

Analysis of the Clinical Efficacy and Safety of CT-Guided Precision Nerve Block for the Treatment of Lumbar Disc Herniation

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Abstract: *Objective:* To investigate the clinical efficacy and safety of CT-guided nerve block therapy in patients with lumbar disc herniation. *Methods:* The study population consisted of inpatients at our hospital diagnosed with lumbar disc herniation in the L4–L5 or L5–S1 segments. Patients were enrolled from December 2024 to June 2026, with a total sample size of 60 cases. Groups were assigned using a random number table, resulting in two groups, each with 30 cases. The control group received conventional epidural block therapy, while the observation group underwent CT-guided precise anterolateral epidural space block therapy. Clinical efficacy was assessed by comparing patients' Visual Analog Scale (VAS) pain scores and Oswestry Disability Index scores at preoperative, 3-day postoperative, 7-day postoperative, and 30-day postoperative follow-up visits. The safety parameters of CT-guided precise anterolateral epidural space block therapy were also analyzed. *Results:* Pain levels and the degree of lumbar functional impairment were assessed in both groups prior to intervention; there were no statistically significant differences in the assessment indicators between the groups ($P > 0.05$). In the observation group, the Visual Analog Scale (VAS) pain scores and Oswestry Disability Index scores at 3 days, 7 days, and 30 days postoperatively were all lower than those in the control group ($P < 0.05$). The overall response rate in the observation group was higher than that in the control group ($P < 0.05$). No cases of precise block failure were observed in the observation group; the distance between the medial margin of the articular process and the lateral margin of the dural sac ranged from a minimum of 3.0 mm to a maximum of 5.8 mm. *Conclusion:* CT-guided precise nerve block therapy for lumbar disc herniation is highly effective, providing significant pain relief and alleviating lumbar dysfunction. The minimum safe distance observed in this cohort between the medial margin of the articular process and the lateral margin of the dural sac was 3.0 mm.

Keywords: CT-guided precise nerve block; Lumbar disc herniation; Clinical efficacy; Safety

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1. Introduction

Lumbar disc herniation is a common degenerative condition in clinical practice. When intervertebral disc tissue herniates and compresses the nerve roots, it causes symptoms such as lower back and leg pain, sensory abnormalities in the lower extremities, and motor dysfunction, severely impacting patients' quality of life ^[1]. While many patients experience significant symptom relief following conservative treatment and physical therapy, some patients still have poor treatment outcomes and require nerve block therapy to alleviate their discomfort ^[2-3]. Conventional epidural blocks involve blind puncture guided by superficial anatomical landmarks. Although this procedure is simple, the puncture process is significantly influenced by individual anatomical variations, resulting in poor puncture accuracy and insufficient targeted drug distribution, which in turn affects treatment efficacy. With the continuous advancement of interventional imaging techniques, CT-guided nerve blocks enable visualization of the puncture path, allowing for precise localization of the anterolateral epidural space and improving both the safety of the puncture and the targeted distribution of the medication ^[4]. CT-guided precise nerve block therapy has been applied in the field of neuropathic pain treatment with good analgesic outcomes; however, research on its use in the treatment of lumbar disc herniation is scarce. Based on this, this study will analyze the clinical efficacy of CT-guided precise nerve block therapy for lumbar disc herniation and determine the minimum safe distance for puncture, thereby providing a basis for the further clinical promotion and application of this therapeutic approach.

2. Materials and methods

2.1. General materials

The study sample consisted of patients hospitalized at our hospital with a confirmed diagnosis of lumbar disc herniation at the L4–L5 or L5–S1 segments. Cases were enrolled from December 2024 to June 2026, with a total sample size of 60 patients. Grouping was performed using a random number table, resulting in two groups, each with 30 patients. Control Group: 17 males and 13 females; age range 33–68 years, mean (50.45 ± 8.69) years; affected segments: 18 cases in the L4–L5 segment and 12 cases in the L5–S1 segment. Observation Group: 16 males and 14 females; ages ranging from 32 to 67 years, with a mean age of (49.08 ± 8.41) years; affected segments: 17 cases at the L4–L5 segment and 13 cases at the L5–S1 segment. The general demographic characteristics of the two groups were comparable ($P > 0.05$), meeting the criteria for intergroup comparison.

2.1.1. Inclusion criteria

- (1) Meets the diagnostic criteria for lumbar disc herniation, with disc herniation at the L4-L5 or L5-S1 levels ^[5];
- (2) First episode of related clinical symptoms, with a disease duration of < 2 weeks; (3) History of recurrence, currently in the acute phase;
- (4) Chronic lumbar disc herniation with an established clinical diagnosis, for which standard conservative treatment has been administered for at least 3 months with poor results;
- (5) Age 20~70 years.

2.1.2. Exclusion criteria

- (1) Severe organic lesions of the spinal canal or tuberculosis;

- (2) Concomitant organ lesions, malignant tumors, hematological disorders, etc.;
- (3) Conditions associated with mental disorders;
- (4) Severe localized skin infections or open wounds;
- (5) A history of hyperthyroidism or a pathological condition predisposing the body to bleeding.

2.2. Methods

The control group received conventional epidural block therapy: The patient was positioned in the lateral decubitus position. The interspinous space at the lesion site was identified, disinfected according to standard procedures, and anesthetized locally. A No.12, 10 cm lumbar epidural needle was then slowly advanced, sequentially penetrating the supraspinous and interspinous ligaments. A distinct sense of giving way was felt upon penetrating the yellow ligament; there was no resistance when air was injected, and no blood or cerebrospinal fluid was observed upon aspiration. The analgesic mixture was then slowly injected (containing 3 mL of inflammatory immune extract from rabbits vaccinated with bovinepox vaccine, 100 mg of vitamin B6, 1 mg of vitamin B12, 50 mg of 2% lidocaine, and 2.5 mL of normal saline) at a total volume of 10 mL. After treatment, the patient is observed in a supine position for 30 minutes.

The observation group underwent CT-guided precise anterolateral epidural space block: Using a multi-slice spiral CT scanner (Siemens SOMATOM go.Up), the patient was positioned prone with a thin pillow placed under the abdomen. A plain CT scan was performed to identify the puncture site. The medial margin of the affected facet joint was designated as the primary target, and the superficial projection points of the puncture path were marked with a positioning pen. After disinfecting the lumbosacral region, a sterile drape was applied. Following local anesthesia of the puncture site with 1% lidocaine, a 1.0 mm diameter, 10 cm long puncture needle was inserted at the marked point, entering the spinal canal vertically along the medial margin of the facet joint. A distinct sensation of breakthrough was felt as the needle tip passed through the ligamentum flavum. The needle core was then withdrawn, and an empty syringe was attached. After confirming that no blood or cerebrospinal fluid is aspirated, proceed under real-time CT guidance along the puncture path to position the needle tip in the anterolateral epidural space at the level of the target intervertebral space. Inject a small amount of contrast agent locally; once the contrast agent is observed to diffuse into the epidural space and around the nerve roots, and after confirming that it has not entered the subarachnoid space, slowly inject the analgesic mixture (containing 3 mL of inflammatory immune extract from rabbits vaccinated with vaccinia virus, 100 mg of vitamin B6, 1 mg of vitamin B12, 50 mg of 2% lidocaine, and 2.5 mL of normal saline) for a total of 10 mL. Withdraw the needle, apply pressure to the puncture site for 5 minutes, and cover with a sterile dressing.

2.3. Monitoring indicators

2.3.1. Pain intensity

Assessed using the Visual Analog Scale at preoperative, 3 days postoperative, 7 days postoperative, and 30 days postoperative follow-up visits. Scores range from 0 to 10, with higher scores indicating more severe pain.

2.3.2. Oswestry disability index

Assessed at preoperative, 3 days postoperative, 7 days postoperative, and 30 days postoperative follow-up visits. It consists of 10 items, with a total score ranging from 0 to 50; a higher score indicates a more severe

degree of lumbar dysfunction.

2.3.3. Efficacy assessment

Efficacy was determined based on the Oswestry Disability Index score. The efficacy index is defined as the percentage of the difference between the baseline and follow-up scores relative to the baseline score; a value of 90% or higher is classified as “cured,” 70% or higher but less than 90% as “marked improvement,” 30% or higher but less than 70% as “improvement,” and less than 30% as “no improvement.” Overall Response Rate = (Number of cases classified as “Complete Remission” + “Marked Improvement” + “Improvement”) / Total Number of Cases $\times$ 100%.

2.3.4. Determination of the safe range

The observation group underwent real-time CT monitoring during the puncture procedure to measure the distance between the medial margin of the articular process and the lateral margin of the dural sac. If the patient experienced intolerable pain, or if the contrast agent diffused into the subarachnoid space after the puncture—indicating failure of precise nerve block—this distance is not suitable for precise nerve block therapy and carries a high risk.

2.4. Statistical methods

Statistical analysis of all data in this study was performed using SPSS 26.0 statistical software. Quantitative data followed a normal distribution and are presented as ($\bar{x} \pm s$); independent samples *t*-tests were used for comparisons between groups. Count data are presented as [n(%)], and a χ^2 test is performed. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Comparison of pain intensity

As shown in **Table 1**, there was no statistically significant difference in preoperative visual analog scale pain scores between the two groups ($P > 0.05$). However, when comparing the postoperative assessment results at different time points (3 days, 7 days, and 30 days) between the two groups, the scores in the observation group were lower than those in the control group ($P < 0.05$).

Table 1. Comparison of pain intensity ($\bar{x} \pm s$, scores)

Category	Preoperative	3 days postoperative	7 days postoperative	30 days postoperative
Control group ($n=30$)	7.19 $\pm$ 1.07	5.12 $\pm$ 0.91	4.06 $\pm$ 0.84	2.75 $\pm$ 0.72
Observation Group ($n=30$)	7.25 $\pm$ 1.11	3.73 $\pm$ 0.76	2.38 $\pm$ 0.68	1.31 $\pm$ 0.42
<i>t</i> value	0.213	6.421	8.514	9.462
<i>P</i> value	0.832	<0.001	<0.001	<0.001

3.2. Comparison of the Oswestry Disability Index

As shown in **Table 2**, the Oswestry Disability Index scores were comparable between the two groups at baseline, with no statistically significant difference ($P > 0.05$); however, when comparing the postoperative assessment results at different time points (3 days, 7 days, and 30 days) between the two groups, the scores in

the observation group were lower than those in the control group ($P < 0.05$).

Table 2. Comparison of the Oswestry Disability Index ($\bar{x} \pm s$, scores)

Category	Preoperative	3 days postoperative	7 days postoperative	30 days postoperative
Control group (n=30)	61.68±7.38	51.16±6.79	41.07±6.32	30.62±5.68
Observation Group (n=30)	62.52±7.22	40.37±6.18	28.84±5.46	16.31±4.41
<i>t</i> value	0.446	6.437	8.021	10.900
<i>P</i> value	0.658	<0.001	<0.001	<0.001

3.3. Comparison of clinical efficacy

As shown in **Table 3**, the clinical efficacy evaluation revealed that the overall response rate in the observation group was higher than that in the control group ($P < 0.05$).

Table 3. Comparison of clinical efficacy [n (%)]

Category	Recovery	Taking effect	Valid	Invalid	Overall Efficiency
Control group (n=30)	12 (40.00)	7 (23.33)	4 (13.33)	7 (23.33)	23 (76.67)
Observation Group (n=30)	21 (70.00)	6 (20.00)	2 (6.67)	1 (3.33)	29 (96.67)
χ^2 value	—	—	—	—	5.192
<i>P</i> value	—	—	—	—	0.023

3.4. Safety parameters for CT-guided precision nerve block therapy

None of the patients in the observation group experienced failure of precise blockage; the minimum distance between the medial margin of the articular process and the lateral margin of the dural sac was 3.0 mm, and the maximum was 5.8 mm.

4. Discussion

Lumbar disc herniation can cause pain in the lower back and legs. The primary pathological mechanism of this condition is the irritation of nerve roots by the herniated disc, leading to localized aseptic inflammation and tissue edema [6]. The mechanism of action for interventional nerve block therapy involves injecting anti-inflammatory and analgesic medications into the target area surrounding the nerve roots to alleviate local inflammation and clinical symptoms [7]. Conventional blind epidural block needle placement is subject to inaccuracies due to factors such as patient obesity and anatomical variations, which can easily cause the medication to diffuse into non-target spaces and compromise clinical efficacy. CT-guided precise nerve block therapy enables the visualization of the puncture path, target space, and surrounding critical anatomical structures, thereby overcoming the limitations of conventional puncture; however, its clinical efficacy and safety in patients with lumbar disc herniation require further clinical studies for validation.

In this study, there was no statistically significant difference in preoperative visual analog scale pain scores between the two groups ($P > 0.05$). However, when comparing the postoperative assessment results at different time points (3 days, 7 days, and 30 days), the scores in the observation group were lower than those in the control group ($P < 0.05$). This suggests that, compared with conventional epidural block therapy, CT-guided precise nerve block therapy can further alleviate pain. Analysis of the reasons: Conventional

epidural blocks involve blind puncture; in some patients, it is difficult to precisely position the needle tip in the lateral epidural space during the procedure, preventing the medication from fully acting on the target area of the affected nerve root, resulting in limited pain relief. CT guidance allows for the visualization of anatomical structures and the puncture path, enabling precise placement of the needle tip in the anterolateral epidural space of the affected segment ^[8]. This allows the medication to act concentrically on the compressed nerve root and the area of aseptic inflammation in the intervertebral disc, more effectively eliminating local inflammatory edema, blocking pain signal transmission, and significantly reducing pain intensity ^[9]. At baseline, the Oswestry Disability Index scores were comparable between the two groups, with no statistically significant difference ($P > 0.05$); however, when comparing the assessment results at different postoperative time points (3 days, 7 days, and 30 days), the scores in the observation group were lower than those in the control group ($P < 0.05$); the overall response rate in the clinical efficacy assessment was higher in the observation group than in the control group ($P < 0.05$). These findings suggest that, compared with conventional epidural block therapy, CT-guided precise nerve block therapy can further alleviate lumbar dysfunction and yield better clinical outcomes. Analysis of Causes: Lumbar dysfunction is caused by a combination of factors, including persistent lower back and leg pain, restricted lumbar mobility due to nerve root irritation, and protective muscle spasms. Since CT-guided precise nerve block can more thoroughly and sustainably alleviate inflammatory compression of the nerve roots, it provides greater relief from pain stimuli, thereby significantly reducing lumbar muscle spasm, eliminating factors that restrict lumbar spine mobility, and achieving more pronounced improvement in lumbar spine dysfunction, which in turn leads to better clinical treatment outcomes ^[10]. None of the patients in the observation group experienced failure of the precise block; the minimum distance between the medial margin of the articular process and the lateral margin of the dural sac was 3.0 mm, and the maximum was 5.8 mm. However, the minimum distance of 3.0 mm observed in this study represents only the lower limit of the measured values for this group of cases and cannot be regarded as a universal absolute safety threshold. In clinical practice, conditions such as lumbar osteophytes, thickening of the ligamentum flavum, and hypertrophy of the facet joints can all lead to a further narrowing of this space. Even with CT guidance, patients with such narrow spaces remain at a higher risk of dural injury. Clinically, the feasibility of puncture should be thoroughly assessed for these patients, and the approach or treatment plan should be modified as necessary.

5. Conclusion

In summary, CT-guided precise nerve block therapy for lumbar disc herniation is highly effective, providing significant pain relief and alleviating lumbar dysfunction. The minimum safe distance observed in this case series between the medial margin of the articular process and the lateral margin of the dural sac is 3.0 mm.

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Disclosure statement

The authors declare no conflict of interest.

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