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# Percutaneous paravertebral endoscopic decompression for the treatment of far-out syndrome involving the L5 nerve root: technical report and preliminary results

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## Abstract

**Objective** The aim of this study was to describe the technique of percutaneous paravertebral endoscopic decompression for the treatment of far-out syndrome and to analyze the early clinical results of this technique.

**Methods** From April 2021 to June 2023, a retrospective study was conducted on patients with far-out syndrome who underwent percutaneous paravertebral endoscopic decompression at Hospital of Chengdu University of Traditional Chinese Medicine. The Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and modified MacNab criteria were utilized for the assessment of leg pain, quality of life, and clinical efficacy, respectively. Clinical outcomes were assessed at the day before surgery, 1 day, 1 month, 3 months, 6 months after surgery, and the last follow-up. Meanwhile, the incidence rate of foraminal stenosis, surgery time, and complications were recorded for comprehensive evaluation.

**Results** This study included a cohort of 16 patients, with a mean age at the time of surgery of  $70.94 \pm 4.04$  years. The average duration of symptoms was  $10.81 \pm 5.13$  months, while the mean follow-up period lasted for  $16.69 \pm 5.84$  months. The results revealed significant improvements in VAS scores and ODI scores at each time point following the operation ( $P < 0.05$ ). According to the modified MacNab criteria, excellent or good outcomes were observed in 15 cases (93.70%). Four patients presented with postoperative numbness, which was effectively alleviated through conservative treatment. One case with a fair outcome exhibited residual radicular symptoms.

**Conclusion** The current technical report presents a successful treatment strategy for far-out syndrome, demonstrating promising preliminary efficacy and safety.

**Keywords** Fully endoscopic techniques, Paravertebral approach, Extraforaminal stenosis, Far-out syndrome, Technical report

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## Introduction

Far-out syndrome refers to the compression and entrapment of the L5 nerve root in the extraforaminal area between the hypertrophied L5 transverse process and the sacral ala (Fig. 1) [1]. This condition was first reported by Wiltse et al. in 1984 [2]. It is actually a type of low back pain and the symptoms are indicative of L5 spinal radiculopathy [3]. However, reaching an accurate diagnosis poses a formidable challenge, often resulting in frequent misdiagnoses. Nerve root canal angiography, diffusion tensor imaging, and oblique coronal magnetic resonance (MR) imaging are considered crucial diagnostic modalities for this syndrome [4, 5]. Despite these challenges, steady progress has been achieved in the understanding of far-out syndrome. The initial management of far-out syndrome typically involves conservative treatment, while the absence of symptom amelioration following conservative measures serves as an indication for surgical intervention. Currently, treatment options predominantly encompass open techniques [6, 7], tunnel techniques [8], surgical microscopes [9, 10], and fully endoscopic techniques [1].

However, the lack of standardized treatment and management strategies for far-out syndrome remains an unresolved issue. The increase in the number of annual publications on far-out syndrome has shown an overall steady growth over the past decade [11]. Compared to conventional open surgery, minimally invasive surgical techniques specifically targeting the pathological points not only minimize trauma to the posterior structures but also mitigate postoperative back pain occurrence, facilitating expedited patient recovery following surgery [11]. The field of minimally invasive surgery primarily encompasses microscopic decompression and endoscopic procedures, both of which have demonstrated favorable

treatment outcomes [1, 12]. Among these techniques, the utilization of magnifying endoscopy and water medium enhances the visual clarity, while the continuous infusion of water throughout the procedure reduces bleeding and potential risks associated with infection [13, 14]. Unilateral biportal endoscopic approach, as an endoscopic technique, has gained widespread interest in recent years, emerging as a popular treatment option for far-out syndrome.

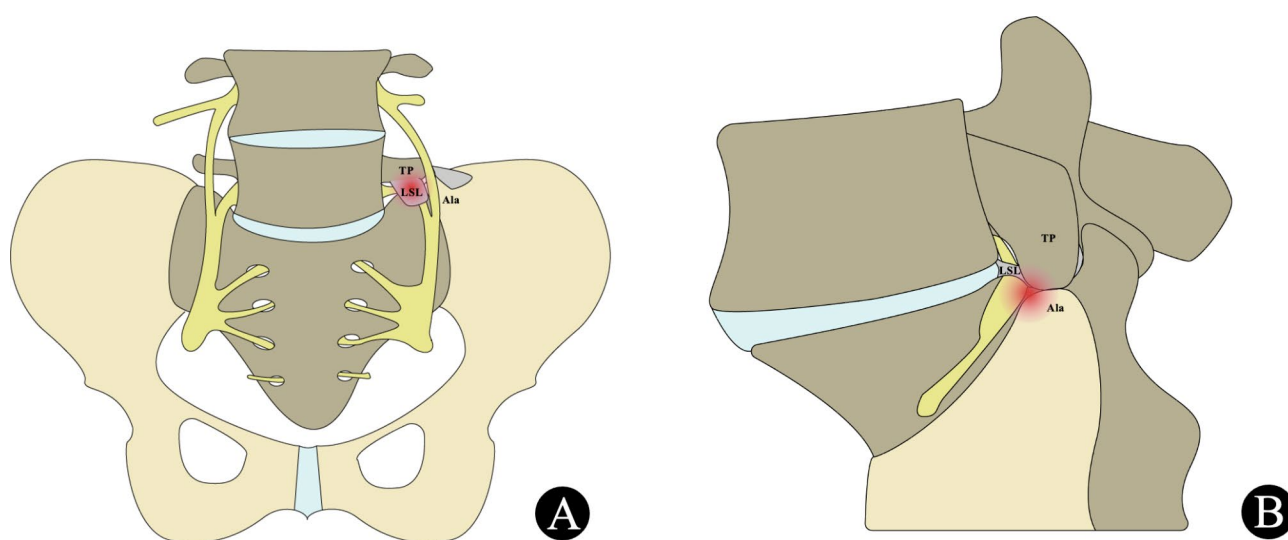
In this study, we present a novel fully endoscopic approach that effectively expands the extraforaminal space between the hypertrophied L5 transverse process and the sacral ala. We provide a comprehensive procedural description and report the primary clinical outcomes observed in a cohort of patients with far-out syndrome.

## Materials and methods

### Subjects

A retrospective study was conducted on consecutive patients diagnosed with far-out syndrome and treated with percutaneous paravertebral endoscopic decompression technique at Hospital of Chengdu University of Traditional Chinese Medicine from April 2021 to June 2023. The present study was approved by the Ethics Committee of the Hospital of Chengdu University of Traditional Chinese Medicine, and written consent was obtained from each patient.

The surgical indications are as follows: (1) complaint of unilateral radiating leg pain due to L5 radiculopathy; (2) inadequate symptoms relief following conventional conservative treatment or persistent and intolerable pain; (3) clinical symptoms and physical findings supported by auxiliary examinations such as computed tomography (CT) or MR; (4) temporary improvement of



**Fig. 1** The far-out syndrome pathological diagram. TP, transverse process; LSL, lumbosacral ligament

unilateral radicular pain after a selective L5 root blocking procedure.

The exclusion criteria are: (1) preoperative L5-S1 vertebral segment instability confirmed by dynamic lumbar X-rays; (2) examinations indicated another source of pain in addition to the far-out syndrome; (3) neurogenic disorders or conditions affecting postoperative assessment; (4) associated with a history of local trauma or previous surgery; (5) existence of surgical or anesthetic contraindications.

### Surgical procedures

Under general anesthesia, patients were performed on the Wilson frame with prone position and appropriate flexion. The puncture target, the lateral aspect of the sacral superior articular process, was identified using an anteroposterior view of the C-arm fluoroscopy. A skin puncture site was marked 2 cm laterally from the target. Following an 8 mm incision, a series of dilators were advanced towards the target and the operative sheath was introduced along with the dilators. The anteroposterior and lateral radiographs confirmed the positioning of the operative sheath among the lateral aspect of the superior articular process, the inferior aspect of the transverse process, and the superior medial aspect of the sacral ala (Fig. 2A). The endoscope (Joimax GmbH, Karlsruhe, Germany; model FS7347171O) was subsequently introduced and performed with continuous saline irrigation. After meticulous anatomical exposure utilizing the endoscopic radiofrequency probes and forceps, a partial excision was performed on the lateral aspect of the superior articular process, the inferior aspect of the transverse process, and the superior medial aspect of the sacral ala using a trephine, drill and rongeur. We continued to expand the workspace, expose the thickening of the extraforaminal and lumbosacral ligaments, and further excise the bony structure at the inferior aspect of the transverse process until reaching the ligament insertion site. Subsequently, a meticulous dissection from inside out was employed to identify the exiting nerve root (Fig. 2B). At this stage,

the pseudarthrosis between the transverse process and the sacral ala was excised along the nerve root to achieve decompression of the extraforaminal area (Fig. 2C). Additionally, confirmation of the relief of nerve root compression and restoration of normal pulsation were made under direct visualization through the spinal endoscope. If necessary, herniated disc tissue or osteophytes were removed. Ultimately, upon successful decompression and confirmation of hemostasis, closure of the skin without drainage was accomplished (Fig. 2D).

### Outcome measurements

Demographic characteristics, operative time, follow-up period, and complications were recorded. The Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), and modified MacNab criteria were utilized for the assessment of leg pain, quality of life, and clinical efficacy, respectively. Clinical outcomes were assessed at the day before surgery, 1 day, 1 month, 3 months, 6 months after surgery, and the last follow-up. The preliminary evaluation was conducted by a research doctor during hospitalization, and follow-ups by telephone interviews or outpatient visits after discharge.

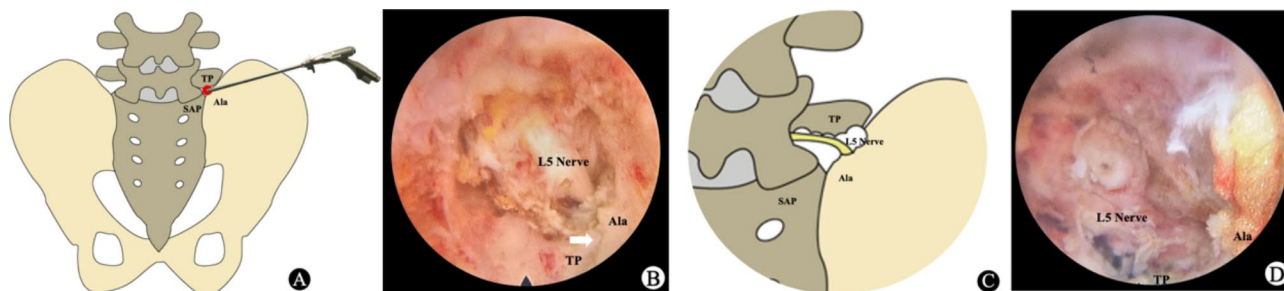
### Statistical analysis

Continuous variables were presented as means with standard deviation, while categorical variables were expressed as numbers and percentages. The paired t-test was used for inter group comparison. The difference was statistically significant ( $P < 0.05$ ). IBM SPSS ver. 25.0 (IBM Co., Armonk, NY, USA) were used for all analyses.

## Results

### Demographic results

Between April 2021 and June 2023, a total of sixteen patients with far-out syndrome were treated with percutaneous paravertebral endoscopic decompression. Table 1 showed the baseline characteristics of the patients. The eligible patient cohort comprised 6 males and 10 females, with a mean age at the time of surgery



**Fig. 2** The surgical procedure diagrams. (A) Schematic anatomy of the coronal view of the positioning of the surgical sheath (red circle). (B) Intraoperative finding of the L5 exiting nerve root was compressed by the pseudarthrosis (white arrow). (C) Schematic anatomy of transverse process and sacral ala along L5 nerve root excision. (D) Intraoperative finding of successful decompression of the extraforaminal area. TP, transverse process; SAP, superior articular process

**Table 1** Baseline characteristics of the patients (n = 16)

Characteristic	Value
Age (years)	70.94 ± 4.04
Gender	
Male	6 (37.50)
Female	10 (62.50)
Duration of symptom (mth)	10.81 ± 5.13
With foraminal stenosis	5 (31.25)
Surgery time (min)	84.50 ± 13.82
Follow-up time (mth)	16.69 ± 5.84

Mean ± SD for continuous variables; N (%) for categorical variables

of 70.94 ± 4.04 years. The average duration of symptoms was 10.81 ± 5.13 months, while the mean follow-up period lasted for 16.69 ± 5.84 months. Additionally, concomitant foraminal stenosis was observed in 5 cases (31.25%).

Clinical results

The improvements in VAS scores and ODI scores at each time point following the operation are illustrated in Fig. 3, while the results of preoperative and last follow-up clinical evaluations are presented in Table 2. The VAS scores for leg pain significantly improved from 7.87 ± 0.41 to 1.51 ± 1.04, and the ODI scores improved from 74.38 ± 18.46 to 13.13 ± 8.23 at the last follow-up. The modified MacNab criteria demonstrated excellent outcomes in 13 cases (81.30%), good in 2 cases (12.50%), and

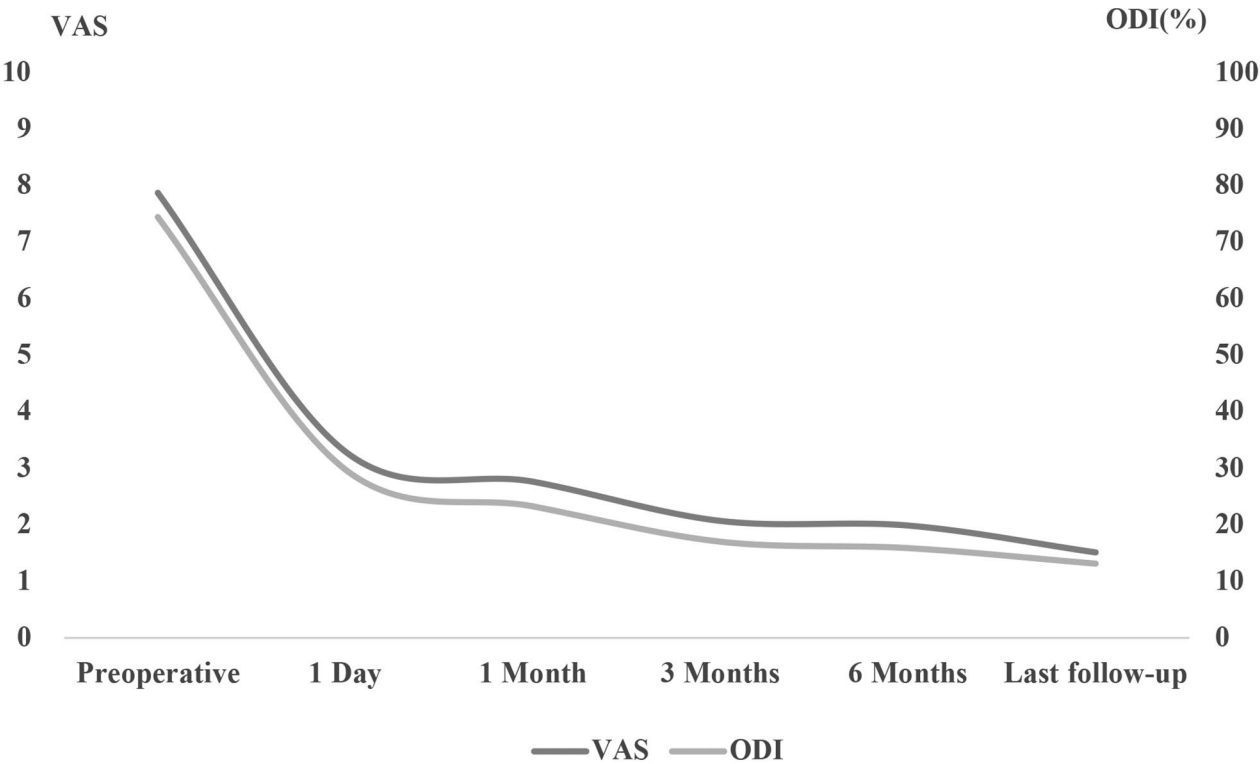
**Table 2** Preoperative and postoperative clinical scores (n = 16)

Variable	Value
VAS	
Preoperative	7.87 ± 0.41
Last follow-up	1.51 ± 1.04*
ODI	
Preoperative	74.38 ± 18.46
Last follow-up	13.13 ± 8.23*
Modified MacNab criteria	
Excellent	13 (81.30)
Good	2 (12.50)
Fair	1 (6.30)
Poor	0
Complications	
Transient numbness	4
Residual radicular symptoms	1

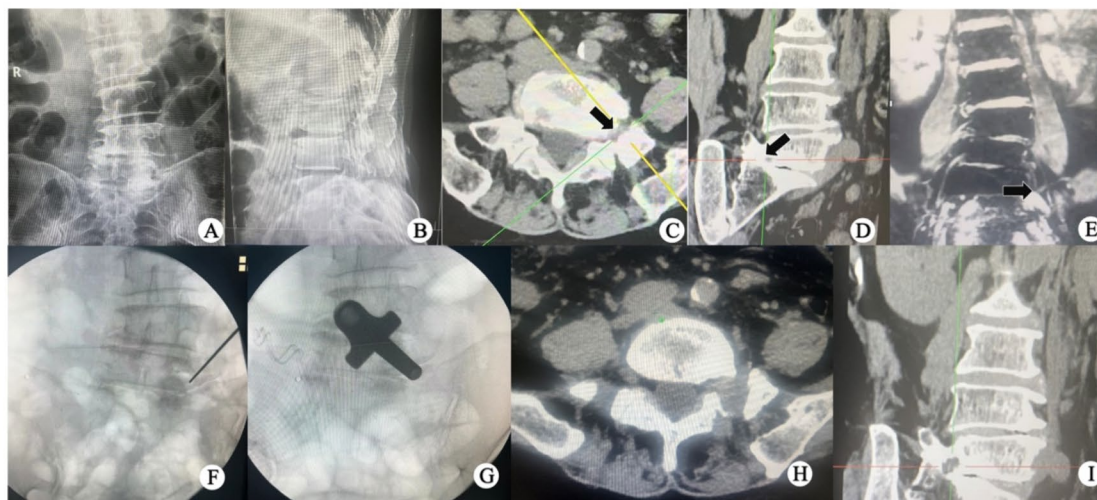
Mean ± SD for continuous variables; N (%) for categorical variables; \* represents the *p*-value less than 0.05

Abbreviations: VAS Visual Analogue Scale; ODI Oswestry Disability Index

fair in only one case (6.30%). Four patients presented with postoperative numbness, which was effectively alleviated through conservative treatment including functional exercises, nutritional support for nerves, anti-inflammatory measures, and edema reduction. One case with a fair outcome showed residual radicular symptoms. Postoperative CT and MRI showed that the extraforaminal compression of L5 nerve root by osteophytes on the lateral



**Fig. 3** Trend of preoperative and postoperative VAS scores and ODI scores



**Fig. 4** A 72-year-old female patient complained of severe pain in the left lower limb for more than one year. (A–D) The preoperative images showed that the L5 nerve root was compressed by a pseudoarthrosis in the extraforaminal area (black arrows). (E) The MR hydrography image showed that the L5 nerve root was compressed. (F) The preoperative diagnostic local injection temporarily relieved her symptoms. (G) The intraoperative C-arm fluoroscopy confirmed that the surgical sheath was located at the target site. (H–I) The postoperative images showed the L5 nerve root was completely decompressed

margin of L5 and S1 vertebral body did not completely resolved. Nevertheless, the patient expressed tolerable residual symptoms and declined further decompression.

#### Representative cases

A 72-year-old female patient presented with persistent severe pain in her left lower extremity persisting for over one year. The symptoms failed to show improvement following conservative treatment. MR images showed no abnormal findings in the spinal canal, while CT scans exhibited prominent osteophytes along the lateral margins of L5–S1 vertebral bodies. Receiving diagnostic local injection preoperatively yielded transient alleviation of her symptoms. Considering the prominent iliac crest, we conducted a paravertebral approach fully endoscopic decompression procedure (Fig. 4).

She exhibited a satisfactory postoperative recovery at the one-month follow-up, with no evidence of radicular symptoms. The 18-month follow-up assessment demonstrated sustained positive outcomes.

#### Discussion

In our study, we present a novel percutaneous paravertebral endoscopic decompression technique for the treatment of far-out syndrome. This procedure effectively removes osteophytes located on the L5 transverse process and sacral alar, as well as addresses the herniated disc and the thickened lumbosacral ligament, thereby alleviating extraforaminal stenosis of the L5 spinal nerve.

The aforementioned clinical outcomes demonstrated a significant improvement in VAS and ODI scores at the last follow-up, with the majority of patients (93.80%) achieving favorable to excellent or good outcomes.

In recent years, full endoscopic techniques have emerged as a prominent therapeutic modality for far-out syndrome [11]. Percutaneous paravertebral endoscopic decompression and unilateral biportal endoscopic decompression, as representatives of fully endoscopic techniques, both utilize posterior approaches, sharing similar principles of minimally invasive theory and surgical procedures. However, compared unilateral biportal endoscopic approach, percutaneous paravertebral endoscopic decompression has several advantages. Firstly, this technique as a uniportal approach avoids unnecessary invasion of surrounding tissue, resulting in reduced trauma [15, 16]. Secondly, positioning the incision closer to the head prevents interference with the high iliac crest, large facet joint, or narrowed lumbosacral foramen [12]. Thirdly, the uniportal approach is easier to create a workspace and the target is more direct, saving time spent on operations and making it less likely to get lost [17, 18]. Fourth, the uniportal approach provides better irrigation management, minimizing the wounded area by irrigation and reducing the potential for complications [19].

The mean age of the patients included in this study was  $70.94 \pm 4.04$  years. Elderly patients often present with complex pathogenic factors associated with intervertebral disc degeneration, the hypertrophy of the facet joints



and ligaments. These pathological changes can contribute to the development of L5 radiculopathy. This inevitably exacerbates the complexity of diagnosis. Although this disease is rare, a preoperative diagnosis of far-out syndrome is important because a lack of diagnosing extraforaminal stenosis at L5–S1 can result in failed back surgery syndrome [12, 19]. Nerve root canal angiography, diffusion tensor imaging, and oblique coronal MRI are considered crucial diagnostic modalities for this syndrome. Therefore, in cases where there is a discrepancy between clinical manifestations and imaging outcomes, it becomes imperative to conduct further diagnostic examination for clarification. We conducted preoperative CT reconstruction, MR hydrography, and selective nerve root block examinations to provide diagnostic support for achieving favorable clinical outcomes.

Postoperative leg pain following lumbar surgery can subside rapidly, yet it is common to observe residual leg paresthesia, dyesthesia or numbness [20, 21]. Four patients presented with postoperative numbness, which can lower patient satisfaction. Previous studies have revealed that preoperative long duration of symptoms together with a severe compression of nerve root significantly increased the risk of presenting numbness [22]. The four patients with postoperative numbness were effectively alleviated through conservative treatment. In addition, one case exhibited residual radicular symptoms after operation. Postoperative CT and MRI showed that the extraforaminal compression of L5 nerve root by osteophytes on the lateral margin of L5 and S1 vertebral body did not completely resolved. We were worried that excessive penetration would damage the peritoneum, which also led to inadequate decompression. Eventually, the patient expressed tolerable residual symptoms and declined further decompression. We have not experienced dural tears, nerve root injuries, retroperitoneal fluid collection or infection after endoscopic decompression. However, a previous study on endoscopic treatment of far-out syndrome via a paraspinal approach observed postoperative abdominal pain due to retroperitoneal fluid collection [1]. This raises concerns regarding the potential risks of peritoneal or even abdominal cavity damage when excessive penetration. Careful manipulation of the trephine or high-speed drill in the appropriate direction is essential to prevent any harm during shaping procedures. In cases of uncertainty, intraoperative C-arm fluoroscopic imaging can be employed to accurately determine the depth reached. Similarly, the nerve roots should also be handled with caution to avoid any potential injury. The iliolumbar ligament is attached to the tip of anteroinferior aspect of the L5 transverse process bilaterally and radiates laterally to attach to the pelvis [23]. We also preserved a weakened iliolumbar ligament. The iliolumbar ligament is a

very important structure for stability of the lumbosacral junction.

## Conclusion

Percutaneous paravertebral endoscopic decompression is a novel technique for the treatment of far-out syndrome, demonstrating promising preliminary efficacy and safety. Given the retrospective and single-cohort nature of this study, along with its relatively small sample size, it is imperative to conduct further exploration in this area.

## Acknowledgements

Not applicable.

## Author contributions

FY, CF and KL contributed equally to this work. FY and CF designed the study, and wrote the manuscript. KL searched the data, and conducted statistical analysis. RC and XF revised the manuscript. All authors read and approved the final manuscript.

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## Data availability

Please contact author for data requests.

## Declarations

### Ethics approval and consent to participate

The study was performed in line with the principles of the Declaration of Helsinki. The survey protocols received approval from the Ethics Committee of the Hospital of Chengdu University of Traditional Chinese Medicine (2023KL-138-01). Informed consent was obtained from all participants.

### Consent for publication

Informed written consent was obtained from the patient for publication of this case report and accompanying images.

### Device status/drug statement

The device(s)/drug(s) is/are FDA-approved or approved by corresponding national agency for this indication.

### Competing interests

The authors declare no competing interests.

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