



Original Article

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Incidence and Risk Factors of Postoperative Ileus in Oblique Lumbar Interbody Fusion Surgery: A Retrospective Study

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Purpose: Postoperative ileus (POI) typically occurs after abdominal surgery but can also affect patients undergoing spinal surgery via the lateral retroperitoneal approach, such as oblique lumbar interbody fusion (OLIF). Therefore, this study aimed to investigate the incidence and risk factors associated with POI in OLIF.

Methods: This retrospective study examined a cohort of 465 patients who underwent OLIF from 2015 to 2023. Patient demographics, comorbidities, pre- and postoperative laboratory test results, and perioperative status were assessed. General condition of patients was assessed using the modified frailty index-11 (mFI-11), prognostic nutrition index, and geriatric nutrition risk index. In OLIF, the size and location of the psoas muscle involved in retraction and its relationship with the vertebral body were also investigated.

Results: POI occurred in 19 patients (4%). Lower mFI-11 was linked to a higher risk of POI. While psoas muscle size had no significant effect on the risk of POI, the anterior location of the psoas muscle relative to the vertebral body was associated with a higher occurrence of POI. Multivariate logistic regression analysis of POI identified mFI-11 as the most significant risk factor ($p = 0.003$).

Conclusion: This study demonstrated that frailty and nutritional status can influence the occurrence of POI after OLIF. Additionally, bowel manipulation associated with the location of psoas muscle and vertebral body was identified as a risk factor. Proper assessment and improvement in patient frailty and nutritional status before surgery can help predict and prevent the occurrence of postoperative POI.

Keywords: Paralytic ileus, Frailty, Nutrition assessment, Psoas muscles, Oblique lumbar interbody fusion



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INTRODUCTION

Oblique lumbar interbody fusion (OLIF) has emerged as an effective and widely used surgical method for treating lumbar degenerative diseases, such as spinal stenosis, spondylolisthesis, and spinal deformity.¹⁻³ OLIF involves dissecting the abdominal muscles to perform a retroperitoneal approach and accessing the ante-psoas corridor anteriorly to the psoas muscle. Unlike

traditional posterior approaches in spinal surgery, OLIF involves bowel manipulation, potentially influencing the occurrence of postoperative ileus (POI).

POI is characterized by nonmechanical blockage of the intestine that commonly develops postsurgery. Persistent ileus postsurgery can manifest with symptoms such as bloating, abdominal pain, nausea, and vomiting, thereby impairing patient mobility, prolonging the length of hospital stay, and resulting in

overall surgical dissatisfaction.⁴⁻⁶ Management strategies for POI include encouraging patient mobilization, fluid replacement, limiting narcotic medication, and, depending on the severity, implementing bowel rest, nasogastric tube drainage, and medical management.^{4,7}

Generally, POI occurs in approximately 10%–27% of abdominal surgeries.^{8,9} In spinal surgeries, the incidence of POI varies between 1.9% and 23.1%, depending on the surgical method.^{5,10-12} Previous studies have indicated that the risk of POI increases with anterior lumbar interbody fusion (ALIF) and OLIF compared to that with posterior spine surgery approaches.⁵ However, recent data show that the occurrence of POI after OLIF was 3.9%, which is not significantly higher than previously reported rates after spinal surgeries.¹³ Therefore, research on the incidence of POI, specifically following the OLIF approach, remains inadequate.

Most spinal surgeries are performed on elderly patients, highlighting the increasing importance of frailty in spinal surgery. Frailty, characterized by decreased physiological reserve in elderly patients, leads to increased vulnerability to stressful situations such as surgery and is a known risk factor for postoperative complications.^{14,15} Therefore, increased frailty is likely to influence the occurrence of POI.

This study aimed to investigate the influence of existing patient conditions, frailty, and nutrition, as well as the size and location of the psoas muscle, on the occurrence of POI.

MATERIALS AND METHODS

1. Study Design and Patients

We obtained informed consent from all the patients and approval from the Institutional Review Board of Chung-Ang University Hospital (2306-006-19473). This retrospective study included 465 patients who underwent OLIF from 2015 to 2023 in our hospital. Patient demographics including age, sex, body mass index (BMI), fusion level, and preoperative diagnosis were also investigated. The study focused on patients with degenerative spinal diseases such as spinal stenosis, spondylolisthesis, and degenerative spinal deformities. The exclusion criteria were as follows: (1) history of abdominal or intestinal surgery, (2) intestinal diseases, such as Crohn disease, and (3) infectious spondylitis.

2. Surgical Technique

The patient is placed in the right lateral position under general endotracheal anesthesia. After draping, the surgical level is

confirmed using C-arm fluoroscopy. A 4- to 5-cm transverse skin incision is performed centered about 2 cm from the anterior margin of the target disc. The external oblique, internal oblique, and transverse abdominal musculature are sequentially bluntly dissected to approach the retroperitoneal space. The retroperitoneal fat and peritoneum are carefully retracted on the ventral side to confirm the anterior margin of the psoas muscle. The psoas muscle is retracted to the dorsal side using a Deaver retractor to secure the space for the target disc. After the guide wire is placed in the target disc, the OLIF system (Medtronic, Memphis, TN, USA) is installed to secure the surgical space. After that, the intervertebral disc is removed, and endplate preparation is performed using a shaver and curette. An appropriately sized trapezoid-shaped polyether ether ketone cage (Clydesdale; Medtronic) filled with demineralized bone matrix (Grafton, Medtronic) is inserted into the intervertebral space using an orthogonal maneuver. The patient is then placed in the prone position, and posterior fixation is performed using a percutaneous pedicle screw system (Longitude system, Medtronic).

3. Clinical and Laboratory Assessments

Preoperative and postoperative laboratory tests, such as white blood cell counts, lymphocyte counts, and hemoglobin, platelet, glucose, albumin, urea nitrogen, creatinine, sodium, potassium, and chloride levels were examined. Anesthesia duration, operative time, and estimated blood loss were investigated perioperatively. Additionally, the amounts of intraoperative remifentanyl and propofol used as anesthetic agents and the cumulative opioid dosage were investigated.

4. Postoperative Ileus

POI was clinically defined as the presence of 2 or more of the following 5 criteria persisting more than 3 days postsurgery: (1) ongoing nausea and vomiting, (2) absence of flatus over the last 24-hour period, (3) inability to tolerate an oral diet over the last 24-hour period, (4) ongoing abdominal distention, and (5) radiological confirmation.¹⁶ In this study, POI was clinically confirmed by including radiological confirmation. According to these criteria, patients were categorized into either nonileus or ileus group.

5. Modified Frailty Index, Prognostic Nutrition Index, and Geriatric Nutritional Risk Index

The American Society of Anesthesiologists (ASA) classification system was used to determine physical status.¹⁷ Modified Frailty Index (mFI-11) was previously described by Velanovich

et al.¹⁸ who assigned individuals a score based on 11 variables present in the Canadian Study of Health and Aging Frailty Index. The mFI-11 comprises 11 variables: impairments in activities of daily living, history of diabetes mellitus, lung diseases, congestive heart failure, myocardial infarction, cardiac conditions, arterial hypertension, clouding or delirium, cerebrovascular problems, history of stroke, and decreased peripheral pulse rates.

Prognostic Nutrition Index (PNI), a combined nutrition-inflammatory score based on the serum albumin level and lymphocyte count ($10 \times \text{serum albumin [g/dL]} + 0.005 \times \text{total lymphocyte count [cells/mm}^3\text{]}$), was calculated.^{19,20} Geriatric Nutritional Risk Index (GNRI) was calculated using the following equation: $\text{GNRI} = (1.489 \times \text{albumin [g/L]}) + [41.7 \times (\text{weight/ideal weight})]$. The weight/ideal weight ratio was set to 1 when the actual weight exceeded the ideal weight. The ideal weight was

calculated using the Lorenz equation as follows: for men, $\text{height} = 100 - ([\text{height} - 150]/4)$; and for women, $\text{height} = 100 - ([\text{height} - 150]/2.5)$.^{21,22}

6. Size and Location of Psoas Muscle

The size of the psoas muscle was measured using magnetic resonance imaging on both sides of the psoas muscle at the L3–4 and L4–5 levels (Fig. 1). The location of the Psoas muscle was compared and analyzed in cases where the distance was $D < -10$ mm (Fig. 2A), $-10 \text{ mm} < D < 10$ mm (Fig. 2B), and $D > 10$ mm (Fig. 2C), based on the anterior margin of the vertebral body at the L3–4 and L4–5 levels (Fig. 2).

7. Statistical Analysis

All statistical analyses were performed using IBM SPSS Sta-

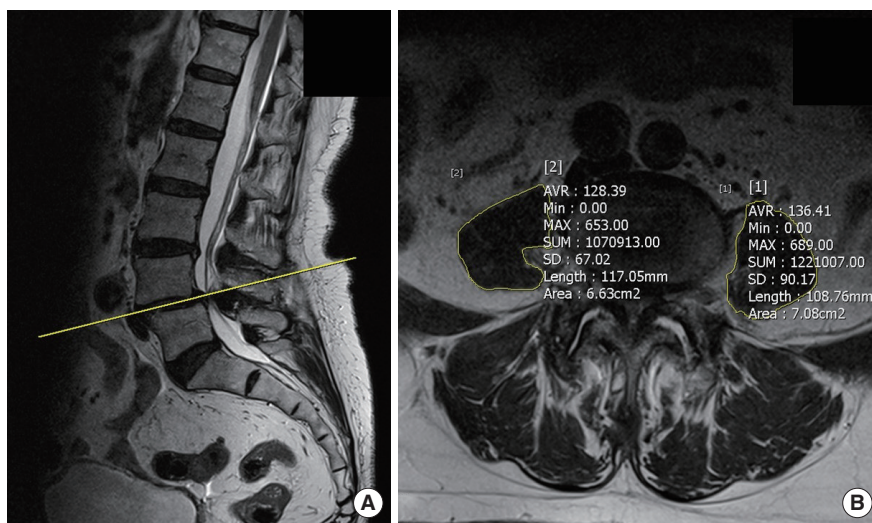


Fig. 1. Size of psoas muscle at the L4–5 disc level. The sagittal (A) and axial views (B). AVR, average volume ratio; SD, standard deviation.

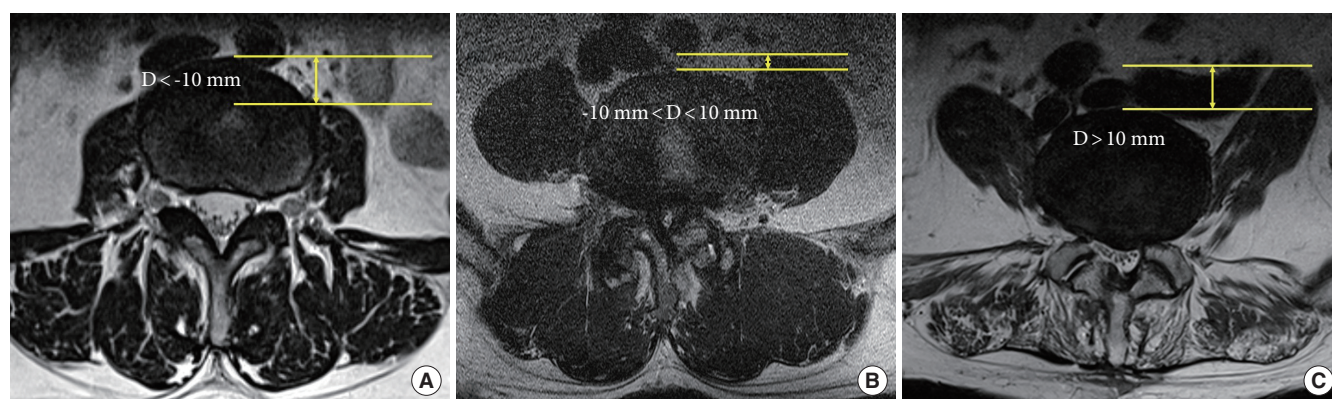


Fig. 2. Location of psoas muscle and vertebral body (distance [D] between the anterior corner of psoas muscle and the anterior corner of the vertebral body); (A) $D < -10$ mm, (B) $-10 \text{ mm} < D < 10$ mm, and (C) $D > 10$ mm.

tistics ver. 21.0 (IBM Co., Armonk, NY, USA). Variables in the nonileus and ileus groups were compared using the independent t-test, Mann-Whitney U-tests, and chi-square tests. Multivariate logistic regression analysis was used to identify the risk factors for POI.

RESULTS

1. Patient Demographics

We investigated the occurrence of POI in 465 patients who underwent OLIF from 2015 to 2023. Overall, 19 of patients (4.1%) developed POI. The patients were divided into nonileus and ileus groups for comparative analyses. The mean age was 69.84 ± 6.24 years in the nonileus group and 72.15 ± 7.15 years in the ileus group, indicating a statistically significant higher incidence of POI in older patients ($p = 0.039$). The occurrence of ileus was not associated with sex, BMI, fusion level, or preoperative diagnosis. The average duration of ileus was 3.75 ± 1.01 days. All patients recovered after bowel decompression using nasogastric tube drainage, and normovolemia was maintained with fluid therapy (Table 1).

2. Preoperative, Postoperative, and Preoperative State

Preoperative and postoperative laboratory tests revealed that the preoperative hemoglobin and albumin levels were lower in the ileus group than in the nonileus group. Additionally, the postoperative hemoglobin and albumin levels were significantly lower in the ileus group than in the nonileus group ($p < 0.05$).

Table 1. Comparison of characteristics of patients with and without postoperative ileus

Characteristic	Nonileus (n = 446)	Ileus (n = 19)	p-value
Age (yr)	69.84 ± 6.24	72.15 ± 7.15	0.039*
Sex, male:female	180:266	6:13	0.592
Body mass index (kg/m ²)	24.89 ± 3.23	26.99 ± 3.14	0.052
Fusion level			0.551
1:2:3:4:5	185:153:81:25:2	1:1:2:15	
Diagnosis			0.227
Spinal stenosis	308	15	
Spondylolisthesis	125	4	
Degenerative deformity	13	0	
Ileus day		3.75 ± 1.01	
Hospital stay (day)	13.80 ± 14.36	24.35 ± 34.83	0.029*

Values are presented as mean $\pm$ standard deviation or number.

* $p < 0.05$, statistically significant differences.

(Table 2).

No significant differences were observed in anesthesia duration, operative time, or estimated blood loss between the nonileus and ileus groups. Additionally, no significant differences were noted in the intraoperative use of remifentanyl and propofol or in the cumulative opioid dosage postoperatively between the nonileus and ileus groups ($p > 0.05$) (Table 3).

3. ASA Physical Status Classification, mFI-11, PNI, and GNRI

The ASA physical status classification was I (2 patients), II (40 patients), III (395 patients), and IV (9 patients) in the nonileus group and II (1 patient), III (15 patients), and IV (3 patients)

Table 2. Comparison of preoperative and postoperative laboratory test results in patients with and without postoperative ileus

Variable	Nonileus (n = 446)	Ileus (n = 19)	p-value
Preoperative laboratory			
WBC ($10^9/L$)	6.88 ± 2.04	6.62 ± 2.07	0.465
Lymphocyte ($10^9/L$)	1.96 ± 0.68	1.95 ± 0.65	1.000
Hemoglobin (g/dL)	12.82 ± 1.52	11.78 ± 1.83	$< 0.001^*$
Platelet ($\times 10^3/mm^3$)	244.89 ± 74.30	221.70 ± 75.85	0.076
Glucose (mg/dL)	121.49 ± 39.87	19.45 ± 57.03	0.286
Albumin (g/dL)	4.13 ± 0.43	3.83 ± 0.56	0.003^*
Urea nitrogen (mg/dL)	19.16 ± 6.45	19.45 ± 10.34	0.165
Creatinine (mg/dL)	0.80 ± 0.37	1.04 ± 0.84	0.088
Sodium (mEq/L)	138.78 ± 2.82	137.79 ± 3.17	0.076
Potassium (mEq/L)	4.21 ± 0.40	4.32 ± 0.56	0.220
Chloride (mEq/L)	103.99 ± 6.89	105.29 ± 3.78	0.260
Postoperative laboratory (1 day)			
WBC ($10^9/L$)	10.60 ± 3.40	10.47 ± 3.41	0.813
Lymphocyte ($10^9/L$)	1.01 ± 0.47	1.00 ± 0.39	0.508
Hemoglobin (g/dL)	11.16 ± 1.38	10.44 ± 1.40	0.003^*
Platelet ($\times 10^3/mm^3$)	199.43 ± 59.67	192.32 ± 68.45	0.504
Glucose (mg/dL)	162.30 ± 52.39	179.89 ± 55.55	0.058
Albumin (g/dL)	4.02 ± 0.54	3.65 ± 0.35	$< 0.001^*$
Urea nitrogen (mg/dL)	22.47 ± 5.75	24.01 ± 8.32	0.154
Creatinine (mg/dL)	0.72 ± 0.25	1.04 ± 0.92	0.038
Sodium (mEq/L)	136.25 ± 8.32	136.39 ± 3.15	0.916
Potassium (mEq/L)	3.96 ± 0.36	4.15 ± 0.49	0.068
Chloride (mEq/L)	103.93 ± 2.83	104.24 ± 3.53	0.548

Values are presented as mean $\pm$ standard deviation.

WBC, white blood cell.

* $p < 0.05$, statistically significant differences.

Table 3. Comparison of perioperative state and opioid doses in patients with and without postoperative ileus

Variable	Nonileus (n = 446)	Ileus (n = 19)	p-value
Perioperative state			
Anesthesia time (min)	265.77 ± 73.69	266.53 ± 73.94	0.953
Operative time (min)	209.19 ± 166.92	209.74 ± 67.31	0.964
Estimated blood loss (mL)	201.23 ± 166.92	232.37 ± 275.29	0.338
Remifentanyl (μg/kg)	33.31 ± 5.92	32.15 ± 5.58	0.250
Propofol (mg/kg)	12.13 ± 3.38	12.68 ± 3.57	0.364
Opioid (mgOME/kg)	6.44 ± 1.70	6.04 ± 1.44	0.175

Values are presented as mean ± standard deviation.

Table 4. Comparison of the ASA classification, modified frailty index, PNI, and GNRI in patients with and without postoperative ileus

Variable	Nonileus (n = 446)	Ileus (n = 19)	p-value
ASA classification			0.010*
1:2:3:4:5	2:40:395:9:0	0:1:15:3:0	
Modified frailty index			< 0.001*
0	91	1	
0.09	115	1	
0.18	146	2	
> 0.27	94	16	
PNI	41.30 ± 4.30	38.32 ± 5.62	0.003*
GNRI	108.05 ± 9.22	106.14 ± 9.66	0.241
No risk (GNRI > 98)	387	15	0.398
Low risk (GNRI 92–98)	34	2	
Moderate risk (GNRI 82–92)	21	2	
Major risk (GNRI < 82)	4	0	

Values are presented as number or mean ± standard deviation.

ASA, American Society of Anesthesiology; PNI, prognostic nutrition index; GNRI, geriatric nutritional risk index.

*p < 0.05, statistically significant differences.

in the ileus group, showing a significant difference between the 2 groups ($p = 0.010$). mFI-11 was 0, 0.09, 0.18, and > 0.27 for 91, 115, 146, and 94 patients, respectively, in the nonileus group and 0, 0.09, 0.18, and > 0.27 for 1, 1, 2, and 16 patients, respectively, in the ileus group, showing a significant difference between the 2 groups ($p < 0.001$). Additionally, PNI was 41.30 ± 4.30 in the nonileus group and 38.32 ± 5.62 in the ileus group, indicating significantly lower PNI in the ileus group ($p = 0.003$) (Table 4).

Table 5. Comparison of size and location of psoas muscle in patients with and without postoperative ileus

Variable	Nonileus (n = 446)	Ileus (n = 19)	p-value
Psoas muscle (cm^2/m^2) (L3–4)	6.29 ± 2.44	6.08 ± 2.70	0.615
Psoas muscle (cm^2/m^2) (L4–5)	7.37 ± 2.56	7.02 ± 2.48	0.758
Psoas muscle location (L3–4)			0.050
A:B:C	76:357:13	3:14:2	
Psoas muscle location (L4–5)			0.002*
A:B:C	17:346:83	0:16:3	

Values are presented as mean ± standard deviation or number.

*p < 0.05, statistically significant differences.

Table 6. Multivariate logistic regression analysis of risk factors for postoperative ileus

Modified frailty index	Exp (B) (95% CI)	p-value
0	-	-
0.09	1.155 (0.125–10.625)	0.899
0.18	1.400 (0.165–11.900)	0.758
> 0.27	20.359 (2.830–146.473)	0.003*

*p < 0.05, statistically significant differences.

4. Size and Location of Psoas Muscle

No significant difference was noted in the size of psoas muscle at the L3–4 and L4–5 levels between the nonileus and ileus groups. However, POI was more frequently observed in patients whose psoas muscle was positioned > 10 mm anterior to the anterior margin of the vertebral body (L3–4; $p = 0.050$, L4–5; $p = 0.002$) (Table 5).

5. Multivariate Logistic Regression Analysis

Multivariate logistic regression analysis of the risk factors affecting the occurrence of POI revealed that mFI-11 of 0.27 or higher was the most influential risk factor for the occurrence of POI ($p = 0.003$) (Table 6).

DISCUSSION

The postoperative state is a unique situation that triggers an appropriate response to injury through a cascade of pro-inflammatory mediators and pain signals.^{23–25} POI occurs due to enteric neural dysfunction and inflammatory response to surgical stress, as well as the effects of anesthetics and opioid pain medications.^{24,25}

POI was defined as a normal physiological response postsur-

gery. The onset of POI is a secondary reaction to inhibitory reflexes, inflammation, and release of neurohumoral peptides resulting from intestinal manipulation and anesthetic exposure. Generally, gastric and small intestinal motility recovers within a few hours postsurgery under general anesthesia, while colonic motility returns within 24–48 hours. An ileus that persists for more than 3 days can be considered a pathological condition.²⁶ POI can result in prolonged length of hospital stay, higher incidence of deep vein thrombosis and pulmonary embolism, and an overall increase in medical costs due to the development of other medical complications.^{5,27}

The incidence of POI postspinal surgery varies depending on the surgical method, ranging from 1.9% to 23.1%.^{5,10–12} Steven et al.⁴ investigated the incidence of POI using a nationwide inpatient sample database for anterior, posterior, and combined anterior-posterior lumbar fusion and reported that the incidence of POI after posterior lumbar fusion was 2.6%, which was lower than the 7.49% after anterior lumbar fusion and the 8.41% after combined anterior-posterior lumbar fusion. Patients who developed POI had prolonged length of hospital stay and increased medical costs. This study identified the following risk factors for POI: male sex, 3 or more fusion levels, alcohol abuse, blood loss, anemia, chronic lung disease, fluid/electrolyte disorders, and weight loss. In our study, the incidence of POI after OLIF, which can be considered a combined anterior/posterior lumbar fusion approach, was 4.1%. Moreover, our study revealed old age, preoperative and postoperative hemoglobin levels, albumin levels, mFI-11, PNI, and location of the psoas muscle as risk factors for POI.

Anesthetic drugs are known to have inhibitory effects on gastrointestinal (GI) motility. Additionally, opioids stimulate μ -opioid receptors in the GI tract, leading to decreased intestinal motility and side effects.²⁸ Some studies have reported a correlation between remifentanyl and opioids and the occurrence of POI during spine surgery.^{13,29} However, the impact of short-acting opioids used in anesthesia, such as remifentanyl, on POI remains poorly understood. Moreover, the risk factors for POI and cumulative intraoperative opioid doses have shown limited consistency.⁹ In our study, remifentanyl, propofol, and opioids did not affect the occurrence of POI.

Previous studies have reported various risk factors for POI. According to Chang et al.,³⁰ a systematic review and meta-analysis identified multiple causes, including age, male sex, anemia, liver disease, gastroesophageal reflux disease, history of chronic lung disease, preoperative weight loss, smoking, fluid and electrolyte imbalances, and surgical range ≥ 3 . Another study on

POI after OLIF reported that, unlike previous findings, inadvertent endplate fracture and the amount of intraoperative remifentanyl were associated with POI.¹³

In contrast, our study of OLIF revealed that factors such as surgical range, operation time, use of anesthetic agents, and opioid-based pain control were less significant. Instead, POI was more closely associated with frailty indicators such as old age, ASA classification, mFI-11, and nutrition-related factors such as hemoglobin level, albumin level, and PNI. This suggests that the occurrence POI is more closely linked to patient frailty and nutritional state than to the technical aspects of surgery, such as size and duration.

Other studies have also found that patient age was closely associated with the risk of POI.^{6,30} Older patients often exhibit decreased GI function and bowel motility.³¹ In our study, the incidence of POI was higher in older patients.

Frailty is an age-related condition characterized by a decreased physiological reserves and increased susceptibility to physiological insults. It is a known predictor of postoperative complications.³² A prominent method for measuring frailty is the mFI-11, which has been shown to be closely related to postoperative complications in numerous studies and has proven to be a useful predictive factor in spine surgery.^{33,34} Frailty is an independent predictor of postoperative complications, length of hospital stay, and mortality⁶ and is closely associated with surgical site infection, major adverse events, prolonged length of stay, unplanned admission, and additionally affects the occurrence of POI. In frail patients, the relative increased risk of POI after colonic resection was reported to be 59%.³⁵ In our study on POI in spine surgery, frailty was the most influential factor in the occurrence of POI.

POIs are associated with the release of cytokines and other inflammatory mediators.⁷ As patients' frailty and nutritional status deteriorate, their response to inflammatory reactions decreases, which could be a contributing factor to the increased incidence of POI.

Many studies have reported a correlation between the duration and extent of spinal surgery and the occurrence of POI.^{4,10,29,30} Prolonged surgery time and larger surgical areas in spinal surgery can lead to increased anesthesia duration, greater blood loss, and higher need for blood transfusions. Consequently, other studies have shown that POI is more common in lumbar spine surgery than in cervical and thoracic spine surgery and when major spine surgery involves more than 3 levels. Deng et al.³⁶ reported surgical duration and estimated blood loss as risk factors for POI. However, in our study, OLIF was performed as a

minimally invasive surgery without the insertion of drainage catheters, resulting in relatively shorter anesthesia duration and surgery times as well as less estimated blood loss. Therefore, no significant differences were observed between the 2 groups.

In our study, when performing OLIF, we approached the retroperitoneal area through the ante-psoas corridor. We investigated whether bowel retraction via a retroperitoneal approach influenced the occurrence of POI and found that the incidence of POI was higher when the psoas muscle protruded anteriorly to the vertebral body, rather than due to the size of the psoas muscle. A surgical trajectory requiring bowel manipulation can affect the occurrence of POI. Thus, ALIF and OLIF can cause less postoperative pain compared with posterior spine fusion, which involves paravertebral muscle dissection.³⁷ However, ALIF and OLIF can frequently cause POI due to bowel manipulation.^{12,13} Particularly, as observed in this study, when the psoas muscle was located anterior to the vertebral body, the risk of bowel manipulation increased, leading to a higher incidence of POI.

The management principles for POI include restoring normal physiology, inserting a nasogastric tube, accurately monitoring fluid input and output, identifying and treating secondary causes, and consulting with a nutritional team.³⁸ In this study, POI management involved early ambulation, minimizing opioid use, and utilizing nonsteroidal anti-inflammatory drugs or acetaminophen for pain control. Additionally, normovolemic intravenous hydration was administered, electrolyte imbalances were corrected, and adequate nutrition was provided through total parenteral nutrition.

This study has some limitations. First, the sample size of 465 patients may not be sufficiently large to capture all potential variables influencing POI. Second, the retrospective nature of the data analysis may affect accurate assessment of the occurrence of ileus, given the complex mechanisms and various influencing factors involved. These factors can introduce bias into the comparative analysis of these influences. Additionally, our study has a limitation in that it presents the total surgical time rather than the surgical time to the lateral approach. However, the time required for percutaneous posterior screw fixation was relatively consistent, resulting in no significant differences in the total surgical time. Future studies are expected to provide more accurate findings by focusing specifically on the surgical time of the lateral approach in relation to the occurrence of POI. Future prospective multicenter studies are warranted to derive generalized results.

CONCLUSION

This study demonstrated that frailty and nutritional status can influence the occurrence of POI after OLIF. Additionally, bowel manipulation associated with the location of psoas muscle and vertebral body was identified as a risk factor. Among these factors, frailty was the most significant factor affecting the occurrence of POI. Proper assessment and improvement in patient frailty and nutritional status before surgery can help predict and prevent the occurrence of postoperative POI.

NOTES

Conflict of Interest: The authors have nothing to disclose.

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REFERENCES

1. Jung J, Lee S, Cho DC, et al. Usefulness of oblique lumbar interbody fusion as revision surgery: comparison of clinical and radiological outcomes between primary and revision surgery. *World Neurosurg* 2021;149:e1067-76.
2. Lee YS, Lee DH, Cho DC, et al. The change of spinal canal according to oblique lumbar interbody fusion in degenerative spondylolisthesis: a prospective observational study. *Neurospine* 2022;19:492-500.
3. Lee S, Jung JW, Lee SW, et al. Fusion assessment of oblique lumbar interbody fusion using demineralized bone matrix: a 2-year prospective study. *Neurospine* 2023;20:1205-16.
4. Artinyan A, Nunoo-Mensah JW, Balasubramaniam S, et al. Prolonged postoperative ileus-definition, risk factors, and predictors after surgery. *World J Surg* 2008;32:1495-500.
5. Fineberg SJ, Nandyala SV, Kurd MF, et al. Incidence and risk factors for postoperative ileus following anterior, posterior, and circumferential lumbar fusion. *Spine J* 2014;14:1680-5.

6. Elgar G, Smiley P, Smiley A, et al. Age increases the risk of mortality by four-fold in patients with emergent paralytic ileus: hospital length of stay, sex, frailty, and time to operation as other risk factors. *Int J Environ Res Public Health* 2022; 19:9905.
7. Mattei P, Rombeau JL. Review of the pathophysiology and management of postoperative ileus. *World J Surg* 2006;30: 1382-91.
8. Asgeirsson T, El-Badawi KI, Mahmood A, et al. Postoperative ileus: it costs more than you expect. *J Am Coll Surg* 2010; 210:228-31.
9. Gao W, Li W, Yan Y, et al. Transcutaneous electrical acupoint stimulation applied in lower limbs decreases the incidence of paralytic ileus after colorectal surgery: a multicenter randomized controlled trial. *Surgery* 2021;170:1618-26.
10. Kiely PD, Mount LE, Du JY, et al. The incidence and risk factors for post-operative ileus after spinal fusion surgery: a multivariate analysis. *Int Orthop* 2016;40:1067-74.
11. Durand WM, Ruddell JH, Eltorai AEM, et al. Ileus following adult spinal deformity surgery. *World Neurosurg* 2018;116: e806-13.
12. Horowitz JA, Jain A, Puvanesarajah V, et al. Risk factors, additional length of stay, and cost associated with postoperative ileus following anterior lumbar interbody fusion in elderly patients. *World Neurosurg* 2018;115:e185-9.
13. Park SC, Chang SY, Mok S, et al. Risk factors for postoperative ileus after oblique lateral interbody fusion: a multivariate analysis. *Spine J* 2021;21:438-45.
14. Obeid NM, Azuh O, Reddy S, et al. Predictors of critical care-related complications in colectomy patients using the National Surgical Quality Improvement Program: exploring frailty and aggressive laparoscopic approaches. *J Trauma Acute Care Surg* 2012;72:878-83.
15. Khan KT, Hemati K, Donovan AL. Geriatric physiology and the frailty syndrome. *Anesthesiol Clin* 2019;37:453-74.
16. Vather R, Trivedi S, Bissett I. Defining postoperative ileus: results of a systematic review and global survey. *J Gastrointest Surg* 2013;17:962-72.
17. Horvath B, Kloesel B, Todd MM, et al. The evolution, current value, and future of the American Society of Anesthesiologists physical status classification system. *Anesthesiology* 2021;135:904-19.
18. Velanovich V, Antoine H, Swartz A, et al. Accumulating deficits model of frailty and postoperative mortality and morbidity: its application to a national database. *J Surg Res* 2013; 183:104-10.
19. Buzby GP, Mullen JL, Matthews DC, et al. Prognostic nutritional index in gastrointestinal surgery. *Am J Surg* 1980;139: 160-7.
20. Massaad E, Saylor PJ, Hadzipasic M, et al. The effectiveness of systemic therapies after surgery for metastatic renal cell carcinoma to the spine: a propensity analysis controlling for sarcopenia, frailty, and nutrition. *J Neurosurg Spine* 2021;35: 356-65.
21. Pablo AM, Izaga MA, Alday LA. Assessment of nutritional status on hospital admission: nutritional scores. *Eur J Clin Nutr* 2003;57:824-31.
22. Cho A, Hong YS, Park HC, et al. Geriatric nutritional risk index is associated with retinopathy in patients with type 2 diabetes. *Sci Rep* 2022;12:11746.
23. Barquist E, Bonaz B, Martinez V, et al. Neuronal pathways involved in abdominal surgery-induced gastric ileus in rats. *Am J Physiol* 1996;270:R888-94.
24. Kalff JC, Schraut WH, Simmons RL, et al. Surgical manipulation of the gut elicits an intestinal muscularis inflammatory response resulting in postsurgical ileus. *Ann Surg* 1998;228: 652-63.
25. Türler A, Moore BA, Pezzone MA, et al. Colonic postoperative inflammatory ileus in the rat. *Ann Surg* 2002;236:56-66.
26. Clevers GJ, Smout AJ, van der Schee EJ, et al. Myo-electrical and motor activity of the stomach in the first days after abdominal surgery: evaluation by electrogastrography and impedance gastrography. *J Gastroenterol Hepatol* 1991;6:253-9.
27. Singhatanadgige W, Tangdamrongtham T, Limthongkul W, et al. Incidence and risk factors for lumbar sympathetic chain injury after oblique lumbar interbody fusion. *Neurospine* 2024;21:820-32.
28. Walters JB, Montagnini M. Current concepts in the management of opioid-induced constipation. *J Opioid Manag* 2010;6:435-44.
29. Gifford C, Minnema AJ, Baum J, et al. Development of a postoperative ileus risk assessment scale: identification of intraoperative opioid exposure as a significant predictor after spinal surgery. *J Neurosurg Spine* 2019;31:748-55.
30. Chang Y, Wong CE, Chen WC, et al. Risk factors for postoperative ileus following spine surgery: a systematic review with meta-analysis. *Global Spine J* 2024;14:707-17.
31. Phillips RJ, Powley TL. Innervation of the gastrointestinal tract: patterns of aging. *Auton Neurosci* 2007;136:1-19.
32. Rockwood K. Conceptual models of frailty: accumulation of deficits. *Can J Cardiol* 2016;32:1046-50.
33. Wilson JRF, Badhiwala JH, Moghaddamjou A, et al. Frailty

- is a better predictor than age of mortality and perioperative complications after surgery for degenerative cervical myelopathy: an analysis of 41,369 patients from the NSQIP database 2010-2018. *J Clin Med* 2020;9:3491.
34. Moses ZB, Oh SY, Fontes RBV, et al. The modified frailty index and patient outcomes following transforaminal lumbar interbody fusion surgery for single-level degenerative spine disease. *J Neurosurg Spine* 2021;35:163-9.
35. Lee C, Mabeza RM, Verma A, et al. Association of frailty with outcomes after elective colon resection for diverticular disease. *Surgery* 2022;172:506-11.
36. Deng WW, Lan M, Peng AF, et al. The risk factors for postoperative ileus following posterior thoraco-lumbar spinal fusion surgery. *Clin Neurol Neurosurg* 2019;184:105411.
37. Mehren C, Mayer HM, Zandanell C, et al. The oblique anterolateral approach to the lumbar spine provides access to the lumbar spine with few early complications. *Clin Orthop Relat Res* 2016;474:2020-7.
38. Bragg D, El-Sharkawy AM, Psaltis E, et al. Postoperative ileus: recent developments in pathophysiology and management. *Clin Nutr* 2015;34:367-76.