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A Study on Clinical Efficacy and Differences between the Endoscopic Fusion and the Oblique Lateral Interbody Fusion in the Treatment of Single-Segment Meyerding garde I and II spondylolisthesis

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Abstract

Objective：This study aims to compare the clinical outcomes and differences between the endoscopic fusion and the oblique lateral interbody fusion in the management of Meyerding grade I and II lumbar spondylolisthesis.

Methods:. A prospective observational study was conducted, enrolling 86 patients with lumbar spondylolisthesis who were admitted to our institution between January 2021 and June 2024. Based on patients' autonomous selection of surgical strategies, the cohort was stratified into the endoscopic fusion group (n = 45) and the oblique lumbar interbody fusion (OLIF) group (n = 41). All patients completed a postoperative follow-up period of no less than 12 months.The following outcomes were compared between the two groups: operative time, intraoperative blood loss, postoperative drainage volume, postoperative bed rest duration, postoperative hospital stay, spondylolisthesis reduction distance, increase Intervertebral space height, postoperative complication incidence, postoperative Visual Analogue Scale (VAS) score, and Oswestry Disability Index (ODI) score. Lumbar fusion status was assessed for all patients in both groups at each follow-up visit, in accordance with the Bridwell classification system. According to the modified MacNab classification, the excellent and good rates of the two groups of patients at the last follow-up were evaluated and compared.

Results: Patients in the OLIF group exhibited superior perioperative outcomes in terms of operative time (167.09±50.59min vs 112.31±26.95min), intraoperative blood loss (167.73±42.27mL vs 114.19±24.54mL), postoperative drainage volume (154.67±22.13mL vs 98.69±10.91mL), and increase in intervertebral space height(4.46±1.79mm vs 5.17±1.65mm）compared with the endoscopic fusion group, with all differences reaching statistical significance (P<0.05). Both patient groups demonstrated effective therapeutic outcomes in the treatment of lumbar spondylolisthesis, with no statistically significant difference in efficacy (P>0.05). Nevertheless, regarding the restoration of intervertebral space height, the OLIF procedure exhibited superior performance (5.17±1.65mm vs 4.4±1.79mm, P<0.05). Furthermore, postoperative low back pain occurred less frequently in patients who underwent the OLIF procedure, with a statistically significant difference observed between the two groups (P < 0.05). However, with prolonged follow-up duration, pain severity in both groups showed a trend toward improvement (F_{time}=58.62, P_{time}<0.001). Additionally, statistically significant differences were observed in both intergroup comparisons and group-time interactions (P<0.05). Regarding neurological function outcomes, no statistically significant difference was observed between the two groups (P>0.05). However, neurological function outcomes of patients in both groups showed a trend toward improvement over the follow-up period. The main effect of time was statistically significant in both groups (F_{time}=185.62, P<0.001). Regarding lumbar fusion status, at the 3-month postoperative follow-up, the fusion rate in the OLIF group was significantly higher than that in the endoscopic fusion group (41.46% vs 20.00%, P<0.05). However, with prolonged follow-up duration, no statistically significant difference was observed in the fusion rates between the two groups (P>0.05). Based on the modified MacNab criteria, the excellent-to-good rate in the OLIF group was higher than that in the endoscopic fusion group (85.37% vs 80.00%). Postoperative complications in both groups were predominantly

concentrated in nerve injury, but no statistically significant difference was observed between the two groups (P>0.05).

Conclusion: This study demonstrated that for patients with Meyerding grade I and II lumbar spondylolisthesis, the oblique lateral interbody fusion technique effectively alleviates postoperative low back pain. Furthermore, it exhibits more favorable and statistically significant effects in reducing operative duration, increasing intervertebral space hight, minimizing intraoperative blood loss and postoperative drainage volume, and enhancing postoperative therapeutic outcomes .

Highlights

1.As a minimally invasive spinal fusion modality, the OLIF technique is performed via the natural anatomical spaces of the human body. This confers several intraoperative advantages, including minimized surgical trauma, reduced intraoperative blood loss and postoperative drainage volume, and shorter operative duration.

2.As an indirect decompression modality, the OLIF can achieve direct decompression effects, effectively fulfilling the objectives of spondylolisthesis reduction and spinal canal decompression.

3.The OLIF technique has been widely recognized for its reliability in ensuring patient safety and therapeutic efficacy, thereby offering valuable references for clinicians in formulating future treatment strategies.

Introducation

Lumbar spondylolisthesis (LS) is defined as the displacement of the superior vertebra relative to the inferior vertebra secondary to lumbar intervertebral disc degeneration, which results in spinal canal stenosis and subsequent nerve root compression, manifesting clinically as low back pain or numbness in the lower extremities [1]. Lumbar spondylolisthesis predominantly occurs at the L4-5 and L5-S1 segments, accounting for over 70% of all spondylolisthesis cases[2]. Clinically, for patients who do not respond to conservative treatment, surgical treatment is usually chosen, among which lumbar fusion technique is widely applied. Traditional open lumbar fusion necessitates resection of the lamina and facet joints, which disrupts the bony architecture and stability of the lumbar spine and is frequently associated with multiple postoperative complications. With the advancement of minimally invasive techniques, multiple novel minimally invasive fusion procedures have been progressively introduced into clinical practice. Among these, the endoscopic fusion and the oblique lateral interbody fusion (OLIF) are the most widely utilized[3]. The endoscopic fusion technique involves the resection of the intervertebral disc and implantation of an interbody fusion cage via endoscopic techniques, combined with posterior lumbar screw fixation. The oblique lateral interbody fusion (OLIF) technique is a surgical approach that achieves exposure via the intermuscular plane between the external oblique, internal oblique, and transversus abdominis muscles, accesses the lateral aspect of the lumbar spine through the

anterolateral aspect of the psoas major muscle and the retroperitoneal space, and subsequently involves intervertebral discectomy, fusion cage implantation, and lateral vertebral body screw fixation[4]. Clinical studies have demonstrated that both procedures are effective for the treatment of Meyerding grade I and II lumbar spondylolisthesis. However, there are differences between the two surgical methods, and it is currently unclear which surgical approach is more effective. This study aims to compare the clinical outcomes and differences between the endoscopic fusion and the OLIF in the management of Meyerding grade I and II lumbar spondylolisthesis.

Material and Methods

A prospective observational study was conducted, enrolling 86 patients with lumbar spondylolisthesis who were admitted to our institution between January 2021 and June 2024. Based on patients' autonomous selection of surgical strategies, the cohort was stratified into the endoscopic fusion group (n=45) and the oblique lumbar interbody fusion (OLIF) group (n=41). All enrolled patients were diagnosed with single-segment lumbar spondylolisthesis at the L4-L5 or L5-S1 level, aged 40~70 years, and free of comorbidities. Patients with concurrent conditions such as lumbar tumors, scoliosis, or lumbar infections were excluded from the study. The follow-up protocol of this clinical trial was approved by the patients themselves and formally endorsed by the Ethics Committee of The Suqian First Hospital , Issue NO.2021-SR-0255. Furthermore, it was confirmed that informed consent was obtained from all participants, and all experiments were performed in strict compliance with relevant guidelines and the Declaration of Helsinki.

Surgical technique

Prior to surgery, the patient completed preoperative evaluations including lateral (Figure 1) and anteroposterior(Figure 2) lumbar spine radiographs, and was diagnosed with L4-L5 spondylolisthesis. Following successful anesthesia, the patient was positioned in the prone position. A C-arm fluoroscope was employed to localize the L4-L5 intervertebral space and the cutaneous landmarks corresponding to the pedicles, which were then marked accordingly. The surgical field was subjected to routine disinfection, followed by the application of sterile drapes. Taking the patient's left side as an example, a 1.5-cm incision was made on the left side of the intervertebral space. After penetrating the deep fascia and muscular tissue, a working channel was inserted. Fluoroscopic localization was confirmed to be accurate. Subsequently, a single-channel endoscopic system was inserted, enabling direct access to the lateral aspect of the L4-L5 facet joint. Under single-channel endoscopy, the inferior articular process of L4 and the superior articular process of L5 were bitten off with gun forceps, the ligamentum flavum was resected, the intervertebral foramen was opened, and the nerve root was exposed. The working channel was advanced into the spinal canal from the lateral aspect of the nerve root, allowing exposure of the L4-L5 intervertebral disc tissue. The intervertebral disc was excised using nucleus pulposus forceps, followed by debridement of the cartilaginous endplates with a curette until the intervertebral space was cleared(Figure 3). Allograft bone was implanted into the anterior-middle region of the intervertebral space, followed by insertion of a Bullet-shaped PEEK fusion cage preloaded with allograft bone into the

intervertebral space(Figure 4). Under fluoroscopic guidance, the cage was confirmed to be in an optimal position(Figure 5).Subsequently, the endoscopic system was withdrawn, a drainage tube was placed indwelling, and the incision was closed with sutures. Subsequently, puncture needles were inserted at the skin marking lines corresponding to the bilateral pedicles of L4 and L5, followed by implantation of guide wires. Pedicle screws were then inserted along the guide wires via screwing, followed by withdrawal of the guide wires. Subsequently, the pedicle screws were distracted to achieve spondylolisthesis reduction, and titanium rods were implanted. Following fluoroscopy, lateral (Figure 6) and anteroposterior (Figure 7) lumbar spine radiographs confirmed satisfactory reduction of the lumbar spondylolisthesis, and the locking nuts were subsequently tightened. Subsequently, the surgical site was irrigated, and the incision was closed in layers. The operation was completed, and the patient was safely transferred back to the ward.

Figure 1–7

Prior to surgery, the patient completed preoperative evaluations including lateral (Figure 8) and anteroposterior(Figure 9) lumbar spine radiographs, and was diagnosed with L4-L5 spondylolisthesis. After successful general anesthesia, the patient was placed in the right lateral position, and the L4-L5 intervertebral space was located using C-arm fluoroscopy. A transverse incision mark line approximately 4cm long was marked on the patient's left abdomen. The surgical area was routinely disinfected, and a sterile sheet was placed. The skin and subcutaneous tissue were incised along the marked line, and the external oblique muscle, internal oblique muscle, and transversus abdominis muscle were bluntly separated to expose the peritoneum and anterolateral aspect of the psoas major muscle. The peritoneum and anterolateral aspect of the psoas major muscle space were slowly separated until reaching the lateral side of the vertebral body. A dilator was placed to establish a working channel and fully expose the intervertebral disc tissue. The annulus fibrosus was incised, and the intervertebral disc tissue and cartilage endplates were removed. Allogeneic bone was evenly spread in the anterior central part of the intervertebral space. A slightly larger Bullet-shaped PEEK fusion cage was selected , filled with allogeneic bone(Figure 10), and slowly implanted through the working channel to expand the intervertebral space(Figure 11). X-ray fluoroscopy reveals reduction of lumbar spondylolisthesis. One screw is implanted into each of the L4 and L5 vertebral bodies, and they are connected using a titanium rod(Figure 12). Following fluoroscopy, lateral (Figure 13) and anteroposterior (Figure 14) lumbar spine radiographs confirmed satisfactory reduction of the lumbar spondylolisthesis. The wound was repeatedly washed, a drainage tube was placed, and the skin and subcutaneous tissue were sutured layer by layer. After the surgery, the patient was safely returned to the ward.

Figure 8–14

Efficacy evaluation metrics

(1)Perioperative parameter—including operation duration, intraoperative blood loss, postoperative drainage volume, and postoperative length of stay—were prospectively collected for both patient groups. Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI) scores were assessed preoperatively

and at 3, 6, and 12 months postoperatively to evaluate pain intensity and functional impairment, respectively. Higher scores on both scales indicate greater symptom severity.

(2) Imaging outcomes: Intervertebral space hight gain: The absolute increase in intervertebral space height measured on postoperative radiographs or CT scans, relative to preoperative baseline. Spondylolisthesis reduction distance: The linear distance by which the slipped vertebra was repositioned anteroposteriorly following surgical reduction.

(3) Postoperative recovery of patients was assessed using the Modified MacNab Criteria. Excellent: Complete resolution of symptoms with no impairment to daily life or work. Good: Mild symptoms with slight limitation of lumbar mobility, without impairment to work or daily life. Fair: Mild symptoms with restricted lumbar mobility, impairing normal work and daily life. Poor: No improvement in symptoms or symptom exacerbation. The excellent and good rate = (total number of excellent and good cases / total number of cases) × 100%.

(4) Lumbar fusion status was assessed using the Bridwell Classification. Grading Criteria: Grade I (Complete Fusion): A continuous bony bridge traverses the intervertebral space, with no motion at the lumbar fusion level on dynamic radiographs; successful fusion is confirmed both clinically and radiologically. Grade II (Stable Fusion): A continuous bony bridge traverses the intervertebral space, with motion < 5°or translation < 3 mm at the lumbar fusion level on dynamic radiographs, successful fusion is confirmed both clinically and radiologically. Grade III (Possible Non-Fusion): The bony bridge within the intervertebral space is discontinuous, motion at the lumbar fusion level on dynamic radiographs ranges from 5°to 10°or translation is 3 to 5 mm, clinical stability may be present, while radiological findings suggest possible non-fusion. Grade IV (Non-Fusion): No bony bridge is present within the intervertebral space, motion > 10°or translation > 5 mm is observed at the lumbar fusion level on dynamic radiographs, failed fusion is confirmed both clinically and radiologically.

Result

All surgical procedures for both patient cohorts were performed by the same attending surgeon team. All patients completed a minimum 12-month follow-up period, with a 100% follow-up compliance rate. Statistical analyses were conducted using SPSS 26.0 software. Categorical variables (including sex, spinal segment, and clinical outcome assessments) were analyzed via the chi-square test, while continuous variables were evaluated using the independent samples t-test. A two-tailed P-value < 0.05 was deemed statistically significant.

As shown in **Table 1**, no statistically significant differences were observed between the two groups in age, gender, disease duration, involved segment, comorbidities, and occupation type (all P > 0.05). These findings indicate that the preoperative baseline characteristics of the two groups were comparable with good balance.

As shown in **Table 2**, statistically significant differences (P<0.05) were observed between the two groups in operation time (167.09±50.59min vs 112.31±26.95min), intraoperative blood loss (167.73±42.27mL vs 114.19±24.54mL), postoperative drainage volume(154.67±22.13mL vs 98.69 ±10.91mL), and change in intervertebral space height(4.46±1.79mm vs 5.17±1.65mm). The oblique lumbar interbody fusion (OLIF) technique exhibited superior performance across these outcomes. However, no statistically significant differences were observed between the two groups in postoperative bed rest duration, postoperative hospitalization stay, and spondylolisthesis reduction distance (all P>0.05), indicating comparable performance of the two surgical techniques across these outcomes. A statistically significant difference was observed in postoperative Visual Analogue Scale (VAS) scores between the two groups (P<0.05), with patients in the endoscopic fusion group exhibiting a higher likelihood of persistent low back pain postoperatively. There was a significant difference in the time effect between the two groups of patients (F_{time}=58.62, Ptime<0.001), indicating that the pain of both groups tended to improve over time. Additionally, a significant group effect was observed ($F_{Intergroup}$=42.15, $P_{Intergroup}$< 0.001), indicating that pain levels differed significantly between the endoscopic fusion and the OLIF groups across the observation period, despite both groups showing improvement over time. There was a significant difference in the interaction effect analysis between the two groups ($F_{Interaction}$=3.18, $P_{Interaction}$<0.05), indicating that the trend of change at different time points between the two groups was statistically significant, suggesting that the pain tended to improve. Regarding neurological function, no statistically significant difference was observed in postoperative follow-up Oswestry Disability Index (ODI) scores between the two groups (P>0.05). However, a significant time effect was identified for neurological function across both groups (F_{time}=158.62, P_{time}<0.001), indicating that neurological function in both groups showed a tendency toward improvement with increasing follow-up duration.

As shown in **Table 3**, regarding lumbar fusion status, a statistically significant difference in fusion rates was observed between the two groups at the 3-month postoperative follow-up (41.46% vs 20.00%, P<0.05). However, no statistically significant difference in fusion rates was detected between the two groups with prolonged follow-up duration (P>0.05). Clinical efficacy was assessed using the modified MacNab criteria. The excellent-to-good rate of the OLIF group was higher than that of the endoscopic fusion group (85.37% vs 80.00%), though no statistically significant difference was observed between the two groups (P>0.05). Postoperative complications in both groups were predominantly manifested as neurological injury symptoms. Statistical analysis revealed no statistically significant difference in the incidence of these complications between the two groups (P>0.05).

Table 1 Preoperative baseline characteristics of the two groups. [n(%),□ $\bar{x}$ ±s□]

	Endoscopic fusion (n=45)	OLIF (n=41)	T/X^2 value	P value
Age	47.95±6.97	48.05±7.19	-0.09	0.73
Gender				
Male	25(55.56)	23(56.09)	0.08	0.95
Female	20(44.44)	18(43.91)		
Disease duration□month□	10.75±4.55	9.92±4.81	0.85	0.41
ODI	28.38±6.66	28.93±6.37	-0.39	0.89
VAS	5.31±1.22	5.29±1.34	0.07	0.96
Segment				
L4-L5	21(46.67)	19(46.34)	0.02	0.98
L5-S1	24(53.33)	22(53.66)		
Comorbidities				
Diabetes mellitus	9(20.00)	8(19.51)	0.34	0.56
Hypertension	4(8.89)	2(4.87)		
Occupation type				
Maunal workers	33(73.33)	28(68.29)	0.21	0.64
Non-manual workers	12(26.67)	13(31.71)		

Table 2 Intraoperative and postoperative data of the two groups. （$\bar{x}$ ±s）

	Endoscopic fusion (n=45)	OLIF(n=41)	T/X^2 value	P value
Operation time（min）	167.09±50.59	112.31±26.95	6.63	＜0.01
Postoperative drainage volume （ml）	154.67±22.13	98.69±10.91	15.08	＜0.01
intraoperative blood loss（ml）	167.73±42.27	114.19±24.54	6.92	＜0.01
Postoperative hospitalization stay（D）	7.60±1.56	7.76±1.88	-0.46	0.67
Postoperative bed rest time(Day)	4.36±1.33	4.75±1.39	0.32	0.19
intervertebral space hight gain（mm）	4.46±1.79	5.17±1.65	-2.43	＜0.05
spondylolisthesis reduction distance（mm）	4.60±1.95	4.32 ±1.68	1.19	0.23
VAS score				
3 months after surgery	3.07±1.32	2.26±0.89	4.06	＜0.01
6 months after surgery	2.89±1.04	1.94±0.53	3.61	＜0.01
12 months after surgery	2.28±0.62	1.70±0.56	3.02	＜0.01
F_{time}，P_{time}	58.62, P＜0.001			
$F_{intergroup}$，$P_{intergroup}$	42.15，P＜0.001			
$F_{Interaction}$，$P_{Interaction}$	3.18， P＞0.05			
ODI score				
3 months after surgery	25.16±5.52	25.07±5.88	0.08	0.93
6 months after surgery	20.46±4.32	20.02±4.18	0.27	0.61
12 months after surgery	15.04±3.78	14.24±3.61	1.03	0.31
F_{time}，P_{time}	185.62， P＜0.001			
$F_{intergroup}$，$P_{intergroup}$	1.03，P＞0.05			
$F_{Interaction}$，$P_{Interaction}$	1.09，P＞0.05			

Table 3 Postoperative follow-up data and complications of the two groups.[n, (%)]				
Fusion Status	Endoscopic fusion(n=45)	OLIF(n=41)	T/X^2 value	P value
3 months after surgery				
Grade I and II fusion	9（20.00）	17（41.46）	4.214	<0.05
Grade III and IV fusion	36（75.56）	24（58.54）		
6 months after surgery				
Grade I and II fusion	28（62.22）	31（75.60）	1.79	0.18
Grade III and IV fusion	17（37.78）	10（24.40）		
12 months after surgery				
Grade I and II fusion	40（88.89）	39（95.12）	1.11	0.29
Grade III and IV fusion	5（11.11）	2（4.88）		
Modified MacNab Criteria				
Excellent and good	36（80.00）	35（85.37）	0.43	0.51
Fair and poor	9（20.00）	6（14.63）		
Complications				
L4 nerve injury	0（0.00）	1（2.44）	0.23	2.91
L5 nerve injury	2（4.44）	2（4.44）		
S1 nerve injury	2（4.44）	0（0.00）		

Discussion

In spinal disorders, lumbar spondylolisthesis is a prevalent condition. Among individuals aged 55 years and older, its incidence accounts for approximately 21.3% of all spinal diseases[5]. For patients with failed conservative management, surgical intervention remains the sole therapeutic option. To date, the lumbar fusion has emerged as the mainstream surgical intervention for this condition. Nevertheless, while the traditional open lumbar fusion enables effective spinal canal decompression, it inevitably disrupts the posterior spinal osseous structures and paraspinal musculature, contributing to postoperative complications including intractable lumbosciatalgia, paraspinal muscle weakness, and adjacent segment degeneration[6]. To address the aforementioned limitations, Foley pioneered spinal endoscopic technology, which enables effective spinal canal decompression yet fails to achieve fusion and internal fixation objectives[7]. With the progressive refinement of surgical approaches, techniques including the endoscopic fusion technique and the oblique lateral interbody fusion (OLIF) technique have been increasingly developed and translated into clinical practice [8]. The surgical approach for the

endoscopic fusion involves resection of the facet joints via an endoscopic system to achieve adequate exposure of the intervertebral foramen and disc tissue, followed by discectomy, spondylolisthesis reduction, and interbody fusion with internal fixation. Despite being a minimally invasive procedure, this surgical approach requires resection of the facet joints and a small portion of the lamina, which disrupts the posterior spinal structures and predisposes patients to postoperative intractable pain or lumbar instability[6-7]. Based on the findings of this experimental study, compared with the OLIF technique, the endoscopic fusion technique exhibited statistically significant differences in time (F_{time} = 58.62, P < 0.001), between-group effect ($F_{intergroup}$=42.15, P< 0.001), and time-group interaction ($F_{interaction}$ = 3.18, P < 0.05). Another surgical approach, the OLIF technique, is performed via the anterior aspect of the psoas major muscle and retroperitoneal space. Under lateral fluoroscopic guidance, the intervertebral disc tissue is exposed and excised, followed by implantation of a large-sized fusion cage to distract the intervertebral space. The resulting tension on the posterior longitudinal ligament facilitates spontaneous reduction of spondylolisthesis[9]. For single-segment spondylo- listhesis, four screws are required for the endoscopic fusion technique to achieve spinal stability. In contrast, the OLIF technique typically achieves equivalent stability with only two screws, thereby reducing the number of lumbar internal fixation implants in patients[10-11]. The endoscopic fusion technique involves a complex procedural workflow, including resection of the facet joints and partial lamina, as well as bilateral pedicle screw fixation. Compared with the OLIF, this approach was associated with significantly longer operative time (167.09±50.59 min vs 112.31 ±26.95 min), greater intraoperative blood loss (154.67±22.13 mL vs 98.69±10.91 mL), and higher postoperative drainage volume (167.73±42.27 mL vs 114.19±24.54 mL) (all P < 0.05). In contrast, the OLIF technique preserves the bony structures of the vertebral body without disruption during the procedure. The facet joints and the three-column spinal structure are generally well preserved, and patients achieve favorable postoperative recovery outcomes.The postoperative hospital stay of the two groups of patients was longer than that of foreign patients. The main reason for this is that patients believe that the recovery speed in the hospital is faster than that at home.

Given that endoscopic fusion technique relies on direct neural decompression, the procedure typically involves resection of the facet joints and partial laminae, compromising the integrity of the spinal canal. This approach consequently impairs both intraspinal neural structures and lumbar spinal stability[12]. As reported by Rahardjo et al, lumbar fusion surgery performed via the transforaminal approach carries a risk of nerve root injury, with approximately 23% of patients developing postoperative neurological dysfunction[13]. In contrast, the OLIF procedure utilizes an anterolateral approach that avoids the spinal canal region, resulting in a relatively lower incidence of such risks in patients[14]. In the present study, the incidence of postoperative neurological injury was higher in the endoscopic fusion group than in the OLIF group (8.89% vs 7.32%). In terms of fusion effect, during long-term follow-up observations, the endoscopic fusion and the OLIF were at the same level, but the short-term fusion rate was slightly lower than that of the OLIF technique[14]. This conclusion is consistent with the present study. At the 3-month postoperative follow-up, the fusion rate of OLIF patients was higher than that of the endoscopic fusion technique (41.46% vs 20.00%, P < 0.05). However, as the follow-up time extended, there was no

significant difference in the fusion rate between the two groups (P > 0.05). This phenomenon can be primarily attributed to the use of larger-sized interbody fusion cages in the OLIF procedure, which provides an expanded bone grafting area and thereby facilitates early intervertebral fusion. Regarding spondylolisthesis reduction, both groups achieved effective treatment of lumbar spondylolisthesis (4.60±1.95 mm vs 4.32±1.68 mm), with no statistically significant difference in efficacy (P>0.05). Furthermore, the OLIF demonstrated a significantly greater ability to restore intervertebral space height compared to the endoscopic fusion group (5.17±1.65 mm vs 4.46±1.79 mm, P<0.05). Regarding the efficacy of nerve decompression, the endoscopic fusion procedure achieves decompression primarily via direct removal of neural compressive lesions, with well-established clinical outcomes. The OLIF is an indirect nerve decompression technique. It achieves the purpose of reducing the slippage and expanding the spinal canal for decompression by restoring the height of the intervertebral space and foramen through the implantation of a larger-sized fusion cage, and by re-establishing the tension of the posterior longitudinal ligament. According to the research by Fujibayashi et al[15], for patients who underwent the OLIF procedure, the cross-sectional area of the dural sac increased by an average of 19.2% compared to preoperative levels, and the foraminal area increased by 43.3%. In cases of nerve root compression, the OLIF technique has been reported in the literature to yield satisfactory decompression outcomes[16]. Based on the data analysis of this study, the postoperative Oswestry Disability Index (ODI) scores of the two groups were comparable (P>0.05), suggesting that the indirect neural decompression achieved via the OLIF can match the efficacy of direct decompression. However, over time, neurological function recovery in both groups showed a gradual improvement trend (F_{time} =185.62, P<0.001).

In summary, as an emerging minimally invasive spinal fusion technique, the OLIF technique has been increasingly adopted in the field of spinal surgery in recent years. A core characteristic of this technique is its utilization of the body's natural anatomical spaces for procedural access. This confers multiple perioperative advantages, including minimized surgical trauma, reduced intraoperative blood loss and postoperative drainage volume, and shorter operative duration. In clinical practice, the OLIF technique not only effectively reduces the risk of persistent postoperative low back pain in patients but also exerts a positive effect on maintaining the biomechanical stability of the spine, with its comprehensive therapeutic efficacy having been widely recognized. Leveraging the aforementioned characteristics, the OLIF technique can serve as a valuable reference for clinicians in optimizing perioperative safety and treatment efficacy, thereby informing future therapeutic decision-making. This study has several limitations: the sample size was relatively small (n=86), the follow-up duration was short (1-year follow-up), and postoperative follow-up indicators cannot rule out the influence of patients' subjective bias. Further validation is warranted in future research.

Declarations

Date availability statement: The date that support the findings of this study are available on the request from the corresponding auther.

Ethics committee approval: All content of this study has been approved by the Suqian First Hospital Ethics Committee,Issue NO.2021-SR-0255,Date:21.05.2021.

Informed consent: written informed consent was obtained from the patients who agreed to take part in the study.

Peer-review: Externally peer-reviewed

Declaration of interests: The authors have no conflict of interest to declare.

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Data Sharing Availability Statement: All data generated or analysed during this study are included in this article and supplementary information files.

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References

1. Feeney KM, Murphy EP, Curran MG, et al. Outcomes following tibiotalocalcaneal arthrodesis using a solid posterior offset intramedullary nail in 44 patients with a minimum 30-month follow-up[J]. Foot and Ankle Surgery, 2024,30(4):325-330.
2. Li R, Shao X, Li X, et al. Comparison of clinical outcomes and spino-pelvic sagittal balance in degenerative lumbar spondylolisthesis: Minimally invasive oblique lumbar interbody fusion (OLIF) versus transforaminal lumbar interbody fusion(TLIF)[J]. Medicine (Baltimore), 2021, 100(10), e23783.
3. Zhuang H, Wang Y, Zhou H, et al. Application of oblique lateral interbody fusion in treatment of lumbar spinal tuberculosis in adults[J]. Orthopaedic Surgery, 2021, 13(3): 447-454.
4. Yin Y, Xue LX. Comparison of three frailty measures for 90-day outcomes of elderly patients undergoing elective abdominal surgery[J]. Australian and New Zealand Journal of Surger y,2021,91(3):384-390.
5. Huo Y, Yang D, Ma L, et al. Oblique lumbar interbody fusion with stand alone Cages for the treatment of degenerative lumbar spondylolisthesis: A retrospective study with 1-year follow -up[J].Pain Research and Management,2020,30(17):1-7
6. Zhang X, Wu H, Chen Y, et al. Importance of the epiphyseal ring in OLIF stand alone surgery: A biomechanical study on cadaveric spines[J]. European Spine Journal, 2021,30(1):79-87
7. Foley KT, Holly LT, Schwender JD. Minimally invasive lumbar fusion[J]. Spine, 2003,19(33) :S26-S35.

8. Ahn Y, Youn MS, Heo DH. Endoscopic transforminal lumbar interbody fusion: a compre- hensive review [J]. Expert Review of Medical Devices, 2019,16(5):373-380.
9. Stuart C, Joseph FM, John DC, et al. Does Percutaneous Lumbosacral Pedicle Screw instrumentation Prevent Long-Term Adjacent Segment Disease after lumbar fusion?[J]. Asian spine journal, 2021, 15(3): 301-307.
10. Otsuki B, Fujibayashi S, Takemoto M, et al. Analysis of the factors affecting lumbar segmental lordosis after lateral lumbar interbody fusion[J]. Spine , 2020, 45(14): E839-E846.
11. Bydon M, Macki M, Kerezoudis P, et al. The incidence of adjacent segment disease after lumbar discectomy: A study of 751 patients[J]. Journal of Clinical Neuroscience, 2017, 35 (13): 42-46
12. Jacquot F, Gastambide D. Percutaneous endoscopic transforaminal lumbar interbody fusion: is it worth it?[J]. International Orthopaedics, 2013, 37(8): 1517-1522
13. Rahardjo P, Utama HW, Setiawati R, et al. Correlation of the risk factors in degenerative lumbar spondylolisthesis with MRI imaging[J]. Malaysian Journal of Medicine and Health Sciences, 2023,19(4):153 -158.
14. Zhu L, Cai T, Shan Y,et al. Comparison of clinical outcomes and complications between percutaneous endoscopic and minimally invasive transforaminal lumbar interbody fusion for degenerative lumbar disease: A systematic review and meta-analysis[J]. Pain Physician,2021,24□6□□ 441-452
15. Fujibayashi, S. Hynes, RA. Otsuki, B. et al. Effect of indirect neural decompression through oblique lateral interbody fusion for degenerative lumbar disease[J]. Spine,40.(2015): E175-E182
16. Nakamura S, Ito F, Ito Z, et al. Methods and early clinical results of percutaneous lumbar interbody fusion[J]. Neurospine,2020,17(4):910-920.

Figures



Figure 1

displays the lateral lumbar spine X-ray of the patient, demonstrating grade I spondylolisthesis at the L4-L5 vertebral level.

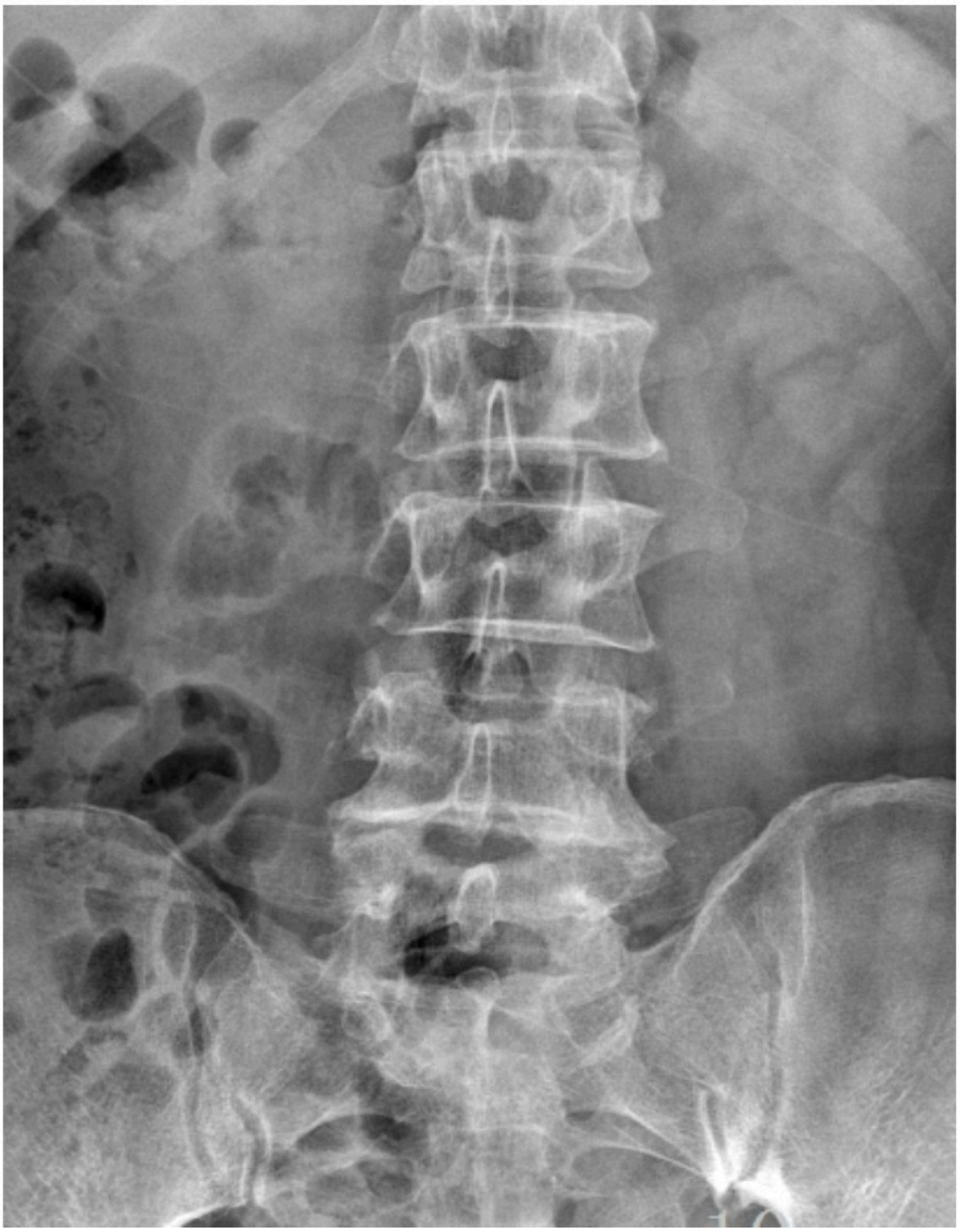


Figure 2

presents the anteroposterior lumbar spine X-ray of the patient, demonstrating a normal spinal alignment.

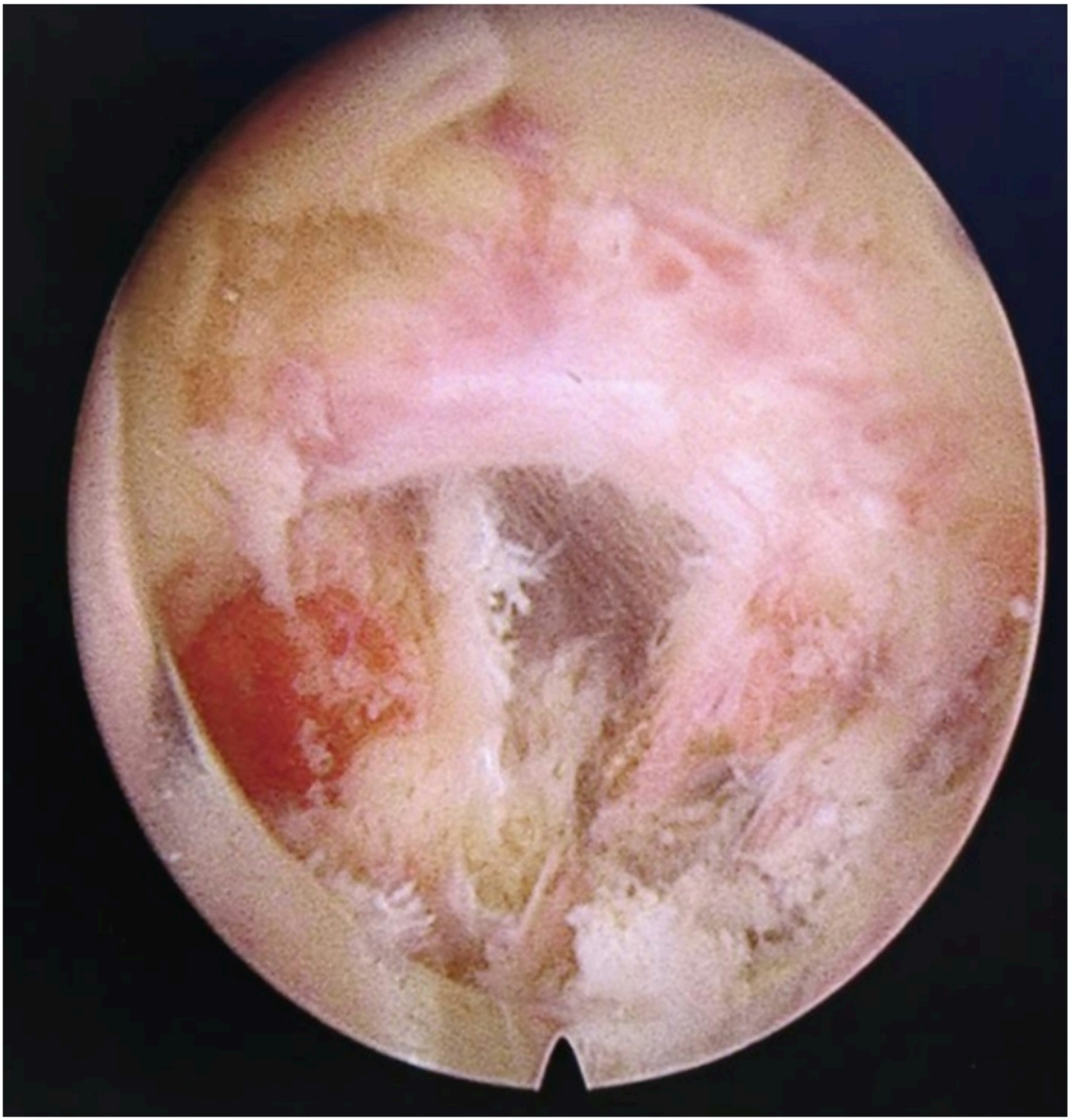


Figure 3

demonstrates complete resection of the lumbar intervertebral disc under endoscopic visualization, with no compression of the lumbar nerves or dural sac.



Figure 4

illustrates a Bullet-shaped PEEK fusion cage packed with autogenous bone graft.

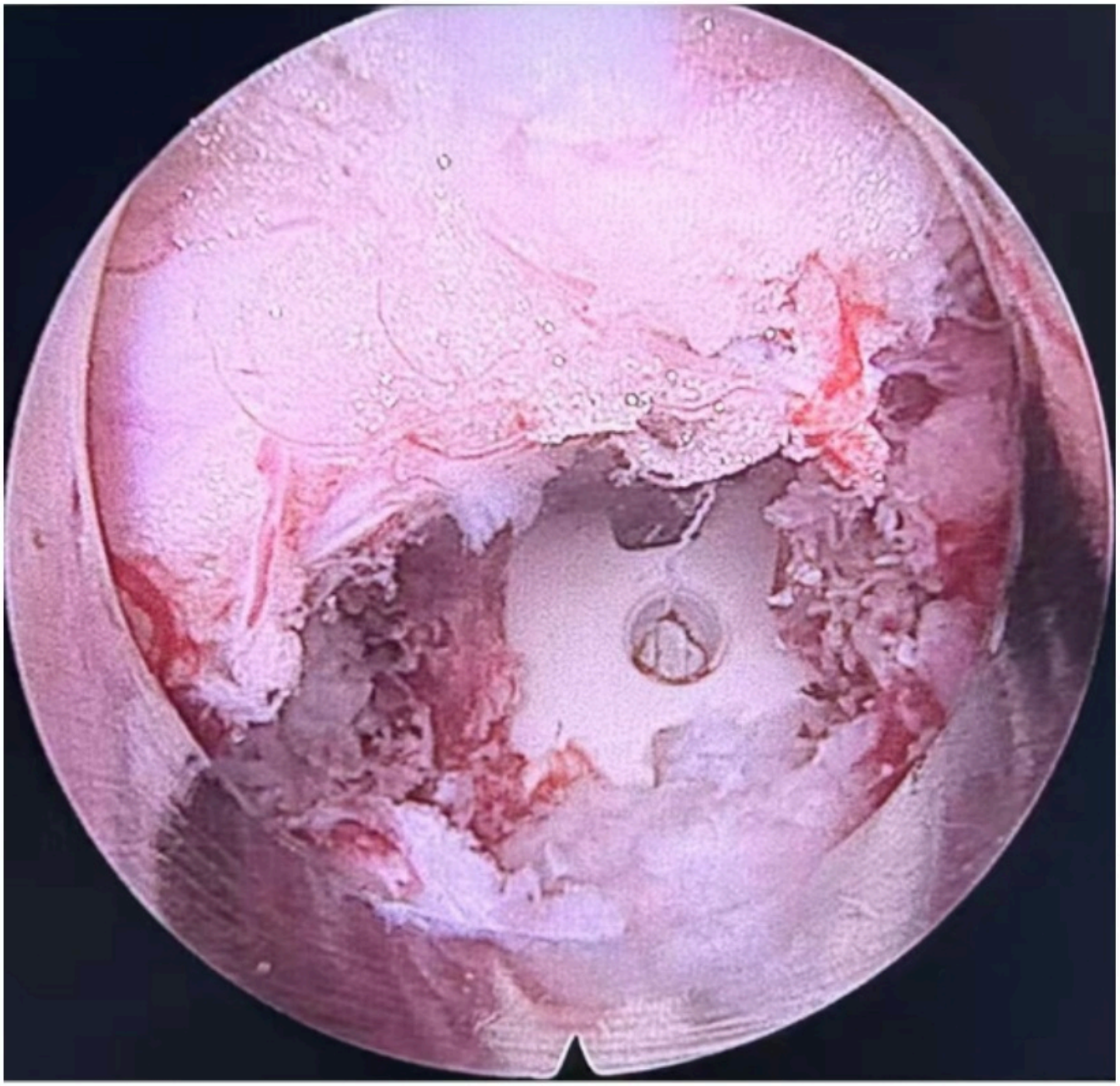


Figure 5

demonstrates the Bullet-shaped PEEK fusion cage implanted within the intervertebral space under endoscopic visualization, with optimal positioning and no compression of the nerves or dural sac.



Figure 6

demonstrates the postoperative lateral lumbar spine X-ray, showing complete reduction of L4-L5 spondylolisthesis with optimal positioning of the screws and fusion cage.



Figure 7

demonstrates the postoperative anteroposterior lumbar spine radiograph, with optimal positioning of the screws and fusion cage.



Figure 8

displays the lateral lumbar spine X-ray of the patient, demonstrating grade I spondylolisthesis at the L4-L5 vertebral level.

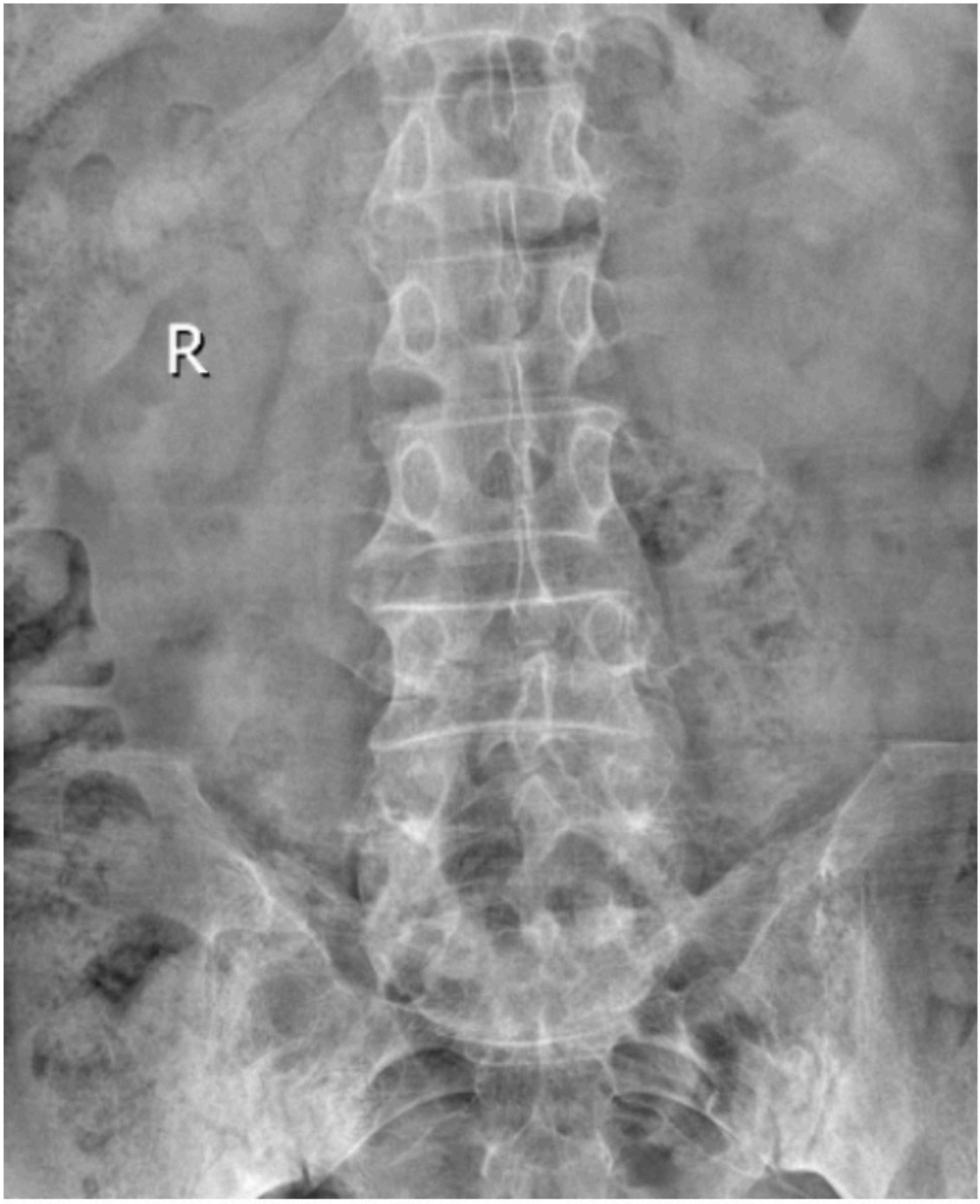


Figure 9

presents the anteroposterior lumbar spine X-ray of the patient, demonstrating a normal spinal alignment.



Figure 10

demonstrates a slightly oversized Bullet-shaped PEEK fusion cage packed with allogeneic bone graft.

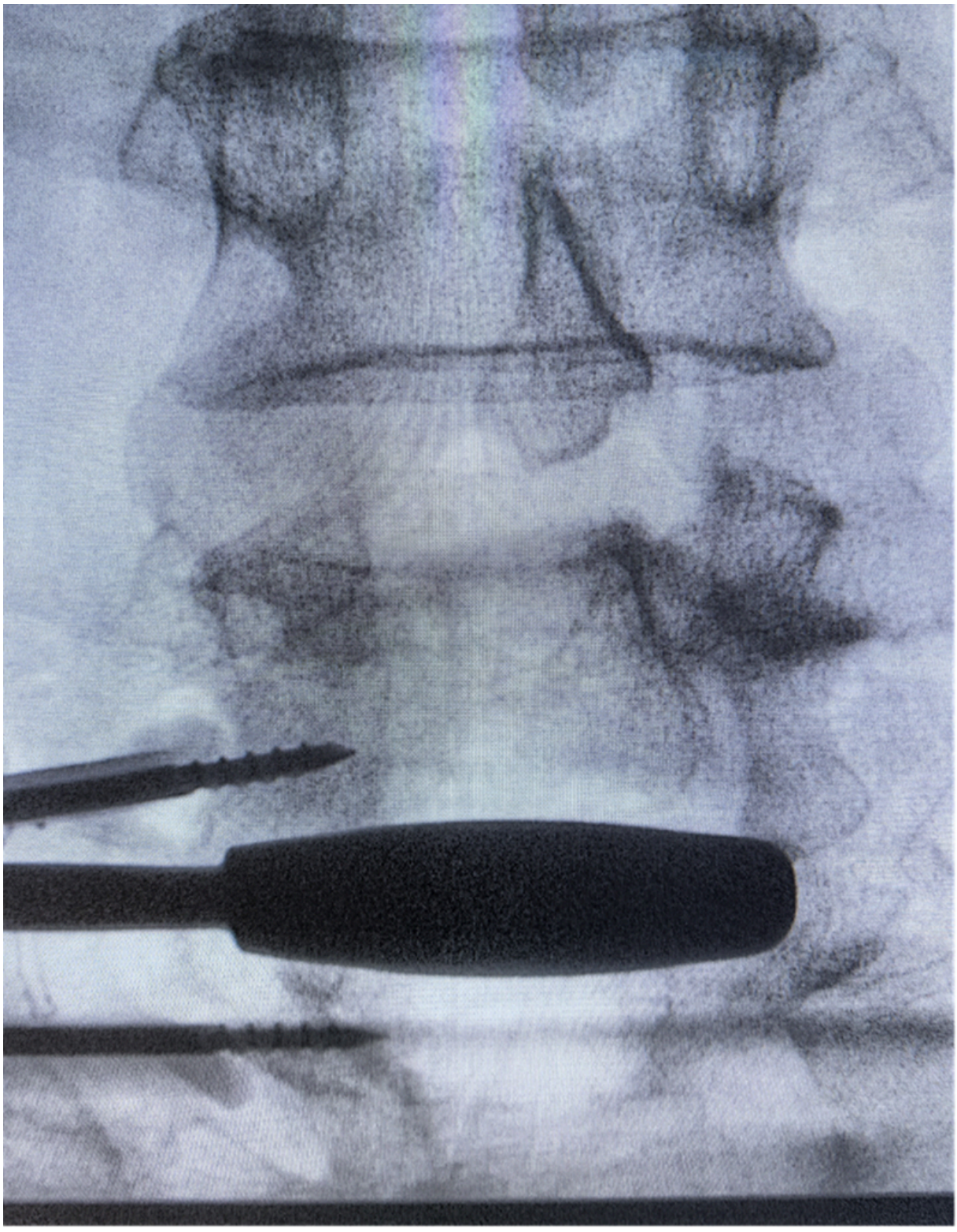


Figure 11

illustrates the implantation of the Bullet-shaped PEEK fusion cage into the intervertebral space.

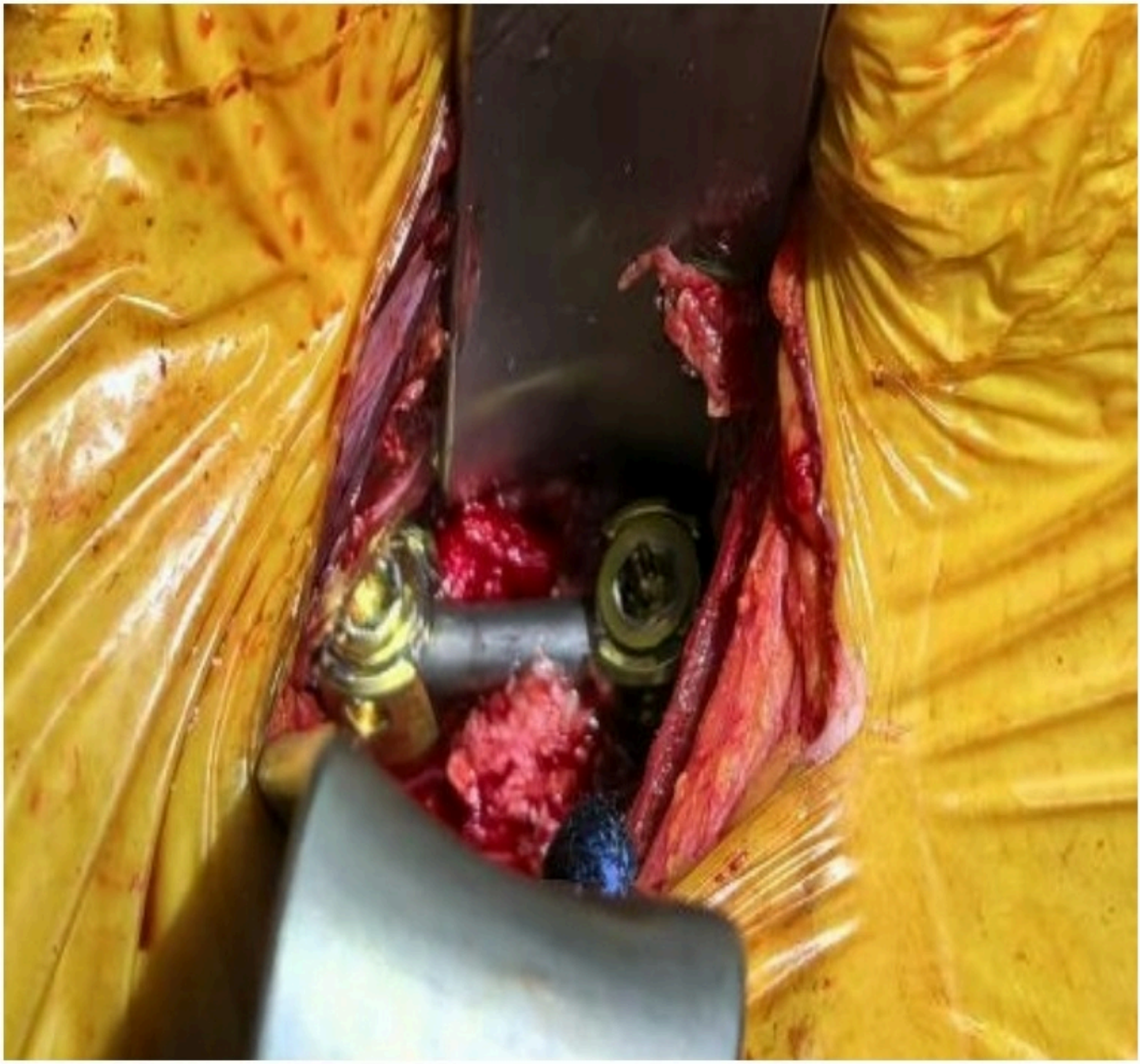


Figure 12

demonstrates the post-implantation status of L4-L5 vertebral screws and the connected titanium rod.



Figure 13

demonstrates the postoperative lateral lumbar spine radiograph, showing complete reduction of lumbar spondylolisthesis with optimal positioning of the screws and fusion cages.

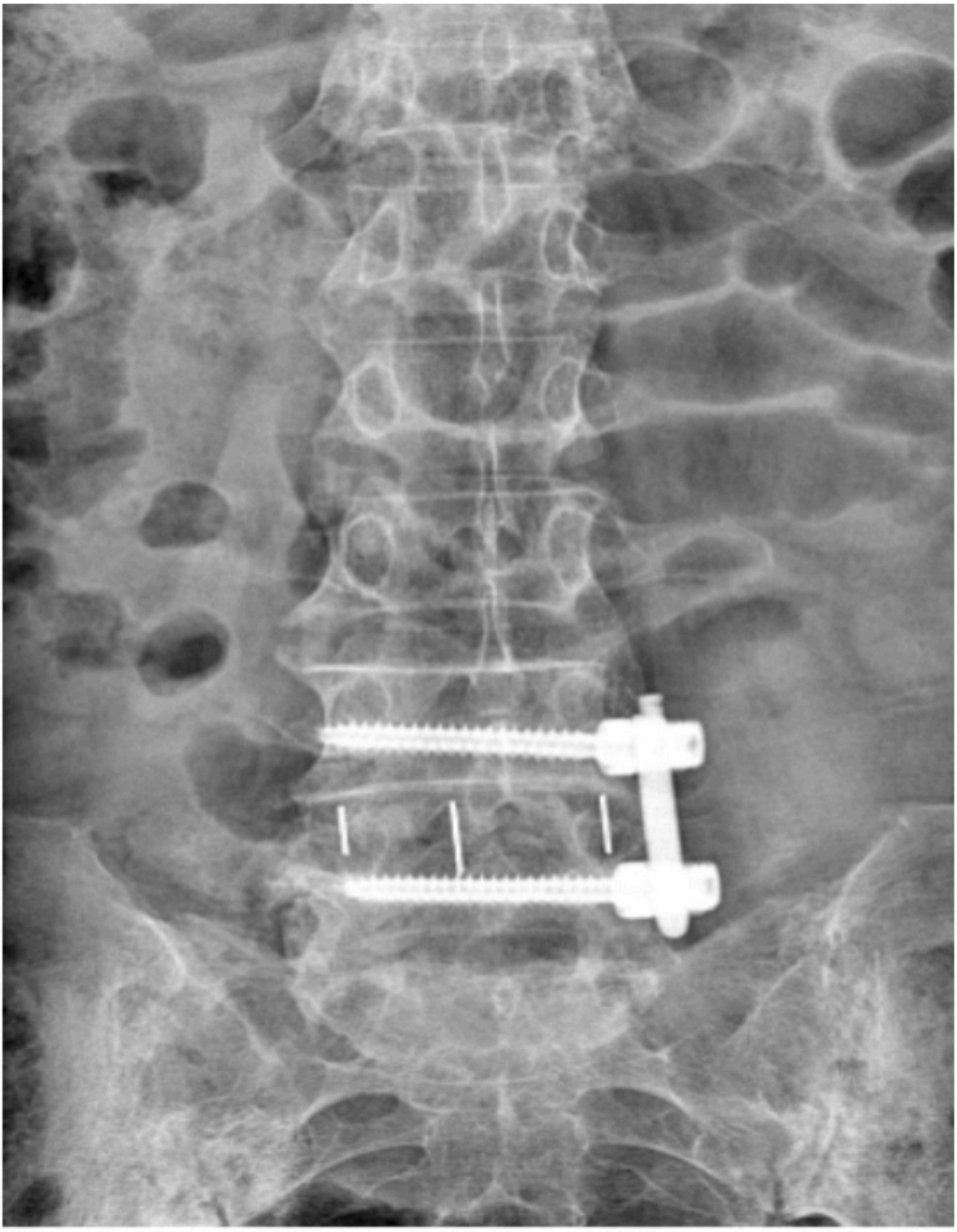


Figure 14

demonstrates the postoperative anteroposterior lumbar spine radiograph with optimal positioning of the screws and fusion cage.

Supplementary Files

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