

Radiological characteristics in coronal and sagittal planes and short-term postoperative outcomes in patients with lumbar disc herniation accompanied by sciatic scoliosis

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Title page**Radiological Characteristics in Coronal and Sagittal Planes and
Short-Term Postoperative Outcomes in Patients with Lumbar Disc
Herniation Accompanied by Sciatic Scoliosis**

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**Radiological Characteristics in Coronal and Sagittal Planes and
Short-Term Postoperative Outcomes in Patients with Lumbar Disc
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Abstract:

Objective: To investigate the coronal and sagittal radiological characteristics of patients with lumbar disc herniation (LDH) with sciatic scoliosis, to establish a new typing system, and to assess the difference in efficacy between percutaneous endoscopic lumbar discectomy (PELD) and transforaminal lumbar interbody fusion (TLIF).

Methods: Patients with LDH with sciatic scoliosis who underwent surgical treatment in our hospital from January 2023 to December 2024 were retrospectively analyzed, and the clinical data of the patients were collected. According to the different surgical methods, they were divided into PELD group and TLIF group. Radiological parameters were measured on the basis of full spine frontal and lateral radiographs. Coronal radiological characteristics were evaluated by using Chunde Li typing, sagittal radiological characteristics were evaluated by using LL and SVA, and scoliosis resolution rate was used to evaluate the resolution of scoliosis in patients.

Results: A total of 137 patients were included, including 25 patients with coronal type 1A, 86 patients with type 1B, and 26 patients with type 2. Four sagittal types were identified by sagittal LL and SVA. Among them, 39 patients (28.5%) showed reduced lumbar lordosis but maintained balance in the sagittal position, 40 patients (29.2%) showed lumbar lordosis maintained and a combination of sagittal imbalance, and 27 patients (19.7%) showed lumbar kyphosis with sagittal imbalance. The TLIF group had higher operation time, bleeding, and postoperative hospitalization days than the PELD group. At one week after surgery, both groups achieved satisfactory clinical outcomes, and in patients with sagittal type III and type IV, the scoliosis resolution rate of scoliosis was higher in the TLIF group than in the PELD group.

Conclusions: Patients with sciatic scoliosis often have a combination of

reduced sagittal lumbar lordosis, sagittal imbalance, and lumbar kyphosis. PELD and TLIF can achieve good surgical efficacy and coronal and sagittal orthopedic results in sciatic scoliosis. The TLIF group had a longer operation time, more bleeding, and more postoperative hospitalization days. For patients with combined sagittal imbalance, the short-term coronal orthopedic results of TLIF were better than those of PELD.

Keywords: lumbar disc herniation, sciatic scoliosis, coronal, sagittal, percutaneous endoscopic lumbar discectomy, transforaminal lumbar interbody fusion

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Introduction

Approximately 1.4%-32%^[1-3] of patients with lumbar disc herniation (LDH) have a combined trunk tilt and scoliotic posture, which is referred to as sciatic scoliosis. The core mechanism is that patients try to relieve pain caused by nerve root irritation by adjusting their trunk posture to reduce nerve root tension, and maintaining an abnormal posture for a long period of time leads to scoliosis^[1]. The paraspinal muscles (e.g., erector spinae, psoas major) reflexively spasm due to pain, exacerbating scoliosis^[4]. These patients, in addition to nerve compression, often have a combination of coronal and sagittal imbalance. Prof. Chunde Li's^[5] study showed that most patients with scoliosis have a relatively straight sagittal plane, with reduced thoracic kyphosis and lumbar lordosis, and proposed a coronal typing of scoliosis. 1A: the scoliosis is located on the ipsilateral side of central sacral vertical line, with the apical vertebra as T1; 1B: the scoliosis is located on the ipsilateral side of the central sacral vertical line, with the apical vertebra as T5-L1; Type 2: the scoliosis was located on both sides of the central sacral vertical line. The above typing was based on the coronal plane and did not involve the sagittal plane.

Surgery should be performed in patients who fail to respond to standardized conservative treatment^[6-8]. Transforaminal lumbar interbody fusion (TLIF) proposed by Harms and Rolinger^[9] is the classic lumbar fusion surgical method^[10-12]. In recent years, with the development of minimally invasive technology, surgical procedures have gradually evolved in the direction of refinement and minimally invasiveness^[13, 14]. Percutaneous endoscopic lumbar discectomy (PELD) has developed rapidly and has gradually become the mainstream surgical procedure for the treatment of LDH^[15, 16]. However, the difference in the efficacy of PELD and TLIF in patients with combined sciatic scoliosis has not been reported.

Therefore, the aim of this study was to perform complementary typing by coronal and sagittal radiological characteristics of patients with LDH with sciatic scoliosis and to assess the difference in efficacy between PELD and TLIF in different types of patients.

Methods

General Information

This retrospective study was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University and carried out by the ethical standards set out in the Helsinki Declaration. Informed consent was received from all participants.

Inclusion criteria: (1) MRI showed LDH, dural sac or nerve root compression; (2) full spine frontal and lateral measurements in the standing position suggested: Cobb's angle $\geq 10^\circ$ or Apical vertebral translation (AVT) $\geq 20\text{mm}$; (3) treatment with PELD or TLIF after at least 6 weeks of ineffective conservative treatment.

Exclusion criteria: (1) combined with lumbar spondylolisthesis or multisegmental lumbar disc herniation and spinal stenosis; (2) definitive diagnosis of structural scoliosis, such as degenerative scoliosis, neuromuscular scoliosis, etc.; (3) age ≤ 18 years old with a definitive diagnosis of adolescent idiopathic scoliosis; (4) history of previous spinal surgery or trauma.

Patients who underwent surgical treatment at our hospital from January 2023 to December 2024 were selected according to the inclusion and exclusion criteria mentioned above. Initially, 920 patients with LDH were screened and a total of 137 patients with sciatic scoliosis were further screened. The patients were divided into PELD group and TLIF group according to the different surgical methods.

Surgical Methods

TLIF: General anesthesia was administered and the patient was placed in the prone position. After locating the responsible segment on the C-arm X-ray machine, a posterior median incision was made centered on the spinous process. The superior and inferior vertebral laminae and zygapophysial joint of the responsible segment were fully exposed. The needle entry point was determined, and four pedicle screws of appropriate length were placed. The inferior articular process on the symptomatic side, part of the superior articular process, and the

ligamentum flavum on the deep surface are removed to expose the intervertebral foramina and intervertebral discs. Protect the dura mater and nerve roots in the spinal canal, incise the intervertebral disc, remove the nucleus pulposus and upper and lower cartilage endplate carefully. Autogenous bone particles were implanted and compacted in the intervertebral space, and a fusion cage of the appropriate size was selected and placed in the intervertebral space. The connecting rods were placed bilaterally and locked with pressure. A negative pressure drain is placed after adequate irrigation of the surgical area.

PELD: Depending on the surgical segment, different accesses were selected. No drains were placed for all endoscopic procedures.

Patients with herniated segments located in L4/5 and above segments were selected for percutaneous endoscopic transforaminal discectomy (PETD) under local anesthesia. After the anesthesia took effect, under the guidance of C-arm X-ray machine, the puncture needle was placed into the posterior superior margin of the vertebral body at the lower level of the intervertebral foraminal area. A level-by-level trocar was placed sequentially and the shoulder of the superior articular process was removed with a ring drill. The nerve root was carefully separated from the ligamentum flavum and posterior longitudinal ligament endoscopically, and the nucleus pulposus tissue compressing the nerve was removed.

Patients with herniated segments located at L5/S1 were selected for percutaneous endoscopic interlaminar discectomy (PEID) under general anesthesia. After the anesthesia took effect, a puncture needle was placed into the medial aspect of the zygapophysial joint under the guidance of a C-arm X-ray machine. Endoscopically, part of the zygapophysial joint is abraded and the dorsal ligamentum flavum of the nerve root is removed. The nucleus pulposus tissue compressing the nerve was removed, and the nerve root was carefully explored over the shoulder and in the axilla for any residue.

Post-operative Treatment

After awakening from anesthesia, the patients were checked for active and

passive ankle dorsiflexion function and underwent straight leg raise test. When the drainage flow was less than 30ml/24h, the drainage tube was removed. Instruct patients to get out of bed gradually under the protection of waist circumference, and endoscopic surgery patients appropriately prolong bed rest time.

Observation Indicators

Clinical efficacy: Patient perioperative indicators including operation time, bleeding, number of intraoperative fluoroscopies, and postoperative hospitalization days were recorded. The patients' visual analog score (VAS) low back pain score, VAS leg pain score, Oswestry dysfunction index (ODI), Japanese Orthopaedic Association scores (JOA) were obtained preoperatively and one week postoperatively.

Radiological indicators: The following parameters were measured on preoperative and postoperative full spine frontal and lateral radiographs using **Surgimap software (version 2.3.2.1; URL: <https://www.surgimap.com/>):**

Cobb's angle: the intersection of the vertical line of the superior edge of the cephalad end vertebrae in the coronal position and the vertical line of the inferior edge of the caudal end vertebrae;

Apical vertebral translation (AVT): horizontal distance from the midpoint of the apical vertebra in coronal lateral projection to the transsacral midline;

Coronal balance distance (CBD): horizontal distance from the plumb line of the cervical 7 in the coronal position to the sacral midline;

Sagittal vertical axis (SVA): the horizontal distance between the sagittal position via the plumb line at the midpoint of the cervical 7 vertebrae and the posterior superior margin of sacral 1;

Thoracic kyphosis (TK): the angle between the upper endplate of the thoracic 5 vertebrae and the lower endplate of the thoracic 12 vertebrae in the sagittal position;

Lumbar lordosis (LL): the angle between the upper endplate of the thoracic 12 vertebrae and the upper endplate of sacral 1 in the sagittal position ;

Pelvic angle of incidence (PI): the angle between the sagittal midpoint of the sacral 1 upper endplate and the line connecting the centers of the femoral heads and the vertical line of the sacral 1 upper endplate passing through the midpoint of the sacral 1 upper endplate (or the midpoint of the line connecting the centers of the two femoral heads if the femoral heads of the two sides do not overlap).

According to previous literature, the magnitude of the difference between PI and LL was used to assess sagittal lumbar lordosis relative to the pelvis. Normal lumbar lordosis was defined as $LL > PI - 10^\circ$ ^[17-21]. Sciatic scoliosis resolution to normal was defined as $AVT \leq 10 \text{ mm}$ ^[22]. Scoliosis resolution rate was defined as the ratio of the number of scoliosis regressions to normal to the total number of patients.

Statistical Analysis

Statistical software IBM SPSS Statistics (version 26; URL: <https://www.ibm.com/products/spss>) was used to analyze the data statistically. The Shapiro-Wilk test was used to test the normality of the data. Continuous Data (age, BMI index, perioperative indicators, radiological indicators) obeyed or approximately obeyed the normal distribution, which was expressed as $(\bar{X} \pm S)$, and the comparison between the same group of patients before and after surgery was performed using the paired samples t-test, and the comparison between the two groups was performed using the independent samples t-test. Categorical data (gender, herniated segments, scoliosis resolution rate, etc.) were expressed as rate (%), and comparisons between the two groups were made using the X^2 test or Fisher's exact probability method, with $P < 0.05$ indicating that the difference was statistically significant.

Results

General Information

A total of 137 patients were included in this study, 87 in the PELD group and 50 in the TLIF group. There were 40 males and 47 females in the PELD group, with a mean age of 36.9 ± 12.1 years, a mean BMI index of $25.2 \pm 3.9 \text{ kg/m}^2$, a mean

symptom duration of 5.9 ± 3.1 months, 58 cases in the L4-5 segment, 17 cases in the L5-S1 segment and 12 cases in the L3-4 segment. In the TLIF group, there were 22 males and 28 females, with a mean age of 38.4 ± 11.3 years, a mean BMI of 24.8 ± 4.1 kg/m², a mean symptom duration of 6.1 ± 2.7 months, 36 cases in the L4-5 segment, 12 cases in the L5-S1 segment, and 1 case each in the L1-2 and L2-3 segments. There was no statistically significant difference between the two groups in terms of gender, age, BMI, symptom duration, and herniated segments ($P > 0.05$, Table 1).

	PELD group	TLIF group
Number of cases (n)	87	50
Sex (male/female)	40/47	22/28
Age (years)	36.9 ± 12.1	38.4 ± 11.3
BMI (kg/m ²)	25.2 ± 3.9	24.8 ± 4.1
Mean Symptom Duration (months)	5.9 ± 3.1	6.1 ± 2.7
Herniated Segments	L4-5/L5-S1/ L3-4: 58/17/12	L4-5/L5-S1/L1-2/L2-3: 36/12/1/1

Table 1 Demographic and Clinical Characteristics for All the Cases

Coronal and Sagittal Typing and Scoliosis Resolution Rate at One Week After Surgery

According to Prof. Chunde Li 's coronal typing of sciatic scoliosis, in this study, there were 25 cases of type 1A, 86 cases of type 1B, and 26 cases of type 2 (Fig. 1).



Figure 1: Chunde Li 's typing. a: Type 1A, with the scoliosis located ipsilateral side to the CSVL and the apical vertebra at T1; b: Type 1B, with the scoliosis located ipsilateral side to the CSVL and the apical vertebra at T8; and c: Type 2: with the scoliosis located on both side of the CSVL.

Based on the preoperative PI, LL and SVA of the patients, the sagittal position of the patients with LDH with sciatic scoliosis was proposed to be typed as follows (Figure 2):

Type I: normal lumbar lordosis ($LL > PI - 10^\circ$) combined with sagittal balance ($SVA < 40\text{mm}$)

Type II: reduced lumbar lordosis ($0^\circ < LL < PI - 10^\circ$) combined with sagittal balance ($SVA < 40\text{mm}$)

Type III: reduced lumbar lordosis ($0^\circ < LL < PI - 10^\circ$) combined with sagittal imbalance ($SVA \geq 40\text{mm}$)

Type IV: lumbar kyphosis combined with sagittal imbalance ($SVA \geq 40\text{mm}$)

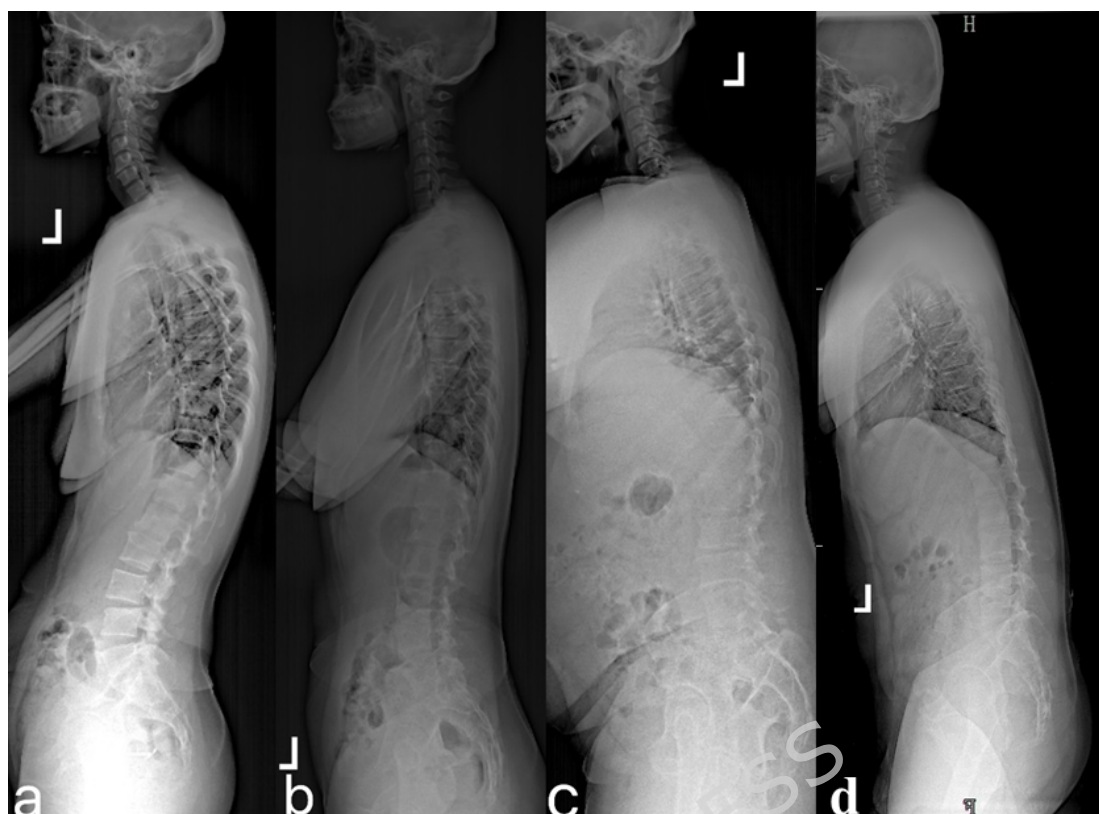


Figure 2: Sagittal typing. a: Type I, normal lumbar lordosis, sagittal balance; b: Type II, reduced lumbar lordosis, sagittal balance; c: reduced lumbar lordosis, sagittal imbalance; Type IV: lumbar kyphosis deformity, sagittal imbalance.

According to the above typing, 31 cases of sagittal position type I, 39 cases of type II, 40 cases of type III, and 27 cases of type IV were found in this study. One week after surgery, for patients with coronal position types 1A, 1B, and 2, the scoliosis resolution rate in the TLIF group was higher than that in the PELD group, but the difference was not statistically significant ($P > 0.05$). For sagittal typed, the scoliosis resolution rate was higher in the TLIF group than in the PELD group for patients with types III and IV, and the difference was statistically significant ($P < 0.05$), while no significant difference was seen for the other types (Table 2). For sagittal type IV patients with combined lumbar kyphosis, 13 cases underwent PELD surgery and 14 cases underwent TLIF surgery. One week after surgery, 7 cases in the PELD group and 11 cases in the TLIF group regained lumbar lordosis, but none of them reached the ideal lumbar anterior convexity angle ($PI-10^\circ$). Typical cases are shown in Figures 3 and 4.

Type	PELD group	TLIF group
Coronal 1A	33.3%	50%
Coronal 1B	40.0%	55.2%
Coronal 2	45.5%	58.3%
Sagittal I	45.5%	55.6%
Sagittal II	46.7%	42.9%
Sagittal III	29.4%	75.0%*
Sagittal IV	25.4%	53.8%*

Table 2 Scoliosis resolution rate at one week after surgery. * Compared with PELD group, the difference was significant ($P < 0.05$)

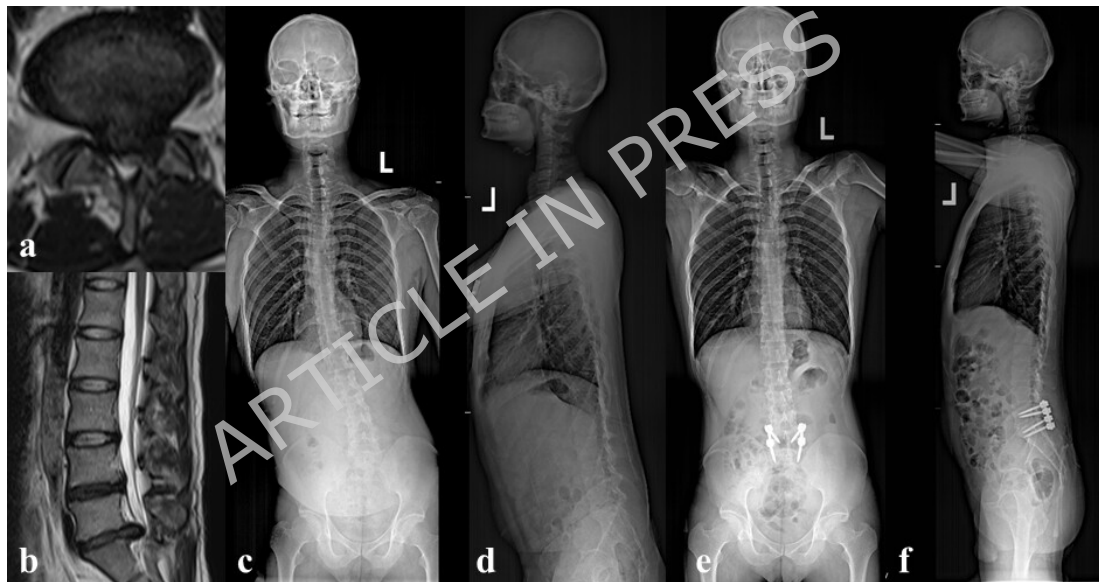


Figure 3: Male patient, 35 years old, was admitted to the hospital with "recurrent low back pain and left lower extremity pain for more than 2 years", diagnosed as L5/S1 LDH, and underwent TLIF in our hospital. a and b are the patient's preoperative MRI images. c and d are preoperative full spine frontal and lateral X-rays of the patient, with coronal position of type 1B, sagittal position of type III, and the Cobb's angle of 16.1°; AVT: 87.4 mm; CBD:81.6 mm; SVA:124.4 mm, TK:4.7°; LL:8.5°; e, f are the patient's 1-week postoperative full spine frontal and lateral X-rays, Cobb's angle: 3.1°; AVT: 4.5 mm; CBD:2.9 mm; SVA:19.2 mm, TK:6.8°; LL:18.8°.



Figure 4: The patient is a 39-year-old male, who was admitted to the hospital with "low back pain for 2 years, aggravated with pain in the left lower limb for 3 months", diagnosed as L4/5 LDH, and underwent PELD in our hospital. a and b are the patient's preoperative MRI images. c and d show the patient's preoperative full spine frontal and lateral X-rays, with the coronal view of type 1B, the sagittal view of type IV, and the Cobb's angle of: 12.8°; AVT: 38.7 mm; CBD:31.0 mm; SVA:195.9 mm, TK:7.5°; LL:29.2° (lumbar kyphosis deformity); e, f are the patient's postoperative 1-week full spine frontal lateral X-rays, Cobb's angle: 2.8°; AVT: 3.4 mm; CBD:2.1 mm; SVA:3.7 mm, TK:6.2°; and LL:15.4°.

Perioperative Indicators

The TLIF group's operation time, bleeding, and postoperative hospitalization days were higher than those of the PELD group, and the difference was statistically significant ($P < 0.05$), and the number of intraoperative fluoroscopies did not show any significant difference between the two groups ($P > 0.05$, Table 3).

parameters	PELD group	TLIF group
operation time (min)	70.4+18.4	121.4+20.7*
Bleeding (ml)	8.4±3.4	180.5±40.6*
number of intraoperative fluoroscopies□time□	5.2±2.1	6.1±3.7
postoperative hospitalization days □day□	1.8±1.3	6.1±2.7*

Table 3 Perioperative indicators. * Compared with PELD group, the difference was significant ($P < 0.05$).

Clinical Efficacy

No significant difference was seen in the preoperative VAS low back pain score, VAS leg pain score, ODI index, and JOA score between the two groups. One week after surgery, VAS low back pain scores in the TLIF group did not show significant differences compared with the preoperative period ($P > 0.05$), and the rest of the indexes in both groups showed significant improvement compared with the preoperative period ($P < 0.05$). The VAS low back pain score and ODI index were higher in the TLIF group than those in the PELD group ($P < 0.05$), and no significant difference was seen in the VAS leg pain score and JOA score ($P > 0.05$, Table 4).

Outcome	PELD group		TLIF group	
	Preoperative	1 week after surgery	Preoperative	1 week after surgery
VAS Low Back Pain	6.8±2.1	2.1±1.3*	6.5±2.3	5.2±1.4#
VAS Leg Pain	7.8±2.0	2.2±1.4*	7.2±2.1	1.8±1.2*
ODI [%]	46.2±8.6	11.0±4.1*	48.7±7.9	20.1±12.6**
JOA	11.8±4.2	23.0±3.5*	12.8±2.6	24.6±2.7*

Table 4 Clinical outcomes of patients. * Compared with preoperative, the difference was significant ($P < 0.05$). # Compared with PELD group at the same time, the difference was significant ($P < 0.05$).

Radiological Indicators

There was no significant difference in the preoperative Cobb's angle, AVT, CBD, SVA, TK, and LL between the two groups ($P > 0.05$). One week after surgery, Cobb's angle, AVT, CBD, SVA were lower than preoperative in both groups ($P < 0.05$). No statistically significant difference was seen between the two groups ($P > 0.05$, Table 5).

Outcome	PELD group		TLIF group	
	Preoperative	1 week after surgery	Preoperative	1 week after surgery
Cobb's angle (°)	17.2±3.1	7.2±2.1*	18.4±3.2	7.5±2.3*
AVT(mm)	26.2±16.3	9.0±2.7*	27.8±14.1	10.1±2.8*
CBD(mm)	21.3±4.2	8.7±2.9*	22.6±5.0	7.9±2.8*
SVA(mm)	49.8±21.3	23.7±15.1*	50.1±21.9	24.2±13.9*

TK(°)	12.4±7.8	13.0±4.7	11.9±6.9	13.4±3.8
LL(°)	34.8±12.1	36.8±7.1	35.1±9.4	38.1±10.1

Table 5 Radiological results of patients. * Compared with preoperative, the difference was significant ($P < 0.05$).

Complications

In this study, surgery was successfully completed in both groups. No serious complications such as cerebrospinal fluid leak and nerve root injury occurred during the operation. Two cases in each of the two groups experienced postoperative buttock pain with clear pressure points, which improved after local blockage treatment. One case in the TLIF group showed poor incision healing, which was improved after intensive dressing changes and hot pack physiotherapy.

Discussion

In this study, sagittal typing was proposed based on the radiological characteristics of sciatic scoliosis, and the early clinical efficacy and radiological orthopedic effects of PELD and TLIF for LDH with sciatic scoliosis were retrospectively compared. While achieving satisfactory orthopedic results, the PELD procedure was associated with less injury, less postoperative pain, and faster recovery compared with TLIF. For patients with combined sagittal imbalance, TLIF has better orthopedic results.

Sagittal Typing of Sciatic Scoliosis

Patients with sciatic scoliosis do not only have a coronal deformity, but often combine it with a relatively straight sagittal plane, reduced thoracic kyphosis and lumbar lordosis, and even a sagittal imbalance^[3, 22]. According to Prof. Chunde Li's study^[5], there are different types of sciatica in the coronal position due to excessive spasm of the ipsilateral or contralateral psoas major, quadratus lumborum, erector spinae, and longissimus and spinalis, but these typed types do not involve morphological changes in the sagittal position of the patient.

Our team used PI-10° as the ideal degree of lumbar lordosis and typed the sagittal position of patients with sciatica scoliosis according to whether the lumbar

lordosis was normal or not and whether it was combined with sagittal imbalance or not.

It was found that 39 (28.5%) patients showed reduced lumbar lordosis but sagittal balance, 40 (29.2%) patients showed lumbar lordosis maintained and combined with sagittal imbalance, and 27 (19.7%) patients showed lumbar kyphosis with sagittal imbalance. The higher the typed level, the more lumbar lordosis was lost and the more severe the sagittal imbalance.

Comparison of Surgical Efficacy

Because of the advantages of less invasion of ligaments and zygapophysial joints, low postoperative infection rate, and avoidance of adjacent segment degeneration, PELD has gradually become a mainstream surgical procedure for the treatment of LDH^[8, 23-25], and it is also safe and effective for patients with sciatic scoliosis^[22, 26, 27]. Wang^[3] retrospectively analyzed 110 patients with sciatic scoliosis and found that the majority of patients had mild to moderate coronal and sagittal imbalances, and that scoliosis could be spontaneously corrected when sciatica resolved immediately after PELD and remained well during the follow-up period.

In this study, surgery was successfully completed in all patients, and the PELD group had shorter operation time, less bleeding, and fewer postoperative hospitalization days. One week after surgery, all patients showed significant improvement in VAS leg pain score, ODI index, and JOA score compared with the preoperative period, but the VAS low back pain score of the TLIF group did not show significant improvement compared with the preoperative period, and the VAS low back pain score and ODI index were higher than those of the PELD group. The above results showed that both PELD and TLIF could achieve satisfactory clinical efficacy, but TLIF had more bone resection and greater muscle and soft tissue damage during the operation, and the postoperative recovery process was slower.

Comparison of Orthopedic Effects

Sciatic scoliosis is a painful compensatory postural abnormality, and early identification and management of the primary pathology can effectively reverse the spinal deformity and avoid progression to structural scoliosis and unnecessary surgeries^[3]. Pluemvitayaporn^[26] et al. found in a retrospective study of 60 patients that 68% of the patients had normalized scoliosis within 12 months after full-endoscopic interlaminar discectomy. Zhang^[27] et al. found that the prevalence of LDH with sciatic scoliosis was significantly higher in adolescents than in adults, and that there was a higher incidence of preoperative coronal imbalance, and sciatic scoliosis gradually subsided at 6 months after surgery, in a retrospective study of 83 patients. The core of the surgical treatment is to release the nerve root compression, not to directly correct the scoliosis^[3]. Scoliosis is self-correcting when nerve compression is relieved^[27]. The orthopedic effect should not only focus on the coronal index, but also focus on the sagittal index. In this study, one week after surgery, the Cobb's angle improved to $7.2\pm 2.1^\circ$ and $7.5\pm 2.3^\circ$ in the PELD and TLIF groups, respectively, from the preoperative values of $17.2\pm 3.1^\circ$ and $18.4\pm 3.2^\circ$, the AVT improved to $9.0\pm 2.7\text{mm}$ and $10.1\pm 2.8\text{mm}$ from the preoperative values of $26.2\pm 16.3\text{mm}$ and $27.8\pm 14.1\text{mm}$, respectively, and the CBD improved from $21.3\pm 4.2\text{mm}$ and $22.6\pm 5.0\text{mm}$ to $8.7\pm 2.9\text{mm}$ and $7.9\pm 2.8\text{mm}$, respectively, and the SVA improved from $49.8\pm 21.3\text{mm}$ and $50.1\pm 21.9\text{mm}$ to $23.7\pm 15.1\text{mm}$ and $24.2\pm 13.9\text{mm}$, respectively. There was no significant difference of the above indexes in the comparison of the two groups after surgery, which indicated that both PELD and TLIF could achieve similar orthopedic results. In addition, postoperative TK and LL did not show significant improvement compared with the preoperative period in both groups, which indicated that the overall imbalance in the coronal and sagittal positions could be corrected rapidly after nerve compression was lifted, and the improvement of thoracic kyphosis and lumbar lordosis in the sagittal position can be considered as a change in compliance after restoration of the coronal position and that sagittal curves required a longer recovery time.

In this study, further typing of sagittal position was done based on preoperative radiological characteristics, and the orthopedic effects of PELD and TLIF on different sagittal position types were investigated using the scoliosis resolution rate one week after surgery. It was found that for patients with sagittal position types III and IV, the scoliosis resolution rates in the TLIF group were 75.0% and 53.8%, which were significantly higher than those in the PELD group (29.4% and 25.4%), which indicated that TLIF had better orthopedic results in cases with combined sagittal imbalance. In the author's opinion, this is related to the use with the fusion cages. Placing the fusion cages in front of the intervertebral space and in full contact with the upper and lower endplates during surgery can reduce the endplate loading stress^[28], which is conducive to intervertebral fusion and the recovery of the intervertebral foraminal height^[29]. It can also indirectly restore the volume of the neural root canal^[30], which has a good indirect decompression effect and promotes the improvement of the coronal and sagittal curves^[31]. In this study, one week after surgery in type IV patients with combined lumbar kyphosis, 53.8% (7 cases) and 78.6% (11 cases) of the PELD and TLIF groups, respectively, had their lumbar spine return to lordosis, but none of the LL reached the ideal state of PI-10°. The difference in the orthopedic effect of PELD and TLIF on lumbar kyphosis deformity needs to be further investigated.

Hiyama^[32] et al. conducted a retrospective analysis of 102 patients, demonstrating that sagittal and pelvic alignment may not affect short-term pain outcomes. In this study, patients with all four sagittal position types experienced significant postoperative improvement in leg pain compared to preoperative levels. This suggests that short-term pain relief is more dependent on the thoroughness of decompression.

For patients with Lumbar Disc Herniation complicated by Sciatic Scoliosis, beyond pain relief, correction of deformity and long-term outcomes are key concerns for both physicians and patients. During TLIF, the use of fusion cages and rod-screw systems effectively corrects sagittal plane imbalance, restores lumbar lordosis, and enhances spinal stability. Improved sagittal curvature

reduces ligament and muscle tension in the lumbosacral region, increases anterior longitudinal ligament tension, boosts intervertebral fusion rates, and inhibits adjacent segment degeneration. These effects collectively alleviate clinical symptoms, improve quality of life, and enhance long-term surgical outcomes^[33, 34].

Conclusions:

In summary, patients with sciatic scoliosis are often combined with reduced lumbar lordosis, sagittal imbalance, and lumbar kyphosis, and PELD and TLIF can achieve good surgical efficacy and coronal and sagittal orthopedic results in sciatic scoliosis. PELD has shorter operation time, less bleeding and postoperative hospitalization days. For patients with combined sagittal imbalance, the short-term coronal orthopedic effect of TLIF is better than that of PELD.

Limitations

This study is a single-center retrospective study with a relatively short follow-up period, and therefore cannot fully reflect the clinical outcomes of patients after surgery. The differences in long-term orthopedic outcomes between PELD and TLIF in the coronal and sagittal planes require further investigation.

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JTY, XYX, and QD developed the research questions and scope of the study. JTY and XYX conducted preoperative and postoperative data screening, and data charting. XYX drafted the manuscript and prepared tables, and figures with JTY's contribution. WBS developed the literature search strategies in collaboration with the other authors. JTY, HLG, WBS, and DQ contributed to the organization, analysis, and interpretation of the results. All authors reviewed the manuscript.

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