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Does incidental durotomy affect clinical outcome in patients with lumbar degenerative diseases after posterior open lumbar interbody fusion? a multicenter observational study

Zhendong Huan[1] and Linkai Lei[2*]

Abstract

Background Incidental durotomy (ID) during spinal surgery is common during spinal surgery. This study aimed to determine whether intraoperative ID affects the perioperative and long-term clinical outcomes in patients with degenerative lumbar disease (DLD) undergoing posterior open lumbar interbody fusion (POLIF).

Methods This multicenter observational study was conducted at two spinal centers between January 2020 and December 2022. The patients were divided into ID and non-ID groups according to whether ID occurred intraoperatively. Primary outcome measure was the length of hospital stay (LOS), while secondary outcome measures were 30-day readmission rate; hospital costs; postoperative visual analog scale (VAS) scores for low back pain (LBP) and leg pain (LP) at 1 day, 3, 7, and 15 days, 1 month, 3, 6, and 12 months; and Oswestry Disability Index (ODI) at 1 month, 3, 6, and 12 months.

Results Intraoperative ID occurred in 8.7% (36/415) patients. LOS, operative time, estimated blood loss, 30-day readmission rate, and hospital costs were significantly higher in the ID group. On average, the LOS increased by 2.9 days and hospital costs increased by 4800.2 yuan per patient. The ID group had significantly higher baseline VAS scores for LBP 15 days and 1 month postoperatively than the non-ID group. The ODI was significantly higher in the ID group than in the non-ID group 1 month postoperatively. No significant differences were noted in the VAS scores and ODI between the two groups at 3, 6, and 12 months postoperatively. Finally, we found that a higher BMI ($P=0.035$, OR: 1.195, 95%CI: 1.012–1.412) and revision surgery ($P=0.022$, OR: 2.901, 95%CI: 1.164–7.233) were risk factors for intraoperative ID.

Conclusions Although ID does not significantly affect the long-term outcomes in patients with DLD after POLIF, it can lead to poorer perioperative clinical outcomes. Lumbar fusion surgery should be performed meticulously to minimize the incidence of intraoperative ID.

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Keywords Degenerative lumbar diseases, Posterior open lumbar interbody fusion, Incidental durotomy, Clinical outcomes, Risk factor

Introduction

As the population ages, degenerative spine diseases (DSD) are becoming more common in the population [1, 2]. Ravindra et al. recently reported that approximately 266 million (3.63%) people worldwide experience DSD and low back pain (LBP) annually [3], which has become one of the largest disease burdens in humans [1]. Spinal decompression and/or fusion surgery is recommended for the treatment of DSD in patients who do not respond well to conservative treatment [4, 5]. In recent years, the use of lumbar fusion surgery for DSD has increased worldwide [6–9]. However, it can also cause surgery-related complications related to the surgery. In particular, incidental durotomy (ID) is common in spinal surgery [10].

The reported incidence of ID after spinal surgery ranges from 0.4 to 15.8% [11]. Previous studies have found that ID during spinal surgery can lead to poorer perioperative outcomes such as higher operative time (OT), estimated blood loss (EBL), length of stay (LOS), in-hospital morbidity, mortality, and healthcare burdens [12–18]. In addition, some studies have found that intraoperative ID can lead to poor long-term outcomes after spinal surgery [17–19]. In contrast, other studies did not find significant differences in long-term outcomes between patients who experienced intraoperative ID and those who did not [20–24].

In addition to the appeal controversy, although there have been multiple studies comparing the clinical outcomes of patients with or without ID, most of those studies have significant heterogeneity, such as inconsistent patients selection, including patients with spinal fracture, degenerative disease or scoliosis [25–28]; Or the surgical site is inconsistent, such as in cases where both cervical, thoracic and lumbar surgery are included [27, 29–31]; Or the surgical approach is inconsistent, such as in cases where both anterior and posterior surgeries are included [16, 29]; Or the surgical methods is inconsistent, such as cases both single decompression surgery and decompression combined with fusion surgery are included [15, 16, 18, 22, 28, 30, 32]; Or the surgical visual field is inconsistent, such as in cases where both minimally invasive spine surgery or open spine surgery are included [28, 33–35]. The heterogeneity of these studies may have reduced the reliability of their conclusions.

Posterior open lumbar interbody fusion (POLIF) is still the mainstream surgical method for the treatment of degenerative lumbar diseases (DLD) [36–38], and mainly includes posterior lumbar interbody fusion (PLIF) and transforaminal lumbar interbody fusion (TLIF) [39]. This study was designed to compare the perioperative and long-term clinical outcomes of patients with DLD with or without ID during POLIF to further explore whether intraoperative ID affects patient outcomes and reduces study heterogeneity.

Materials and methods

This multicenter observational study included two spine centers. All clinical data were collected prospectively from patients with DLD who underwent POLIF between January 2020 and December 2022. An independent follow-up nurse conducted follow-ups on all the patients and completed the follow-up work in December 2023. The data were accessed for research purposes between January 2024 and June 2024. All patient data were anonymized and de-identified before the analysis to avoid patient information leakage. This study was conducted with the review and approval of the hospitals' ethics committees of Yantaishan hospital (LL-2024-199-L). All patients consented to participate in the study and signed an informed consent form.

Inclusion criteria

(1). Patients with DLD and indicated for single-level POLIF surgery included degenerative lumbar spondylolisthesis and stenosis with or without lumbar disc herniation (LDH). (2). Patients aged 40–80 y. (3). Patients who agreed to participate in the study.

Exclusion criteria

(1). Patients with spinal deformities, tumors, or fractures. (2). Patients with other underlying diseases such as chronic obstructive pulmonary disease, coronary heart disease, myocardial infarction, brain diseases such as brain tumors, and cerebral infarction. (3). Patients who refused to participate in the study.

Inclusion and preoperative assessment of patients

The patients were included by the surgeon according to the inclusion and exclusion criteria. The patients were fully informed of the study process, and the purpose and possible results of the study was explained to the patient to relieve their doubts about participating in the study and to obtain their cooperation in completing the postoperative follow-up. Patients were then assessed using the baseline visual analog scale (VAS) scores for LBP, leg pain (LP), and the Oswestry Disability Index (ODI). In addition, sex, age (years), body mass index (BMI; kg/m2), comorbidities, history of smoking and spine surgery, and American Society of Anesthesiologists (ASA) scores

were recorded. Revision surgery was defined as a lumbar surgery performed at the same level prior to the planned procedure.

Surgical procedure

All patients underwent surgery under general posterior anesthesia. The surgical modalities included PLIF and TLIF. The surgical procedure was performed according to the classic literature [39] and via a midline approach. Decompression of the spinal canal and removal of the intervertebral disc were performed, followed by intervertebral bone grafting and fusion. The pedicle screw was then implanted and fixed using a screw and a rod. If a dural tear occurred during the surgery, it was sutured as much as possible and sealed with fibrin glue. If complete laceration closure was not possible, the surface of the dural tear was covered with a piece of autologous fascia and sealed with fibrin glue. An incisional drainage tube was routinely placed postoperatively.

Grouping and postoperative treatment

The patients were divided into ID and non-ID groups based on whether ID occurred postoperatively. For patients without ID, the drainage tube was removed after the drain became serous and the 24-hour drain was less than 50 ml. Determining whether cerebrospinal fluid (CSF) leakage occurs postoperatively is necessary. If CSF leakage occurs after surgery, a drainage tube is usually placed for approximately 5–7 days, and the drainage tube is removed after the incision has healed. If there is still no obvious CSF leakage at 48–72 h postoperatively, the drainage tube should be removed promptly. Patients were discharged when the VAS scores for LBP and LP were < 3 and the incision showed no evidence of incision infection and poor healing.

Follow-up

An independent follow-up staff investigated the patient-reported outcomes (PROs), including VAS scores of LBP and LP at 1 day, 3, 7, and 15 days, 1 month, 3, 6, and 12 months, and the ODI at 1 month, 3, 6, and 12 months postoperatively. In addition, LOS, 30-day readmission rate, and hospital costs were recorded. In patients with postoperative complications, timely feedback should be provided to the surgeons for subsequent treatment. In addition, the OT and EBL were recorded.

Statistical methods

For continuous variables such as age, BMI, OT, EBL, LOS, hospital costs, VAS scores for LBP and LP, and ODI, the Wilcoxon rank-sum test (non-normally distributed variables, Median -interquartile range) or student's t (normally distributed variables, mean ± standard deviation) were adopted to compare the differences. Categorical variables such as sex, ASA scores, smoking, comorbidities, revision surgery, surgical methods, 30-day readmission rate, and chi-square or fisher's exact tests were used to compare the differences. Univariate and multivariate logistic regression analyses were used to examine risk factors for the intraoperative occurrence of ID. Statistical significance was set at $P < 0.05$. For patients with less than 10% missing postoperative data, mean/median imputation was used to supplement the missing data. Statistical analyses were conducted using the SPSS statistics.27 software (IBM Corp., Armonk, NY, USA). Figures were generated using the Graphpad Prism 9.0 (Graphpad Software, San Diego, CA, USA).

Results

The inclusion and exclusion procedures are illustrated in Fig. 1. Initially, 530 participants were included in this study, while 61 patients under 40 years of age and seven patients over 80 years of age were excluded. Eight patients with spinal deformities and six with fractures were excluded from the study. Twelve patients had severe underlying diseases, and 21 refused to participate in the study. A total of 415 participants were included in the study. Among the patients who underwent POLIF, 36 had intraoperative ID and 387 did not have intraoperative ID. Intraoperative ID occurred in 8.7% (36/415) of patients. Subsequently, one patient in the ID group and 8 patients in the non-ID group were lost to follow-up. Finally, 35 patients in the ID group and 371 patients in the non-ID group were included in this study.

No significant differences were recorded in the sex, age, ASA scores, smoking, diabetes, hypertension, and surgical methods between the two groups. However, the BMI (25.9 ± 1.6 vs. 24.8 ± 2.4, $P = 0.008$) and the proportion of revision surgery (22.9%, 8/35 vs. 7.5%, 28/371, $P = 0.002$) were significantly higher in the ID group than in the non-ID group (Table 1).

The OT (174.4 ± 14.2 min. vs. 156.5 ± 26.5 min, $P < 0.001$) and EBL (259.3 ± 44.2 ml. VS. 200.2 ± 47.5 ml, $P < 0.001$) were significantly higher in the ID group than those in the non-ID group. Additionally, the LOS (9.1 ± 2.1 days. VS. 6.2 ± 1.3 days, $P < 0.001$), 30-day readmission rate, and hospital costs (52721.2 ± 5961.9 yuan. VS. 47921.7 ± 4465.4 yuan. $P < 0.001$) were significantly higher in the ID group than those in the non-ID group. On average, the LOS of each ID patient increased by 2.9 days and hospital costs increased by 4800.2 yuan (Table 1). In the ID group, 74% (26/35) of patients experienced CSF leakage after surgery. The removal of the drainage tube was delayed and the patients were advised to rest in bed. In addition, the 30-day readmission rate was significantly higher in the ID group than in the non-ID group (11.4%, 4/35. vs. 3.5%, 13/371, $P = 0.049$). In the ID group, 3 patients and 1 patient were readmitted

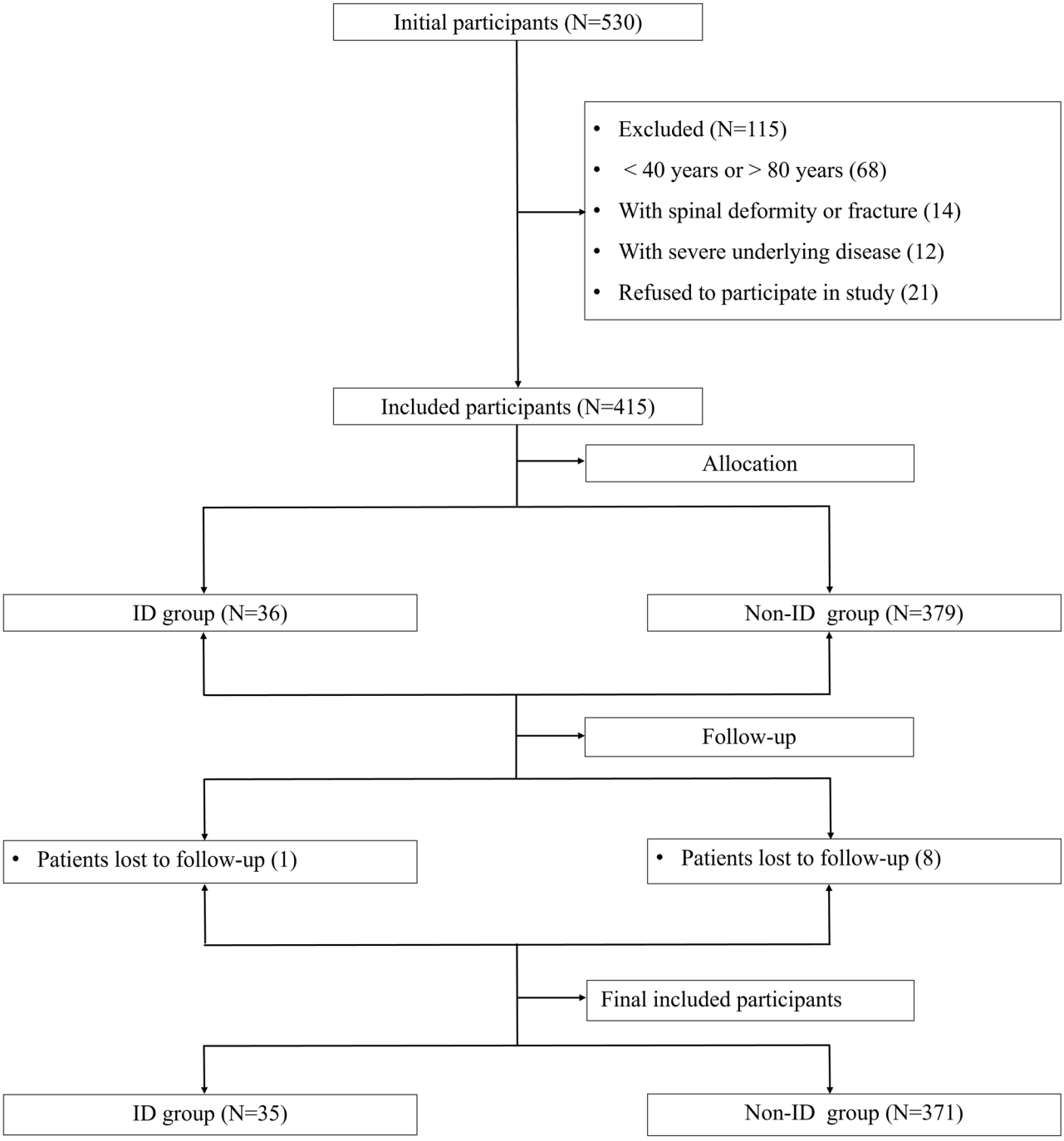

Fig. 1 The inclusion and exclusion flowchart of this study

because of poor wound healing and surgical site infection, respectively. In the non-ID group, 4 patients for poor wound healing, 3 patients for surgical site infection, 2 patients for residual LP, 1 patient for residual LP, 1 patient for heart disease, 1 patient for pulmonary infection, and 1 patient for diabetes were readmitted.

The PROs of the two groups are shown in Tables 2, 3 and 4. No significant differences were noted in the VAS scores for LBP and LP, and ODI between the two groups. In addition, the ID group had significantly higher VAS scores for LBP at 15 days and 1 month postoperatively than the non-ID group (Fig. 2A). The ODI was significantly higher in the ID group than that in the non-ID group 1 month postoperatively (Fig. 2C). However, no significant difference was noted in the VAS scores of LP postoperatively (Fig. 2B), and VAS scores of LBP and ODI between the two groups at the remaining follow-up time points.

Table 1 Patients' clinical parameters of the two groups

Subgroup	ID group (*N* = 35)	Non-ID group (*N* = 371)	*P* value
Sex			0.617
Men	19 (54.3%)	185 (49.9%)	
Women	16 (45.7%)	186 (50.1%)	
Age (year)	59.1 ± 6.2	57.3 ± 8.9	0.245
BMI (kg/m2)	25.9 ± 1.6	24.8 ± 2.4	0.008
Smoking	7 (20.0%)	48 (12.9%)	0.411
Diabetes	5 (14.3%)	36 (9.7%)	0.390
Hypertension	10 (28.6%)	86 (23.2%)	0.473
Revision surgery	8 (22.9%)	28 (7.5%)	0.002
ASA score			0.034
1	0 (0.0%)	1 (0.3%)	
2	26 (74.3%)	330 (88.9%)	
3	9 (25.7%)	40 (10.8%)	
Operative time (minutes)	174.4 ± 14.2	156.5 ± 26.5	< 0.001
Estimated blood loss (ml)	259.3 ± 44.2	200.2 ± 47.5	< 0.001
Surgical methods			0.438
PLIF	19 (54.3%)	176 (47.4%)	
TLIF	16 (45.7%)	195 (52.6%)	
Length of hospital stay (day)	9.1 ± 2.1	6.2 ± 1.3	< 0.001
Hospital costs (Yuan)	52721.2 ± 5961.9	47921.7 ± 4465.4	< 0.001
30-day readmission rate	4 (11.4%)	13 (3.5%)	0.049

BMI: body mass index, ASA: American Society of Anesthesiologists, PLIF: Posterior lumbar interbody fusion, TLIF: Transforaminal lumbar interbody fusion

Table 2 Comparison of LBP of the two groups

Subgroup	ID group (*N* = 35)	Non-ID group (*N* = 371)	*P* value
Pre LPB VAS score	4.8 ± 2.3	4.8 ± 2.1	0.837
Post LBP VAS score (1 day)	3.2 ± 1.2	3.1 ± 1.1	0.596
Post LBP VAS score (3 days)	2.2 ± 1.0	2.2 ± 0.9	0.943
Post LBP VAS score (7 days)	1.8 ± 0.9	1.5 ± 0.9	0.083
Post LBP VAS score (15 days)	1.7 ± 1.1	1.3 ± 1.0	0.012
Post LBP VAS score (1 month)	1.5 ± 1.0	1.1 ± 0.9	0.017
Post LBP VAS score (3 months)	1.1 ± 0.7	1.0 ± 0.8	0.589
Post LBP VAS score (6 months)	1.0 ± 0.8	0.8 ± 0.8	0.380
Post LBP VAS score (12 months)	0.8 ± 0.7	0.7 ± 0.8	0.842

Low back pain: LBP, Incidental durotomy: ID

Risk factors for ID

Univariate and multivariate logistic regression analyses were performed with ID as the dependent variable, and ASA scores, BMI, and revision surgery as independent variables (Table 5). Univariate logistic regression analysis revealed that the ASA scores ($P = 0.021$, OR: 2.872, 95%CI: 1.262–6.539), MBI ($P = 0.008$, OR: 1.246, 95%CI: 1.060–1.465), and revision surgery ($P = 0.004$, OR: 3.630, 95%CI: 1.509–8.733) were associated with the intraoperative occurrence of ID. However, multivariate logistic regression analysis suggested that higher BMI ($P = 0.035$, OR: 1.195, 95%CI: 1.012–1.412) and revision surgery ($P = 0.022$, OR: 2.901, 95%CI: 1.164–7.233) were risk factors for intraoperative ID. For every unit increase in a patient's BMI, the odds of developing SSI increased by approximately 19.5%. The intraoperative ID was approximately 2.901 times higher in the patients who underwent revision surgery than in those who underwent primary lumbar surgery.

Table 3 Comparison of LP VAS scores of the two groups

Subgroup	ID group (*N* = 35)	Non-ID group (*N* = 371)	*P* value
Pre LB VAS score	6.5 ± 2.0	6.2 ± 1.8	0.307
Post LP VAS score (1 day)	1.7 ± 1.1	1.8 ± 1.2	0.820
Post LP VAS score (3 days)	1.3 ± 0.9	1.5 ± 1.1	0.366
Post LP VAS score (7 days)	1.0 ± 0.8	1.1 ± 0.8	0.371
Post LP VAS score (15 days)	1 (2)	1 (2)	0.329
Post LP VAS score (1 month)	1.0 ± 0.9	1.1 ± 0.9	0.750
Post LP VAS score (3 months)	1.1 ± 0.9	0.9 ± 0.8	0.146
Post LP VAS score (6 months)	0.8 ± 0.8	1.0 ± 0.8	0.246
Post LP VAS score (12 months)	1.0 ± 0.9	1.1 ± 0.9	0.531

Leg pain: LP, Incidental durotomy: ID

Table 4 Comparison of ODI of the two groups

Subgroup	ID group (*N* = 35)	Non-ID group (*N* = 371)	*P* value
Pre ODI	59.1 ± 13.8	58.3 ± 14.3	0.740
Post ODI (1 month)	16.6 ± 6.6	14.0 ± 7.1	0.044
Post ODI (3 months)	10.3 ± 4.1	10.8 ± 4.2	0.542
Post ODI (6 months)	10.9 ± 4.7	10.3 ± 4.1	0.875
Post ODI (12 months)	9.8 ± 4.6	10.2 ± 4.9	0.708

Oswestry Disability Index: ODI, Incidental durotomy: ID

Discussion

In this study, we compared the perioperative and long-term clinical outcomes of patients with DLD, with and without ID, during POLIF. We found that ID led to higher LOS, OT, EBL, hospital costs, and 30-day readmission rates. In addition, we found that patients in the ID group had higher VAS scores for LBP at 15 days and 1 month and higher ODI at 1 month postoperatively. However, no significant difference was noted in the VAS scores for LBP, LP, and ODI between the two groups at the remaining follow-up time points. Additionally, we found that higher BMI and the revision surgery were the risk factors of ID.

Several previous studies have compared the perioperative and long-term outcomes of spinal surgery with and without ID [12–24]. In general, studies have found that the occurrence of ID can increase the LOS, hospital costs, complication rates, and mortality rates. Nandyala et al.

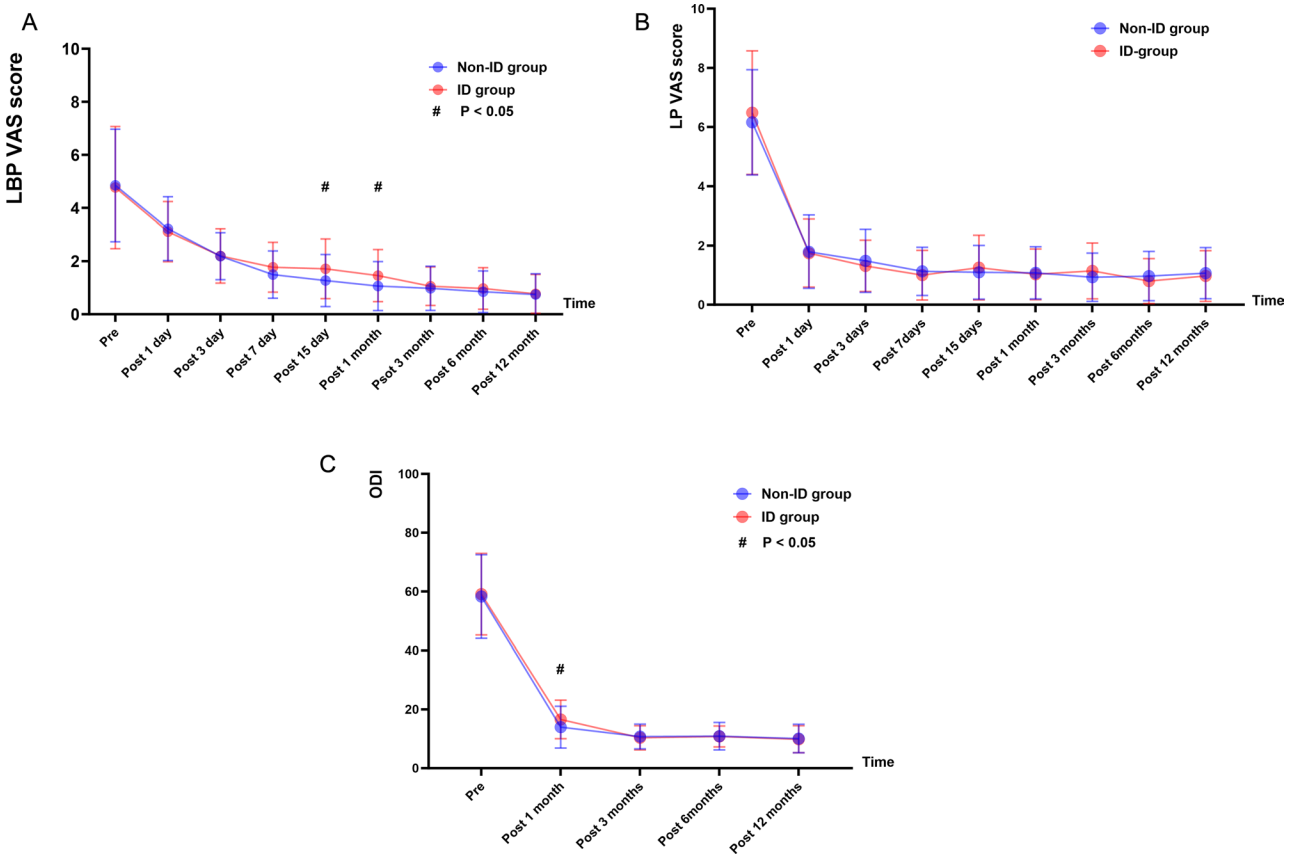

Fig. 2 **A**: The LBP VAS scores of the ID group were significantly higher than those of the non-ID group 15 days and 1 month after surgery. **B**: There was no significant difference in LP VAS scores between the two groups. **C**: The ODI of the ID group were significantly higher than those of the non-ID group 1 month after surgery

Table 5 Univariate and multivariate logistic regression analysis of ID

Variables	Univariate analysis			Multivariate analysis		
	P value	OR	95% CI	*P* value	OR	95%CI
ASA score	0.012	2.872	1.262–6.539	0.051	2.347	0.998–5.518
BMI	0.008	1.246	1.060–1.465	0.035	1.195	1.012–1.412
Revision surgery	0.004	3.630	1.509–8.733	0.022	2.901	1.164–7.233

BMI: body mass index, ASA: American Society of Anesthesiologists

found that patients with ID had a longer LOS and higher rate of perioperative complications ($P<0.001$) after cervical and lumbar surgeries. Cervical and lumbar ID and their postoperative sequelae added a mean of additional $7,638 and $2,412 per patient, respectively [15]. A recent retrospective study by Hanna et al. found that the CSF leakage was associated with an increased LOS (5.39 ± 3.86 days. VS. 3.74 ± 2.55 days, $P<0.0001$), hospital costs (120129.0 ± 88123.5 $. VS. 89226.8 ± 65350.3 $, $P<0.0001$), and mortality (0.3% VS. 0.1%, $P<0.05$) after elective lumbar fusion surgery [16]. In this study, we also found that patients with ID had a longer LOS (9.1 ± 2.1 days. VS. 6.2 ± 1.3 days, $P<0.001$), 30-day readmission rate (11.4%, 4/35. VS. 3.5%, 13/371, $P=0.049$), and hospital costs (52721.2 ± 5961.9 yuan. VS. 47921.7 ± 4465.4 yuan, $P<0.001$). The LOS in each ID patient increased by 2.9 days and hospital costs increased by 4800.2 yuan simply as occurrence of ID increases the OT and operative costs, and the occurrence of CSF leakage after the surgery also increases the LOS, thus increasing the total hospital cost.

Whether ID affects perioperative and long-term postoperative PROs remains controversial [17–24]. Few studies have reported the perioperative PROs in patients with ID. In this study, we found that patients in the ID group had higher VAS scores for LBP at 15 days and 1 month and ODI at 1 month postoperatively. The VAS scores for LBP were significantly lower in the non-ID group than in the ID group, although there seemed to be minor difference between the two groups in VAS scores for LBP at

15 days and 1 month after surgery. This minor difference was due to the overall favorable outcome of the surgical procedure in both groups, as the VAS score for LBP was significantly improved in both groups compared to the preoperative score. In addition, it also shows a trend that the non-ID group may recover better from LBP in the early postoperative period. This is not difficult to explain, because ID may affect the speed of incision healing in patients, resulting in more severe LBP in the early postoperative period. Additionally, the 30-day readmission rate was significantly higher in the ID group than in the non-ID group (11.4%, 4/35. vs. 3.5%, 13/371, $P = 0.049$). This suggests that patients with ID may have poorer perioperative outcomes than patients without ID. However, these perioperative outcomes may be influenced by variables such as our finding that the proportion of revision surgery was significantly higher in the ID group than in the non-ID group. For long-term PROs, Kothe et al. found that ID patients had a poorer improvement in LBP than non-ID patients 12 months after decompression surgery for lumbar spinal stenosis [17]. Strömqvist et al. also found that, compared to patients with LDH without ID, patients with ID reported higher residual LP and ODI and poorer quality of mental life one year after surgery. They also found that patients with lumbar stenosis had a poorer quality of mental life [18]. However, other studies have found that ID does not affect patients [20–24]. Desai et al. found no differences in the 36-item Short Form Health Survey (SF-36) scores for physical pain or function and the ODI at 1, 2, 3, and 4 years in patients with or without ID [23]. A retrospective study by Bagley et al. involving 1,741 patients undergoing lumbar fusion also found no significant differences in the VAS scores for LBP and LP, and ODI between ID and non-ID patients 1 and 2 years after surgery [23]. In this study, we reached conclusions similar to those of Bagley et al. No significant differences were noted in the VAS scores and ODI between the two groups at 3, 6, and 12 months after surgery, indicating the equivalence of long-term efficacy between the two groups.

Several studies have explored the risk factors for ID during spinal surgery, including sex, age, revision surgery, lumbar stenosis, surgical approach (posterior approach), obesity, smoking, surgical segment, ossification of the posterior longitudinal ligament, adhesion of the spinal cord and dura mater, spinal canal stenosis, cervical fracture, revision surgery, surgical time, spondylolisthesis, and surgical site (thoracic or lumbar spine) [11–13, 16, 22, 25, 28, 30–32, 40–42]. In this study, we found that the ASA score, MBI, and history of lumbar spine surgery were associated with revision surgery and the intraoperative occurrence of ID. However, multivariate logistic regression analysis suggested that a higher BMI ($P = 0.035$, OR: 1.195, 95%CI: 1.012–1.412) and revision surgery ($P = 0.022$, OR: 2.901, 95%CI: 1.164–7.233) were risk factors for the intraoperative development of ID. For every unit increase in a patient's BMI, the odds of developing SSI increased by approximately 19.5%. The intraoperative ID was approximately 2.901 times higher in the patients who underwent revision surgery than in those who underwent primary lumbar surgery. For patients with previous lumbar spine surgery, the loss of isolation of the ligamentum flavum at the site of revision surgery or the local formation of surgical scars increased the difficulty of surgery, resulting in a high incidence of ID [11, 25, 27, 31]. Additionally, we speculate that a higher BMI indicates a deeper surgical site in the lumbar spine, leading to inconvenience in open surgery [41]. Finally, OT and EBL were not included in the univariate and multivariate analyses because intraoperative ID may increase OT and EBL. The increase in OT and EBL was not the cause of ID but the result of intraoperative ID. In addition, revision surgery may also result in longer OT and EBL, and we found that the proportion of revision surgery in the ID group was significantly higher than that in the non-ID group. Therefore, OT and EBL were not included in this multivariate logistic risk factor analysis.

Although it remains controversial whether repair is needed after ID [29, 43–46], timely repair of ID and fibrin glue is recommended by most surgeons. In this study, despite timely repair and sealing, 74% (26/35) of patients still experienced CSF leakage after surgery. Various methods for repairing dural tears in clinical practice, including direct suturing, autologous fascia suturing, autologous fat grafting, allogeneic patches, epidural blood patches, and fibrin glue sealing, may indirectly indicate the uncertainty of the effectiveness of dural tear [11, 29, 43–47]. CSF leakage resulted in an increased LOS because we tried to keep the patient on bed rest and delay drain removal. Although some recent studies have found that early ambulation does not lead to worse clinical outcomes in patients with CSF leakage and may even reduce perioperative complications [48–51], we found that early ambulation in patients with CSF leakage is associated with severe headache; therefore, early ambulation is not recommended.

Limitations of this study

Although this was a multicenter, observational study and all clinical data were collected prospectively, the clinical data were retrospectively analyzed, which may lead to an unavoidable basis, such as case selection. For example, we found a significant difference in the proportion of revision surgery between the ID and non-ID groups, which may affect the clinical outcomes of both groups. Additionally, the total sample size, positive sample size (ID), and follow-up period of this study were limited. This study included only 415 patients, and the follow-up

period was only one year. In addition, we only collected PROs, including the VAS and ODI, without other PROs such as the SF-36 and EuroQol five-dimensional questionnaires. Furthermore, the risk factors associated with ID may be diverse, and the independent variables included in this study may not have covered all potential factors, particularly the surgeon's technique. Therefore, in the future, large-sample, multicenter, prospective, long-term follow-up studies are warranted to further clarify the impact of ID on patients undergoing POLIF.

Conclusion

Although ID does not significantly affect long-term outcomes of patients with DLD after POLIF, it can lead to poor perioperative clinical outcomes. Surgeons should meticulously perform the surgery to minimize the probability of intraoperative ID.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13018-025-05792-2.

Supplementary Material 1

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None.

Author contributions
Zhendong Huan: Collect the data, Investigation, Writing original draft. Linkai Lei: Conceptualization, Investigation, Methodology, Writing - review & editing.

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No.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethical approval
The study design and protocol were approved by the Ethics Committee of Yantaishan Hospital (LL-2024-199-L). In this study, the authors adhered to the Declaration of Helsinki (2013), and all procedures meet the requirements of ethical, moral and scientific principles.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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