18]. Although cesarean section may cause abdominal wall fibrosis involving the aponeurosis and rectus abdominis muscles at the entry site of the anterior approach, this change tends primarily to make the initial opening of the abdominal wall more difficult, without producing significant distortion of the retroperitoneal corridor used to access the lumbar spine. Recent large-scale data similarly found no significant increase in ALIF complications after prior cesarean section, whereas non-obstetric abdominal surgery was associated with higher risk [17]. Cholecystectomy and bariatric surgery were also classified as low risk because they are generally located in the upper abdomen and anatomically distant from the corridor used for ALIF, despite their potential to generate adhesions [19, 22].

Moderate-risk procedures were grouped separately because they may alter the abdominal wall or adjacent intra-abdominal planes without consistently involving deep pelvic or retroperitoneal dissection. Appendectomy can generate adhesions, but these are usually localized to the right lower quadrant and lateral to the typical ALIF corridor. Abdominoplasty does not enter the peritoneal cavity, but it can produce extensive anterior abdominal wall scarring and vascular alteration, which may make the initial dissection and retraction more demanding [20]. Hernia repair was also retained in the moderate-risk group because its effect depends on the technique and anatomical location. Preperitoneal mesh repair can make later pelvic dissection more difficult, whereas more superficial anterior repairs are less likely to distort the operative corridor directly [21].

The high-risk category included procedures with more direct anatomical overlap with the ALIF access corridor. Hysterectomy is associated with frequent pelvic adhesions and involves dissection in planes that are close to the structures encountered during L5-S1 exposure [23]. Prostatectomy can produce marked pelvic anatomical changes and fibrosis in the space of Retzius (retropubic space) and adjacent retroperitoneal tissues [24]. Previous ALIF is particularly relevant because revision anterior exposure

requires individualized planning regarding whether to re-enter through the prior ipsilateral corridor or use a contralateral route, and whether the exposure should be performed from the right or left. Re-entering through the same side may require dissection through dense perivascular and periureteral scar, whereas a contralateral route may provide a less scarred plane but introduces different level-specific vascular relationships. Same-level reoperation at L5-S1 is particularly complex because fibrosis may tether the iliac vessels to the disc space; by contrast, adjacent-level extensions to more cephalad levels may encounter less scarred planes, although exposure remains technically demanding. In a series from our group of 135 revision ALIF procedures performed for TLIF/PLIF cage removal, four vascular injuries occurred, all involving the left iliac vein and all managed intraoperatively without sequelae [11]. Earlier evidence likewise showed higher complication rates for same-level revisions, which were typically in the lower lumbar spine, than for adjacent-level extensions, which were more often performed at upper lumbar levels [25]. These observations provide a plausible anatomical basis for why the high-risk subgroup behaved differently from the other strata in the adjusted analysis.

The number of prior abdominal surgeries was not independently associated with intraoperative injury. Risk may therefore not increase simply with the number of procedures: one operation involving deep pelvic or retroperitoneal dissection may be more relevant than several procedures performed in anatomically distant regions. This may explain why the count-based model was less informative than the anatomy-based stratification.

Operative time and blood loss did not differ significantly between groups. Previous abdominal surgery therefore did not appear to increase operative burden when considered as a binary exposure. Preoperative assessment may instead prioritize prior procedures involving the pelvic, retroperitoneal, or anterior lumbar corridor [1–3, 7, 15].

The study included a large retrospective cohort, standardized data collection, multivariable adjustment, and propensity score matching. The anatomy-based classification enabled the evaluation of heterogeneous prior abdominal procedures according to their expected relationship with the ALIF access corridor. As a retrospective single-center analysis, the findings should be interpreted in light of possible residual confounding and variation in the completeness of historical records. The proposed anatomical classification represents a literature- and anatomy-informed framework that warrants prospective validation using direct or standardized measures of adhesions and retroperitoneal fibrosis. Because individual vascular injury subtypes were uncommon, the corresponding subgroup estimates have wider uncertainty and should be confirmed in larger multicenter cohorts.

CONCLUSION

Previous abdominal surgery, analyzed as a binary exposure, was not associated with a significant increase in overall intraoperative injury during ALIF. High-risk prior procedures with greater anatomical overlap with the anterior access corridor were associated with higher injury odds after adjustment, whereas the number of previous abdominal surgeries was not. Preoperative assessment may therefore

benefit from considering the anatomical location and nature of prior surgery rather than its presence or count alone.

DECLARATIONS

Disclosure

The authors declare that they have no conflicts of interest in relation to the content of this manuscript.

Ethics declaration

This study was approved by the Prevent Senior Research Ethics Committee (No. 91708525.0.0000.0063), ensuring compliance with ethical standards for research involving human subjects. Informed consent was waived due to the retrospective nature of the study and the use of anonymized data.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Data availability

All data used were openly available.

Conflict of interest

The authors have no competing interests to declare that are relevant to the content of this article.

Clinical Trial Number

Not applicable.

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