

# Application of continuous epidural anesthesia in transforaminal lumbar endoscopic surgery: a prospective randomized controlled trial

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## Abstract

**Objective:** This study aimed to compare intraoperative lower back pain and leg pain, surgical time, and intraoperative X-ray dose in patients offered local infiltration anesthesia or continuous epidural anesthesia for transforaminal endoscopic spine system (TESSYS) surgery.

**Methods:** A total of 98 patients who received TESSYS treatment for single-segmental lumbar disc herniation were included, and were randomly divided into two groups: group A (49 cases; local infiltration anesthesia) and group B (49 cases; continuous epidural anesthesia). Surgical duration, intraoperative X-ray dose, and visual analog scale (VAS) scores of lower back pain and leg pain before surgery, during surgery, and 48 h after surgery were recorded and compared.

**Results:** After surgery, the VAS scores of both lower back pain and leg pain decreased in group A, and similar findings were found in group B. Group B had a shorter surgical duration, lower intraoperative X-ray dose, and lower intraoperative VAS scores of lower back pain and leg pain compared with group A.

**Conclusion:** Compared with local infiltration anesthesia, continuous epidural anesthesia was more effective for pain relief during TESSYS for single-segmental lumbar disc herniation, and also contributed to a shorter surgical duration and lower X-ray exposure.

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## Keywords

Lumbar disc herniation, transforaminal endoscopic surgery system (TESSYS), epidural anesthesia, local infiltration anesthesia, lower back pain, leg pain

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## Background

Lumbar disc herniation is among the most common spinal disorders in modern society, its incidence having increased alongside social progress and an accelerated pace of life.<sup>1–3</sup> Increasing numbers of young people in particular are affected by lumbar disc herniation, and the overall prevalence of lumbar disc herniation ranges from 12.2% to 43%.<sup>4–6</sup> Transforaminal endoscopic surgery system (TESSYS) was developed by Hoogland Spine Products GmbH in Germany in 2007<sup>7</sup> and has been successfully applied to endoscopic lumbar discectomy in 1,054 cases, representing one of the most rapidly developing minimally invasive lumbar spine surgery techniques.<sup>8</sup>

Advantages of TESSYS include a small incision (only 8 mm), less hemorrhage, a clear surgical field, high safety, fast recovery, shorter hospital stay, and lower cost. Researchers in China have expanded the indications of TESSYS, with calcified and free lumbar disc herniation and lumbar spinal stenosis also indicated.<sup>8–10</sup>

To improve surgical safety and reduce the intraoperative risk of nerve root injury, local infiltration anesthesia is typically preferred in TESSYS, as this anesthetic method allows for patient–surgeon communication during surgery.<sup>11</sup> However, local infiltration anesthesia may fail to provide sufficient pain relief, and some patients have to discontinue surgery because of intolerance of the pain.<sup>12</sup> Thus, the choice of an appropriate anesthetic method remains a major concern with TESSYS. To address this issue, we performed a prospective randomized controlled

trial to compare the efficacy of local anesthesia with continuous epidural anesthesia in TESSYS.

## Methods

### *Clinical data*

**Inclusion and exclusion criteria.** Inclusion criteria for this study were: (1) single-segmental lumbar disc herniation; (2) no previous lumbar disc decompression; (3) no history of severe cerebrovascular and cardiovascular diseases; (4) planned TESSYS surgery.

Exclusion criteria were: (1) history of lumbar spinal stenosis, severe lumbar spondylolisthesis, or structural kyphoscoliosis; (2) history of cerebrovascular or cardiovascular disease; severe liver, kidney, or hematopoietic disorders; and mental illnesses rendering the patient unfit for TESSYS surgery; (3) females who were pregnant or lactating.

**Patients.** A total of 98 patients eligible who underwent TESSYS surgery for single-segmental lumbar disc herniation from January to July 2016 were included. Each patient was informed of the possible anesthetic method before surgery, and written informed consent was obtained from all patients prior to participation. Using a random number table, patients were divided into two groups: group A (local infiltration anesthesia) and group B (continuous epidural anesthesia), with 49 cases in each group. The protocol was approved by the Clinical Laboratory Ethics Committee of Tianjin People's Hospital (2015–Fast Review no. B02).

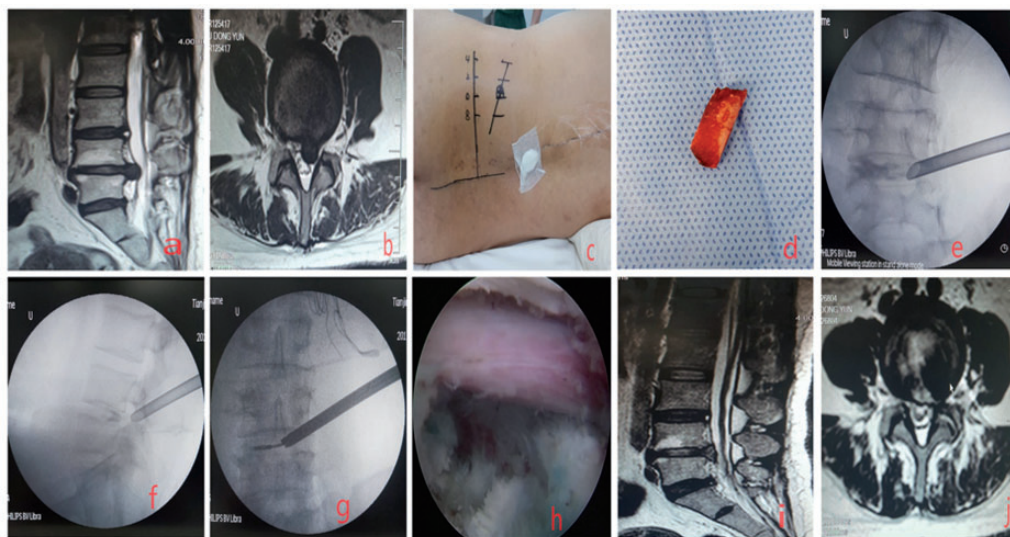
## Methods

**Surgical procedures.** Patients in both groups underwent TESSY surgery by the same surgeon. A foraminoscope was inserted after foraminoplasty, the herniated nucleus pulposus was removed from the intervertebral disc under the foraminoscope, and nerve root decompression was performed until complete reduction of the nerve root was achieved (Figure 1).

**Postoperative treatment.** Patients were required to lie in bed for 3–4 h after surgery, and

then initiated out-of-bed activities with a spinal support corset. The intensity of activities increased gradually, and immobility and excess movement were prohibited. After surgery, patients were intravenously administered neurotrophin, mannitol, and dexamethasone. Patients were discharged 76 hours after surgery, and were advised to avoid continuous periods in a sitting position of more than 30 min.

**Choice of anesthetic method.** Patients in group A received local infiltration anesthesia to each level of tissue along the percutaneous



**Figure 1.** A 41-year-old female in Group B, who suffered radiating pain and numbness in the left lower limb for 3 months. (a) Preoperative sagittal T2-weighted MRI indicated horizontal protrusion of the lumbar disc at the L4/5 level, with compression of the dural sac and cauda equina. (b) Preoperative axial T2-weighted MRI indicated central herniation of the lumbar disc on the left side at the L4/5 level, with nerve root compression on the left side at L5. (c) Preoperative epidural intubation, with the patient lying on the healthy side and puncture site markings on the body surface. (d) Resected lateral or ventral surface of superior articular process on the left side of L5 during foraminotomy. (e–f) Intraoperative anteroposterior and lateral views indicating good positioning of the working channel. (g) Intraoperative anteroposterior view indicated the feasibility of bilateral nerve root decompression under the transforaminal unilateral approach. (h) Removal of the intervertebral disc and nucleus pulposus compressing the nerve root under foramenoscopy, with 270° circumferential decompression of the nerve root and complete decompression of the nerve root. (i–j) Sagittal and axial T2-weighted MRI at 14 days after surgery indicated complete removal of the herniated lumbar disc and nucleus pulposus, good expansion of the dural sac and nerve root at the affected segment, and full decompression.

puncture route using a mixture of 0.2% ropivacaine and 0.4% lidocaine. After the superior articular process was accessed by puncture, 360° circular injection of the anesthetic was performed. For patients in group B, continuous epidural anesthesia was offered intraspinally using 0.3% ropivacaine. Dexmedetomidine was given to enhance the intraoperative analgesic effect if necessary.

**Evaluation.** Pain was evaluated using a visual analogue scale (VAS).

**Observation indicators.**

1. Preoperative pain was evaluated using VAS scores. Preoperative VAS scores for lower back pain and leg pain were recorded.
2. Intraoperative pain was evaluated using postoperative VAS scores for lower back pain and leg pain measured immediately after surgery.
3. Postoperative pain was evaluated using postoperative VAS scores for lower back pain and leg pain measured at 48 h after surgery.
4. Surgical duration (min), excluding anesthesia, was recorded at the end of surgery.
5. Intraoperative X-ray dose (mGY) was measured using a Philips BV Pulsara C-ARM mobile X-ray imaging system (Philips Healthcare, Best, The Netherlands) at the end of surgery.

**Statistical process.** All statistical analyses were performed using SPSS 19.0 software (IBM Corp, Armonk, NY, USA). Measurements were expressed as  $\bar{x} \pm SD$ . VAS scores before and after surgery were compared using a paired samples t-test. VAS scores between two groups were compared using an independent samples t-test. Values of  $P < 0.05$  indicated a significant difference (two-sided).

**Table 1.** Baseline characteristics of patients in group A and group B.

	Group A (n=46)	Group B (n=49)
Age (years)	42.52 ± 15.307	44.88 ± 13.535
Sex ratio (males: females)	29:17	30:19
Affected segments		
L2/3	1	0
L3/4	1	5
L4/5	29	23
L5/S1	15	21
Type of lumbar disc herniation		
Central	6	4
Paracentral	34	40
Foraminal	1	2
Extremely lateral	5	3

**Results**

A total of 98 patients eligible were included from January to July 2016. There were 49 cases in group A, and surgery was successful for 46 cases but terminated in 3 cases because of severe intraoperative pain or a sudden rise in blood pressure or respiratory alkalosis caused by severe intraoperative pain. There were 49 cases in group B, and surgery was successful in all patients. Thus, a total of 95 patients were included in the data analysis, with 46 cases in group A and 49 cases in group B. The baseline data of the included cases are shown in Table 1.

**Normality testing**

Tests of normality were first performed for related data in the two groups. Differences in age; sex; affected segments; type of lumbar disc herniation; preoperative, intraoperative, and postoperative VAS scores for lower back pain and leg pain; surgical duration; and intraoperative X-ray dose were compared between the two groups. P values were all above 0.05 in the test of normality for each variable

**Table 2.** Comparison of baseline data between the groups.

	N	Age	Sex	Affected segments	Type of lumbar disc herniation
Group A	46	42.52±15.307	0.62±0.492	2.17±0.581	1.10±0.726
Group B	49	44.88±13.53 <sup>①</sup>	0.63±0.489 <sup>①</sup>	2.32±0.664 <sup>①</sup>	1.11±0.652 <sup>①</sup>

<sup>①</sup>P>0.05, comparison of baseline information between group A and group B.

**Table 3.** VAS scores for lower back pain and leg pain before and after surgery.

	Preoperative VAS scores for lower back pain	Postoperative VAS scores for lower back pain	Preoperative VAS scores for leg pain	Postoperative VAS scores for leg pain
Group A	4.88±2.725	1.93±0.712 <sup>①</sup>	8.71±1.954	1.57±1.579 <sup>①</sup>
Group B	5.20±3.153	1.18±0.811 <sup>①</sup>	8.23±2.054	1.25±1.643 <sup>①</sup>

<sup>①</sup>Comparison of VAS scores for lower back pain and leg pain before and after surgery in group A and group B; p<0.05.

(group A: P values were 0.996, 0.076, 0.105, 0.083, 0.054, 0.640, 0.091, 0.187, 0.409, 0.573, 0.383, and 0.093, respectively; group B: P values were 0.500, 0.093, 0.433, 0.275, 0.103, 0.094, 0.307, 0.253, 0.087, 0.691, 0.413, and 0.174, respectively). Thus, the data for each variable in each group followed a normal distribution. Next, the variables were analyzed statistically using t-test, one-way ANOVA, correlation analysis, and regression analysis.

**Comparison of baseline data between the two groups**

As shown in Table 2, the two groups of patients showed no significant differences in the following baseline variables: age, sex, affected segments, and type of lumbar disc herniation.

**Preoperative and postoperative VAS scores for lower back pain and leg pain**

As shown in Table 3, postoperative VAS scores for lower back pain and leg pain were significantly decreased compared with

**Table 4.** Intraoperative VAS scores for lower back pain and leg pain.

	Intraoperative VAS scores for lower back pain	Intraoperative VAS scores for leg pain
Group A	4.67±1.183	5.67±1.883
Group B	1.25±1.164 <sup>①</sup>	1.38±1.484 <sup>①</sup>

<sup>①</sup>Comparison of intraoperative VAS scores for lower back pain and leg pain between group A and group B, p<0.05.

preoperative levels both group A and group B. Moreover, there was no significant difference in postoperative leg pain between the two groups (1.25±1.643 versus 1.57±1.579).

**Intraoperative VAS scores for lower back pain and leg pain**

As shown in Table 4, intraoperative VAS scores for lower back pain and leg pain in group B were 1.25±1.164 and 1.38±1.484, respectively, and were significantly lower than the values for group A (4.67±1.183 and 5.67±1.883, respectively).



**Table 5.** Comparison of surgical duration and intraoperative X-ray dose between group A and group B.

	Surgical time (min)	Intraoperative X-ray dose (mGY)
Group A	118.71±24.598	14.77±3.095
Group B	64.91±24.981 <sup>①</sup>	4.61±3.073 <sup>①</sup>

<sup>①</sup>Comparison of surgical duration and intraoperative X-ray dose between group A and group B,  $p < 0.05$ .

**Surgical duration and intraoperative X-ray dose**

As shown in Table 5, surgical duration for group B was considerably shorter than that of group A. Moreover, the intraoperative X-ray dose was significantly lower in group B than in group A.

**Discussion**

Our study found that both lower back pain and leg pain were significantly decreased after TESSYS surgery in both group A and group B. This finding indicated that both local filtration anesthesia and continuous epidural anesthesia were effective in relieving postoperative lower back pain and leg pain in TESSYS surgery. Moreover, there was no significant difference in postoperative leg pain between the two groups.

In our study, intraoperative lower back pain and leg pain, surgical duration, and intraoperative X-ray dose were also investigated. The results showed that intraoperative VAS scores for lower back pain and leg pain in group B were significantly lower than those in group A, indicating that continuous epidural anesthesia was more effective in relieving lower back pain and leg pain following TESSYS surgery. Furthermore, the surgical duration was considerably shorter in group B than in group A, and the intraoperative X-ray dose was significantly lower in group B

than in group A. These findings confirmed the superiority of continuous epidural anesthesia over local infiltration anesthesia in TESSYS surgery.

In consideration of the abundance of nerves, blood vessels, and lymphatic vessels in the intervertebral foramen, TESSYS surgery is typically performed under local infiltration anesthesia to allow timely communication between the surgeon and the patient during the procedure, which may reduce the risk of nerve root injury.<sup>15</sup> However, it remains unclear whether local infiltration anesthesia alone can provide sufficient pain relief. Previous studies<sup>12,16</sup> showed that local infiltration anesthesia failed to adequately control pain during TESSYS surgery, especially during foraminoplasty, which was in agreement with our findings. Among the patients receiving local infiltration anesthesia in our study, intraoperative VAS scores for lower back pain and leg pain were  $4.67 \pm 1.183$  and  $5.67 \pm 1.883$ , respectively, indicating moderate pain, and one patient even discontinued surgery because of intolerable pain. One patient suffered from respiratory alkalosis because of severe intraoperative pain, with sudden numbness affecting the entire body, leading to termination of surgery. Another patient experienced a sudden rise in blood pressure to 200/170 mmHg attributable to severe intraoperative pain, and also discontinued surgery. These results indicate that insufficient pain relief with local infiltration anesthesia can increase not only patients' discomfort, but also surgical risk.

Continuous epidural anesthesia is a common intraspinal anesthesia method achieved by injecting local anesthetic into the epidural space via puncture catheterization. The spinal nerve root below the puncture plane is blocked, and the region innervated by this spinal nerve root is hence anesthetized. Epidural anesthesia offers a good analgesic effect on the operated site as well as simplicity, fast recovery,

and low cost. However, little has been reported on the application of this anesthetic method in TESSYS. A recent study reported the use of continuous epidural anesthesia in TESSYS and analyzed post-operative lower back pain, immune mechanisms, and changes in inflammatory factors, and concluded that continuous epidural anesthesia was superior to local infiltration anesthesia.<sup>18</sup> However, the study did not examine intraoperative lower back pain and leg pain, intraoperative X-ray dose, or surgical duration. In the present study, post-operative lower back pain as well as intraoperative lower back pain and leg pain, surgical duration, and intraoperative X-ray dose were investigated, strengthening the conclusion that continuous epidural anesthesia is superior to local infiltration anesthesia in patients undergoing TESSYS surgery.

There were some limitations to our study. First, the sample size was small, and the findings therefore require validation in a larger patient population. Second, our study was a single-center trial, and further multi-center trials are thus required in the future. Finally, the mechanism by which continuous epidural anesthesia appears superior to local infiltration anesthesia in relieving intraoperative lower back pain and leg pain was not further explored in this study.

From the current prospective randomized controlled trial, we concluded that continuous epidural anesthesia in TESSYS for single-segmental lumbar disc herniation can achieve efficacy comparable with local infiltration anesthesia and is more effective in pain relief during TESSYS for single-segmental lumbar disc herniation. Moreover, epidural anesthesia reduces intraoperative risk related to pain, shortens surgical duration, and decreases X-ray exposure for both patient and surgeon. In summary, epidural anesthesia can be considered a superior anesthetic for TESSYS surgery.

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## Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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