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ORIGINAL ARTICLE

Randomized Controlled Trial

Coaxial radiography guided puncture technique for percutaneous transforaminal endoscopic lumbar discectomy: A randomized control trial

Li-Ping Chen, Bin-Song Wen, Heng Xu, Zheng Lu, Lai-Jun Yan, Han Deng, Hong-Bo Fu, Hong-Jie Yuan, Pei-Pei Hu

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Abstract

BACKGROUND

The coaxial radiography-guided puncture technique (CR-PT) is a novel technique for endoscopic lumbar discectomy. As the X-ray beam and the puncturing needle are maintained in a parallel and coaxial direction, the X-ray beam can be used to guide the trajectory angle, facilitating the choice of the puncture site and providing real-time guidance. This puncture technique offers numerous advantages over the conventional anterior-posterior and lateral radiography-guided puncture technique (AP-PT), especially in cases of herniated lumbar discs with a hypertrophied transverse process or articular process, high iliac crest, and narrowed intervertebral foramen.

AIM

To confirm whether CR-PT is a superior approach to percutaneous transforaminal endoscopic lumbar discectomy compared to AP-PT.

METHODS

In this parallel, controlled, randomized clinical trial, herniated lumbar disc patients appointed to receive percutaneous endoscopic lumbar discectomy treatment were recruited from the Pain Management Department of the Affiliated Hospital of Xuzhou Medical University and Nantong Hospital of Traditional

Chinese Medicine. Sixty-five participants were enrolled and divided into either a CR-PT group or an AP-PT group. The CR-PT group underwent CR-PT, and the AP-PT group underwent AP-PT. The number of fluoroscopies during puncturing, puncture duration (min), surgery duration (min), VAS score during puncturing, and puncture success rate were recorded.

RESULTS

Sixty-five participants were included, with 31 participants in the CR-PT group and 34 in the AP-PT group. One participant in the AP-PT group dropped out due to unsuccessful puncturing. The number of fluoroscopies [median (P25, P75)] was 12 (11, 14) in the CR-PT group *vs* 16 (12, 23) in the AP-PT group, while the puncture duration (mean ± SD) was 20.42 ± 5.78 *vs* 25.06 ± 5.46, respectively. The VAS score was 3 (2, 4) in the CR-PT group *vs* 3 (3, 4) in the AP-PT group. Further subgroup analysis was performed, considering only the participants with L5/S1 segment herniation: 9 patients underwent CR-PT, and 9 underwent AP-PT. The number of fluoroscopies was 11.56 ± 0.88 *vs* 25.22 ± 5.33; the puncture duration was 13.89 ± 1.45 *vs* 28.89 ± 3.76; the surgery duration was 105 (99.5, 120) *vs* 149 (125, 157.5); and the VAS score was 2.11 ± 0.93 *vs* 3.89 ± 0.6, respectively. All the above outcomes demonstrated statistical significance ($P < 0.05$), favoring the CR-PT treatment.

CONCLUSION

CR-PT is a novel and effective technique. As opposed to conventional AP-PT, this technique significantly improves puncture accuracy, shortens puncture time and operation time, and reduces pain intensity during puncturing.

Key Words: Herniated lumbar disc; Coaxial; Puncture; Anterior-posterior; L5/S1

Core Tip: Puncturing is the first step for percutaneous endoscopic lumbar discectomy. Compared with the anterior-posterior and lateral radiography-guided puncture technique (AP-PT), the coaxial radiography-guided puncture technique (CR-PT) has the advantage of guiding the trajectory angle, facilitating the choice of the puncture site, and also providing real-time guidance for puncturing. This study aimed to compare the two techniques. In this randomized controlled trial, the CR-PT technique demonstrated significantly better puncture accuracy, and shorter puncturing and operation duration. We argue that the CR-PT technique is an advisable option in percutaneous endoscopic lumbar discectomy, especially for unusual cases.

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INTRODUCTION

Percutaneous endoscopic lumbar discectomy (PELD) is a promising treatment for herniated lumbar disc (HLD). Its advantages over conventional surgery include less intraoperative bleeding, minimal paraspinal muscle injury, high clinical efficacy, and rapid functional recovery. Therefore, PELD has become a popular surgical method[1-8]. Furthermore, in PELD surgery, only a tiny part of the bone tissue is removed, which does not compromise spinal stability[9,10].

Despite its numerous advantages, PELD is technically challenging and has a steep learning curve[11,12]. Accurate puncturing and working channel intubation are required to create favorable conditions for endoscopic surgery[13,14]. However, the puncture technique is relatively difficult, especially in percutaneous transforaminal endoscopic lumbar discectomy (PTELD), which requires specific puncture angles to certain parts of the intervertebral foramen. In addition, for a L5/S1 segment HLD case with a hypertrophied L5 transverse process and articular process, high iliac crest, and narrowed intervertebral foramen, the puncturing is more difficult[15,16].

Conventionally, intermittent anteroposterior and lateral radiography is used for accurate puncturing. However, this process relies on the surgeon's experience to determine and adjust the trajectory angle and depth of the needle. Occasionally, an inappropriate puncture angle leads to failure of the

endoscopic surgery[17,18]. Repeated puncturing results in a prolonged operation and increased exposure to radiation[19,20]. Moreover, repeated puncturing increases the patient's pain perception.

This paper describes a novel coaxial radiography-guided puncture technique (CR-PT) that we developed in our clinical practice. This technique focuses on maintaining the X-ray beam and the puncturing needle in a parallel and coaxial direction[21,22]. With the coaxial technique, the X-ray beam can be used to facilitate puncture site selection and guide the trajectory angle while providing real-time guidance. We hypothesized that this new technique reduces the difficulty of the puncture process, reduces the number of Xray fluoroscopies, shortens the puncture duration, and increases the puncture accuracy. Therefore, the new puncture technique was compared with the conventional anterior-posterior and lateral radiography-guided puncture technique (AP-PT) in order to confirm its superiority.

MATERIALS AND METHODS

Study design

This is a parallel, controlled, single-blinded, randomized clinical trial. The participants were recruited from the Pain Management Department of the Affiliated Hospital of Xuzhou Medical University and Nantong Hospital of Traditional Chinese Medicine and were assigned to two parallel groups: CR-PT group and AP-PT group. The CR-PT group underwent CR-PT, and the AP-PT group underwent AP-PT. This study complied with The Declaration of Helsinki, and the trial was approved by the Institutional Ethics Committee of Clinical Research of Nantong Hospital of Traditional Chinese Medicine. The clinical trial was registered on the Chinese Clinical Trial Registry website (Registration number ChiCTR2200058894) and written informed consent was obtained from all the participants. No external funding was available for the trial.

Inclusion criterion: HLD patients appointed to receive PELD treatment.

Exclusion criteria: Patients with verbal communication disorders; patients with mental disorders; patients who underwent percutaneous inter-laminar endoscopic lumbar discectomy.

Randomization and masking

One researcher was in charge of the enrollment and allocation. The participants were allocated according to their year of birth. Participants with an odd-numbered birth year were assigned to the CR-PT group, while participants with an even-numbered birth year were assigned to the AP-PT Group. The participants were blinded to which group they were assigned.

Another researcher was assigned to evaluate the outcomes. The operations were performed by two surgeons in the two respective hospitals. They were not blinded to the allocation. Data processing and statistical analysis were performed by another researcher who was blinded to the allocation. The allocation method was revealed after the completion of the statistical analysis.

Outcomes

The primary outcomes included the number of fluoroscopies during puncturing and the puncture duration (min). The puncture duration was defined as the time taken from setting the operation position to the needle tip reaching the correct target. The secondary outcome was the surgery duration (min), which was defined as the time taken from setting the operation position to suturing. The VAS score during puncturing and the puncture success rate were also evaluated as secondary outcomes. Successful puncturing was defined as the needle tip reaching the correct target; otherwise, the puncture was deemed unsuccessful. The outcomes were recorded during and after the surgeries by a separate researcher.

Sample size

The sample size was set based on the number of fluoroscopies. According to the previous literature, the effect size was set to be 4 and the standard deviation was set to be 4.6, with $\alpha = 0.05$ and beta = 0.1. The sample size was 32 for each group. As no follow-up work was needed in the study, no dropout rate was considered. The sample size was calculated to be 64.

Interventions

CR-PT procedure: MRI or CT was performed before surgery, and the proper lateral and cranial tilt angle of the trajectory was measured (Figure 1). The participant was placed in the prone position, and a cushion was placed under the abdomen to reduce lumbar lordosis. Then, the C-arm was tilted to the predetermined lateral and cranial oblique angulation, and the superior part of the lateral border of the superior articular process (SAP), also known as the shoulder of the SAP, was identified as the target. In some circumstances, some modifications were made to the target selection. In L5/S1 segment cases, if the intervertebral foramina and the SAP were obstructed by the iliac crest, the C-arm was tilted cranially

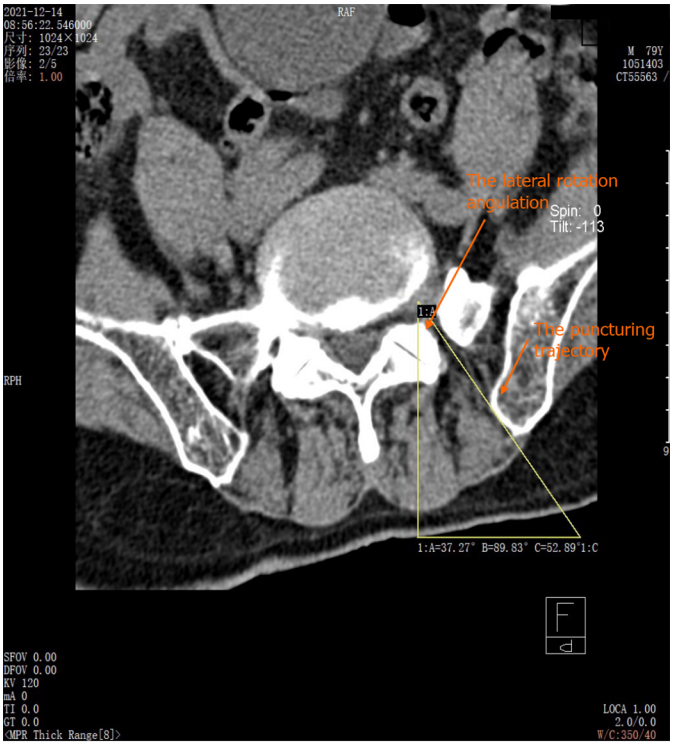

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Figure 1 Proper trajectory angle measured in computed tomography scan. For this far lateral type herniated lumbar disc case, a much smaller lateral tilt angulation of the trajectory was measured in the computed tomography scan beforehand.

and slightly medially until the intervertebral foramina and the SAP could be visualized. The radiopaque marker was then placed on the skin superimposing the target, which was marked, disinfected, and draped. Subsequently, the marked skin and subcutaneous tissues were anesthetized. A needle (17G, 15 cm) was inserted a short distance until it was seated in the subcutaneous tissues overlying the target, and the angle of the needle was adjusted until it was parallel to the X-ray axis. In this instance, the needle hub projected directly over the tip and was aligned with the target, as displayed in Figure 2. The needle was advanced while maintaining a parallel direction to the X-ray axis until contact with the shoulder of the SAP was made. Then, anteroposterior and lateral radiography was performed to confirm the needle placement.

In some cases, the SAP could not be visualized clearly despite setting the C-arm to the predetermined angulation, and mild angulation adjustments were made to allow for proper visualization. This situation occurred when the lateral oblique angle of the C-arm was very large. In such cases, a guiding needle was utilized in addition to the puncturing needle (Figure 3).

First, the radiopaque marker was placed and the skin was prepared for puncture as described above. The guiding needle (20G, 15 cm) was inserted sagittally under X-ray guidance until contact was made with the SAP, and the needle was repositioned and advanced slightly along the lateral border of the SAP. The needle was further advanced slightly to ensure that the needle tip was situated near the ventral margin of the SAP, and the anteroposterior and lateral view was taken to confirm the position (Figure 4). Then, the tip of the guiding needle was set as the puncturing target, and the coaxial technique was performed as described above (Figure 5).

AP-PT procedure

The C-arm was set at the correct alignment to achieve a standard lumbar anteroposterior radiography. This process ensured that the X-ray beam was parallel to the disc and that the endplate was displayed as a straight line. Subsequently, the center longitudinal line of the lumbar spine and an oblique line passing through the shoulder of the SAP were marked. For the L5/S1 Lumbar disc, the oblique line should reach above the peak point of the iliac crest. Then, a longitudinal line parallel and 10-14 cm lateral to the center line was drawn. The intersection of the lateral longitudinal line and the oblique line was defined as the puncture point (Figure 6). After disinfection, draping, and anesthesia, a needle was inserted. During the procedure, anteroposterior and lateral views were taken every 1 cm of needle advancement, confirming that the needle was oriented to the shoulder of the SAP (Figure 7). Slight modifications in direction were performed as necessary. When the needle tip touched the SAP, anteroposterior and lateral radiographs were taken to confirm the needle position.

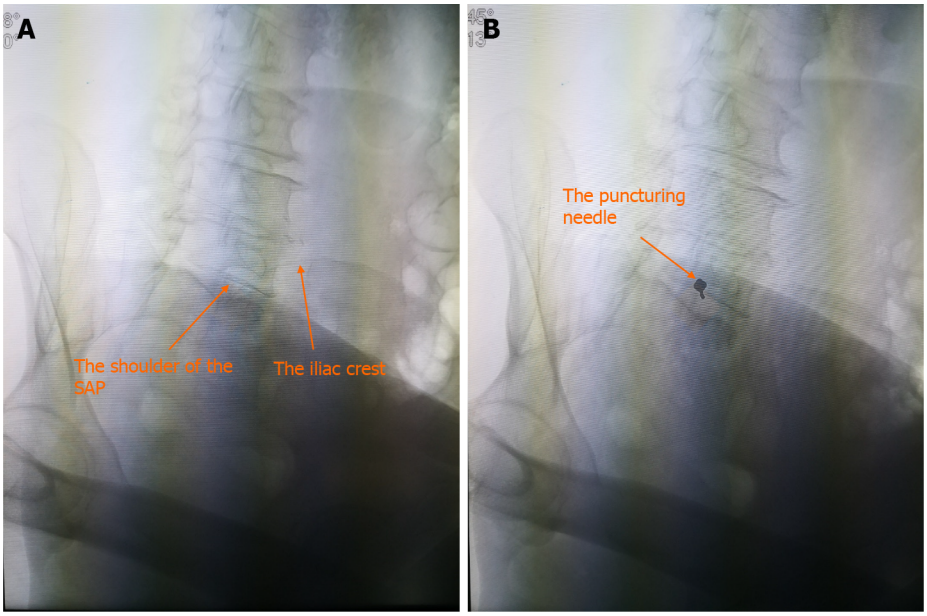

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Figure 2 X-ray films of the coaxial radiography-guided puncture technique. A: For the coaxial radiography-guided puncture technique, the target should be identified first, which is usually the shoulder of the superior articular process; B: The needle was maintained coaxial to the X-ray beam and parallel to the X-ray axis. In this instance, the needle hub projected directly over the tip and aligned with the target, and the needle appeared as a dot instead of a line. SAP: Superior articular process.

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Figure 3 Picture of the coaxial radiography-guided puncture technique with an additional guiding needle. If the superior articular process could not be visualized clearly, a guiding needle was used in addition to the puncturing needle. This usually occurred when the lateral oblique angle of the C-arm was very large.

Statistics

Quantitative variables with a normal distribution are presented as the mean ± SD, while non-normally distributed variables are reported as the median (P25, P75). An independent *t*-test was performed to analyze normally distributed data with homogeneity of variance. A separate variance estimated *t*-test was performed to analyze normally distributed data without homogeneity of variance. The remaining quantitative data were statistically analyzed by the Wilcoxon rank sum test. For qualitative variables, Fisher's exact test and Pearson chi-square test were applied. In this study, $P < 0.05$ was considered statistically significant. SPSS version 26 was utilized for statistical analyses. Moreover, a subgroup analysis of the patients with L5/S1 HLD was performed using the same statistical methodology.

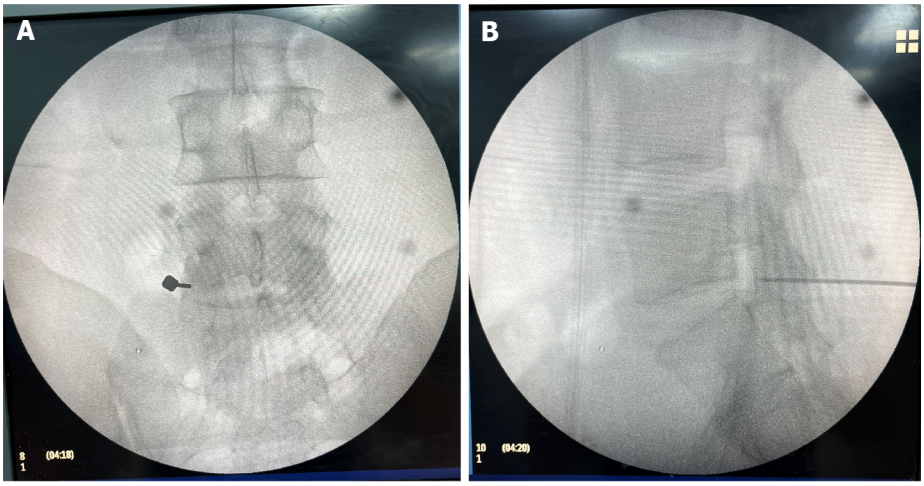

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Figure 4 X-ray films of a successful puncturing of a guiding needle. The anteroposterior and lateral views confirmed the needle tip placement near the ventral margin of the superior articular process.

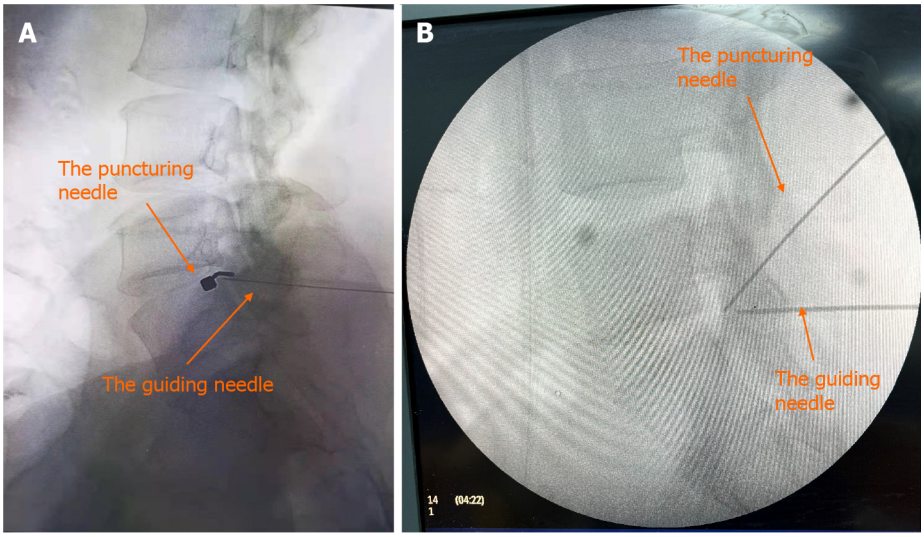

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Figure 5 X-ray films of a successful puncturing with an additional guiding needle. A: The C-arm was set at the coaxial position and puncture was performed under coaxial radiography guidance. In this position, the puncturing needle was shown as a dot rather than a line; B: The lateral view shows that the puncturing needle has reached the tip of the guiding needle, indicating a successful puncture.

RESULTS

In total, 86 participants were evaluated from April 2022 to May 2023, and 65 participants were enrolled in the trial. Among the enrolled participants, 16 were from the Nantong Hospital of Traditional Hospital, and 49 were from the Affiliated Hospital of Xuzhou Medical University. One participant in the AP-PT group dropped out due to AP-PT failure and eventually underwent CR-PT. Therefore, statistical analysis was performed for 64 participants, with 31 participants in the CR-PT group and 33 in the AP-PT group.

The demographic characteristics of the patients showed no statistically significant difference between the two groups, as displayed in Table 1.

The number of fluoroscopies [median (P25, P75)] was 12 (11, 14) in the CR-PT group *vs* 16 (12, 23) in the AP-PT group, while the puncture duration (mean ± SD) was 20.42 ± 5.78 *vs* 25.06 ± 5.46, respectively. All the variables demonstrated statistically significant differences ($P < 0.05$), as displayed in Table 2.

Furthermore, a subgroup analysis of the clinical outcomes was performed on the participants who underwent L5/S1 segment surgery. In total, 15 participants were included in the subgroup analysis, with 7 patients from the CR-PT subgroup and 8 from the AP-PT subgroup. The number of fluoroscopies was 11.56 ± 0.88 *vs* 25.22 ± 5.33, and the puncture duration was 13.89 ± 1.45 *vs* 28.89 ± 3.76, respectively. All the variables demonstrated statistically significant differences ($P < 0.05$), as displayed in Table 3.

Table 1 Demographic data of patients included in the two groups

	CR-PT group (31)	AP-PT group (34)	*P* value
Sex (male:female)	19:12	18:16	0.5
Height (cm)	168.29 ± 7.99	167.53 ± 8.18	0.71
Weight (kg)	66 (62, 75)	69 (60, 80)	0.17
BMI (kg/cm^2)	25.3 (22.63, 28.04)	27.25 (23.19, 33.35)	0.15
Age	55 (41, 65)	58 (38, 66)	0.5
Surgical segment			
L1/L2	0	2	0.57
L2/L3	1	0	
L3/L4	1	3	
L4/L5	20	19	
L5/S1	9	10	
Laterality (left:right)	18:13	12:22	0.07
Pain duration (mo)	6 (1, 24)	6 (2, 24)	0.64

Normally distributed data are presented as the mean ± SD; non-normally distributed data are presented as the median (P25, P75). AP-PT: Radiography-guided puncture technique; CR-PT: Coaxial radiography-guided puncture technique.

Table 2 Clinical outcomes of the two groups

	CR-PT group (31)	AP-PT group (33)	*P* value
Number of fluoroscopies	12 (11, 14)	16 (12, 23)	0.002
Puncture duration	20.42 ± 5.78	25.06 ± 5.46	0.002
Surgery duration	115 (107, 124)	123 (92, 148.5)	0.173
VAS score during puncturing	3 (2, 4)	3 (3, 4)	0.021
Puncture success rate (34 participants included for AP-PT group)	100%	97.06%	1

AP-PT: Radiography-guided puncture technique; CR-PT: Coaxial radiography-guided puncture technique.

Table 3 Clinical outcomes of the two groups in the L5/S1 segment

	CR-PT subgroup (9)	AP-PT subgroup (9)	*P* value
Number of fluoroscopies	11.56 ± 0.88	25.22 ± 5.33	0
Puncture duration	13.89 ± 1.45	28.89 ± 3.76	0
Surgery duration	105 (99.5, 120)	149 (125, 157.5)	0
VAS score during puncturing	2.11 ± 0.93	3.89 ± 0.6	0

AP-PT: Radiography-guided puncture technique; CR-PT: Coaxial radiography-guided puncture technique.

No complications were reported in the trial.

DISCUSSION

This clinical trial was carried out to compare the two puncturing techniques. The aim of the study was to confirm whether CR-PT is a superior approach to percutaneous transforaminal endoscopic lumbar discectomy compared to AP-PT. The number of fluoroscopies during puncturing, puncture duration,

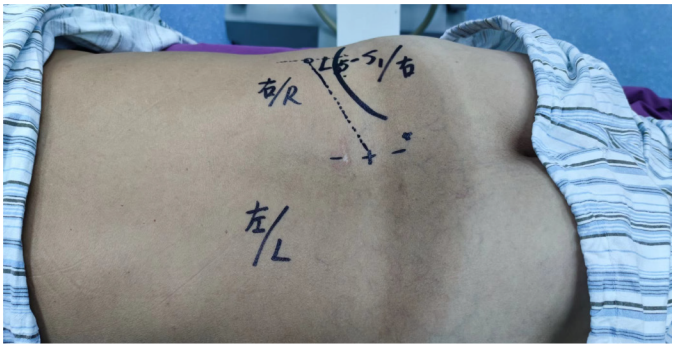

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Figure 6 Picture of puncturing direction in the radiography-guided puncture technique marked in the skin. A lateral longitudinal line parallel to the center longitudinal line was drawn, about 10-14 cm from the center line, and the intersection of the lateral longitudinal line and the oblique line passing through the tip of the superior articular process was chosen as the puncture point.

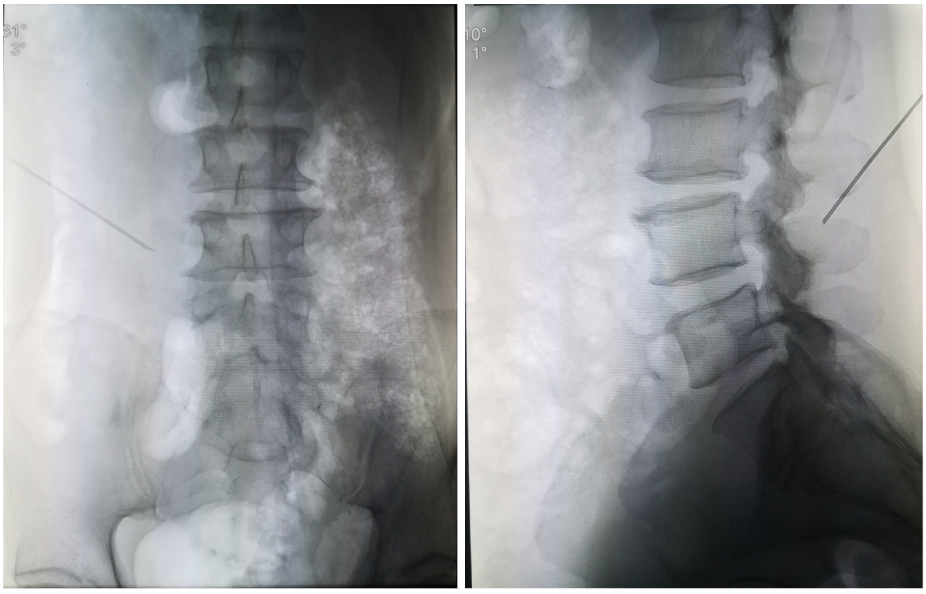

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Figure 7 X-ray films of the radiography-guided puncture technique. The needle should be oriented to the shoulder of the superior articular process under both the anteroposterior and lateral views.

surgery duration, VAS score during puncturing, and puncture success rate were recorded.

One participant with L5/S1 segment HLD dropped out due to an unsuccessful AP-PT procedure. All the clinical outcomes demonstrated superiority with statistical significance favoring the CR-PT group except the surgery duration. Additionally, a subgroup analysis was performed, focusing on L5/S1 segment participants. All the clinical outcomes demonstrated statistically significant superiority in the CR-PT subgroup compared to the AP-PT subgroup. The superiority was more obvious in the subgroup analysis.

The superiority of CR-PT over AP-PT may be attributed to the following points. In the coaxial puncturing technique, the puncturing needle and X-ray beam share a common axis, which is easier to observe on radiography and allows for less needle repositioning. Additionally, as opposed to AP-PT, this novel puncturing technique does not require shifting the C-arm machine between the lateral position and the anteroposterior position repeatedly. The working cannula tilt angulation is crucial for PTELD, as it should be accurate and individualized. For example, a central-type disc herniation requires a larger lateral oblique angulation, whereas a small lateral oblique angulation is warranted in a foraminal type or far lateral type HLD case. Similarly, caudal hernia prolapses require a larger cranial tilt angulation, otherwise minor cranial tilt angulation is necessary. In the coaxial technique, the individualized puncturing angle and the individualized puncturing spot can be predetermined and guaranteed by setting the C-arm angulation beforehand. Hence, the angulation of the working cannula intubation can be optimized, which facilitates subsequent endoscopic surgery. However, for AP-PT, selecting the optimal puncture point and puncturing angulation depends on the surgeon's expertise,

which is much less accurate.

Our research demonstrated a more obvious superiority of CR-PT in HLD of the L5/S1 segment, which may be due to the following reasons. First, L5/S1 segments typically require a smaller lateral rotation angle, allowing easy visualization of the SAP. Therefore no guiding needle is required, which shortens puncturing time. Second, in the coaxial technique, the iliac crest is relatively easily avoided due to the more accurate angulation. Therefore, we believe that CR-PT is far more advantageous in L5/S1 cases.

Other innovative puncturing techniques have been reported for PELD. Zeng *et al*[14] reported a novel targeted puncture technique using a lumbar disc herniation target collimator, indicating superiority over the conventional free-hand injection method. Fan *et al*[23] applied a so-called HELLO system, which consisted of a self-made surface locator and a puncture-assisted device to guide the percutaneous puncturing process. The report also indicated improved puncturing accuracy and reduced fluoroscopic duration, as well as preoperative location duration. Moreover, C-arm navigation and 3D printing technologies have been applied in multiple studies. Qin *et al*[13] reported that using the C-arm navigation system could dramatically reduce the number of fluoroscopies and puncture attempts compared with the conventional method. Erken *et al*[24] reported the use of a collimation device to facilitate puncturing in PELD. However, all these methods require additional equipment and could increase the cost of the procedure. In contrast, our method requires no additional device and provides a more convenient and practical approach.

Nevertheless, the limitations of this study should be acknowledged. The sample size was small. Thus, further clinical research with a larger sample size is required. Second, the puncturing technique relies on personal expertise and surgeons have their personal preferences, and our result can only provide an alternative reference.

CONCLUSION

CR-PT in PTELD is a novel and effective technique. It enables individualized cranial and lateral tilt angulation during puncturing, accurate identification of the puncturing location, fewer needle direction adjustments, and no need for repeated C-arm angulation shifting. This technique significantly improves puncture accuracy, shortens puncture time and operation time, and reduces pain during puncturing. Therefore, CR-PT could be an advisable option in PTELD.

ARTICLE HIGHLIGHTS

Research background

As a conventional puncture technique in endoscopic discectomy, anterior-posterior and lateral radiography-guided puncture technique (AP-PT) has limitations, such as repeated intermittent radiographs and inaccurate needle angulation. Although some innovative puncturing techniques have been reported, most of them require additional equipment. This paper describes an innovative coaxial radiography-guided puncture technique (CR-PT) and verifies its feasibility and superiority compared to the traditional AP-PT technique.

Research motivation

The coaxial radiography-guided puncture technique (CR-PT) is commonly applied in conventional procedures; however, we applied this technique in endoscopic lumbar discectomies. For some difficult cases, a guiding needle was used and the tip of the guiding needle was set as the target, which subsequently enabled the coaxial puncture technique to be performed.

Research objectives

The aim of the research was to verify the superiority of CR-PT over AP-PT in endoscopic lumbar discectomies.

Research methods

This is an RCT trial. The participants were assigned to either a CR-PT group or an AP-PT group. The number of fluoroscopies during puncturing, puncture duration (min), surgery duration (min), VAS score during puncturing, and puncture success rate were recorded and compared.

Research results

The trial verified the superiority of CR-PT over AP-PT in terms of puncture duration, puncture accuracy, and VAS score during puncturing.

Research conclusions

The CR-PT technique is a novel and effective technique. This technique significantly improves puncture accuracy and shortens puncture duration. Therefore, CR-PT could be an advisable option in endoscopic discectomy.

Research perspectives

This study lays a foundation for further research on the CR-PT technique in trans-interlaminar endoscopic lumbar discectomies and endoscopic cervical discectomies.

FOOTNOTES

Author contributions: Yuan HJ, Chen LP, and Xu H designed the research study; Yuan HJ and Chen LP performed the procedure; Hu PP, Fu HB, and Xu H recorded the outcomes; Wen BS, Deng H, and Lu Z did the statistical work, Wen BS, Yan LJ, and Yuan HJ wrote the manuscript; all authors have read and approved the final manuscript.

Institutional review board statement: This study complied with The Declaration of Helsinki, and the trial was approved by the Institutional Ethics Committee of Clinical Research of Nantong Hospital of Traditional Chinese Medicine (Approval No. 20221230-5).

Clinical trial registration statement: The clinical trial was registered on the Chinese Clinical Trial Registry website (Registration number ChiCTR2200058894).

Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

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REFERENCES

1 **Li Z**, Zhang C, Chen W, Li S, Yu B, Zhao H, Shen J, Zhang J, Wang Y, Yu K. Percutaneous Endoscopic Transforaminal Discectomy versus Conventional Open Lumbar Discectomy for Upper Lumbar Disc Herniation: A Comparative Cohort Study. *Biomed Res Int* 2020; **2020**: 1852070 [PMID: 32190653 DOI: 10.1155/2020/1852070]
2 **Choi KC**, Kim JS, Park CK. Percutaneous Endoscopic Lumbar Discectomy as an Alternative to Open Lumbar Microdiscectomy for Large Lumbar Disc Herniation. *Pain Physician* 2016; **19**: E291-E300 [PMID: 26815256]
3 **Li WS**, Yan Q, Cong L. Comparison of Endoscopic Discectomy Versus Non-Endoscopic Discectomy for Symptomatic Lumbar Disc Herniation: A Systematic Review and Meta-Analysis. *Global Spine J* 2022; **12**: 1012-1026 [PMID: 34402320 DOI: 10.1177/21925682211020696]
4 **Perez-Roman RJ**, Gaztanaga W, Lu VM, Wang MY. Endoscopic decompression for the treatment of lumbar spinal stenosis: an updated systematic review and meta-analysis. *J Neurosurg Spine* 2022; **36**: 549-557 [PMID: 34767533 DOI: 10.3171/2021.8.SPINE21890]
5 **Qin R**, Liu B, Hao J, Zhou P, Yao Y, Zhang F, Chen X. Percutaneous Endoscopic Lumbar Discectomy Versus Posterior Open Lumbar Microdiscectomy for the Treatment of Symptomatic Lumbar Disc Herniation: A Systemic Review and Meta-Analysis. *World Neurosurg* 2018; **120**: 352-362 [PMID: 30205219 DOI: 10.1016/j.wneu.2018.08.236]
6 **Pan M**, Li Q, Li S, Mao H, Meng B, Zhou F, Yang H. Percutaneous Endoscopic Lumbar Discectomy: Indications and Complications. *Pain Physician* 2020; **23**: 49-56 [PMID: 32013278]
7 **Gadjradj PS**, Harhangi BS, Amelink J, van Susante J, Kamper S, van Tulder M, Peul WC, Vleggeert-Lankamp C, Rubinstein SM. Percutaneous Transforaminal Endoscopic Discectomy Versus Open Microdiscectomy for Lumbar Disc Herniation: A Systematic Review and Meta-analysis. *Spine (Phila Pa 1976)* 2021; **46**: 538-549 [PMID: 33290374 DOI:

10.1097/BRS.0000000000003843]
8 **Kapetanakis S**, Gkantsinikoudis N, Charitoudis G. Implementation of Percutaneous Transforaminal Endoscopic Discectomy in Competitive Elite Athletes With Lumbar Disc Herniation: Original Study and Review of the Literature. *Am J Sports Med* 2021; **49**: 3234-3241 [PMID: 34491150 DOI: 10.1177/03635465211032612]
9 **Ahn Y**, Lee SH, Park WM, Lee HY, Shin SW, Kang HY. Percutaneous endoscopic lumbar discectomy for recurrent disc herniation: surgical technique, outcome, and prognostic factors of 43 consecutive cases. *Spine (Phila Pa 1976)* 2004; **29**: E326-E332 [PMID: 15303041 DOI: 10.1097/01.brs.0000134591.32462.98]
10 **Jarebi M**, Awaf A, Lefranc M, Peltier J. A matched comparison of outcomes between percutaneous endoscopic lumbar discectomy and open lumbar microdiscectomy for the treatment of lumbar disc herniation: a 2-year retrospective cohort study. *Spine J* 2021; **21**: 114-121 [PMID: 32683107 DOI: 10.1016/j.spinee.2020.07.005]
11 **Lee SG**, Ahn Y. Transforaminal Endoscopic Lumbar Discectomy: Basic Concepts and Technical Keys to Clinical Success. *Int J Spine Surg* 2021; **15**: S38-S46 [PMID: 34974419 DOI: 10.14444/8162]
12 **Hsu HT**, Chang SJ, Yang SS, Chai CL. Learning curve of full-endoscopic lumbar discectomy. *Eur Spine J* 2013; **22**: 727-733 [PMID: 23076645 DOI: 10.1007/s00586-012-2540-4]
13 **Qin H**, Deng L, Xu L, Mu Q, Luo X, Huang S, Wang M, Luo C, Huang C, Huang W. Puncture and localization for percutaneous endoscopic lumbar discectomy with C-arm navigation: a randomized controlled cadaver trial. *Ann Transl Med* 2021; **9**: 1730 [PMID: 35071424 DOI: 10.21037/atm-21-5844]
14 **Zeng Y**, Bao J, Su J, Tan P, Xie W, Huang Z, Xia H. Novel targeted puncture technique for percutaneous transforaminal endoscopic lumbar discectomy reduces X-ray exposure. *Exp Ther Med* 2017; **14**: 2960-2968 [PMID: 28966678 DOI: 10.3892/etm.2017.4917]
15 **Yan Y**, Zhu M, Cao X, Zhang Y, Zhang X, Xu M, Zhang D. Different approaches to percutaneous endoscopic lumbar discectomy for L5/S1 lumbar disc herniation: a retrospective study. *Br J Neurosurg* 2020; 1-7 [PMID: 33331186 DOI: 10.1080/02688697.2020.1861218]
16 **Choi KC**, Park CK. Percutaneous Endoscopic Lumbar Discectomy for L5-S1 Disc Herniation: Consideration of the Relation between the Iliac Crest and L5-S1 Disc. *Pain Physician* 2016; **19**: E301-E308 [PMID: 26815257]
17 **Fan G**, Gu X, Liu Y, Wu X, Zhang H, Gu G, Guan X, He S. Lower Learning Difficulty and Fluoroscopy Reduction of Transforaminal Percutaneous Endoscopic Lumbar Discectomy with an Accurate Preoperative Location Method. *Pain Physician* 2016; **19**: E1123-E1134 [PMID: 27906942]
18 **Zheng C**, Li J, Zeng G, Ye W, Sun J, Hong J, Li C. Development of a Virtual Reality Preoperative Planning System for Postlateral Endoscopic Lumbar Discectomy Surgery and Its Clinical Application. *World Neurosurg* 2019; **123**: e1-e8 [PMID: 30144600 DOI: 10.1016/j.wneu.2018.08.082]
19 **Mariscalco MW**, Yamashita T, Steinmetz MP, Krishnaney AA, Lieberman IH, Mroz TE. Radiation exposure to the surgeon during open lumbar microdiscectomy and minimally invasive microdiscectomy: a prospective, controlled trial. *Spine (Phila Pa 1976)* 2011; **36**: 255-260 [PMID: 20736891 DOI: 10.1097/BRS.0b013e3181ceb976]
20 **Ahn Y**, Kim CH, Lee JH, Lee SH, Kim JS. Radiation exposure to the surgeon during percutaneous endoscopic lumbar discectomy: a prospective study. *Spine (Phila Pa 1976)* 2013; **38**: 617-625 [PMID: 23026867 DOI: 10.1097/BRS.0b013e318275ca58]
21 **Lavy C**. Variations in selective nerve root block technique. *Ann R Coll Surg Engl* 2015; **97**: 245 [PMID: 26491737 DOI: 10.1308/003588414x13814021678277]
22 **Ko S**, Kwon J, Lee Y, Chae S, Choi W. Comparison of Pain-reducing Effect After Selective Nerve Root Block According to the Type of Lumbar Foraminal Stenosis. *Clin Spine Surg* 2019; **32**: E60-E64 [PMID: 30273185 DOI: 10.1097/BSD.0000000000000723]
23 **Fan G**, Guan X, Zhang H, Wu X, Gu X, Gu G, Fan Y, He S. Significant Improvement of Puncture Accuracy and Fluoroscopy Reduction in Percutaneous Transforaminal Endoscopic Discectomy With Novel Lumbar Location System: Preliminary Report of Prospective Hello Study. *Medicine (Baltimore)* 2015; **94**: e2189 [PMID: 26656348 DOI: 10.1097/MD.0000000000002189]
24 **Erken HY**, Yilmaz O. Collimation Reduces Radiation Exposure to the Surgeon in Endoscopic Spine Surgery: A Prospective Study. *J Neurol Surg A Cent Eur Neurosurg* 2022; **83**: 6-12 [PMID: 34030187 DOI: 10.1055/s-0041-1726111]

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