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ORIGINAL RESEARCH

A Novel Transverse Ultrasound-Guided Approach for Puncturing the Cervical Dorsal Root Ganglion at the Level of Articular Pillar for Radiofrequency Treatment

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Purpose: Currently, minimally invasive intervention surgery for cervical spondylotic radiculopathy mostly involves the use of cervical dorsal root ganglion (DRG) block or radiofrequency modulation therapy. Here, we proposed a novel transverse ultrasound-guided approach for puncturing the cervical dorsal root ganglion at the level of joint column for radiofrequency treatment.

Patients and Methods: A retrospective analysis of the clinical data of 30 patients with cervical spondylotic radiculopathy admitted to the Pain Department of Taihe Hospital Affiliated with Hubei Medical University from January 2021 to March 2024 was performed. During surgery, motor electrical stimulation was used to induce movement in the nerve-innervated area, and the relationship between the puncture needle tip and the cervical DRG position was verified using a C-arm X-ray machine. The numerical rating scale (NRS) was used for preoperative and postoperative pain assessment, clinical treatment effectiveness was evaluated, surgical duration and the associated complications were also recorded.

Results: Thirty patients exhibited clear cervical DRG images under ultrasound guidance, and the punctures were successful in all patients. Motor electrical stimulation induced movement in the corresponding nerve innervation area in the range of 0.3–0.8 mv in all patients. No serious complications occurred during the procedure.

Conclusion: The transverse ultrasound-guided approach for puncturing the cervical dorsal root ganglion at the level of joint column for radiofrequency treatment is effective, convenient, and safe.

Keywords: ultrasound guidance, neck DRG, cervical spondylotic radiculopathy, pulse RF

Introduction

Cervical spondylotic radiculopathy is a common degenerative disease and a common type of cervical spondylosis. It is caused by changes such as cervical disc herniation, small joint bone hyperplasia, ligament calcification, and carotid atherosclerosis, which can cause nerve root compression or stimulation, leading to a series of functional disorders in the corresponding innervated segments. Conventional treatment methods (including physical therapy, rehabilitation therapy). have difficulty sustaining symptom relief, and most of them lack clear surgical indications.

With the gradual acceptance of minimally invasive intervention therapy for pain, most patients with cervical spondylotic radiculopathy can quickly control or alleviate symptoms through minimally invasive intervention therapy, producing immediate results. The traditional cervical nerve root block through inter-tubercular groove approach involves

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injecting analgesic and anti-inflammatory drugs around the "nerve root". In fact, only a small amount of injectate penetrates down the "nerve root" into the intervertebral foramen and reaches the origin generating pain.

By improving the local blood circulation of the nerve root and reducing inflammatory edema of the nerve root, thereby improving the inflammatory environment around the nerve root and blocking the transmission of pain signals, pulsed radiofrequency weakens pain perception. Multiple studies have shown that the efficacy of pulsed radiofrequency is significantly better than that of simple nerve block therapy.[1,2] The principle of pulsed radio frequency is to generate electric fields and thermal pulses in the target area, which can regulate the expression of relevant genes related to the signal transduction pathways, such as proinflammatory gene expression, to regulate pain more persistently without damaging these tissue structures. It is widely used in the diagnosis and treatment of chronic pain diseases, especially in the treatment of neuropathic pain.[3]

Due to its real-time, dynamic, and nonradiation advantages, ultrasound guidance ensures that minimally invasive intervention treatment is safer and more convenient while also reducing radiation exposure for doctors and patients.[4,5] With the widespread application of ultrasound-guided cervical spondylosis, various puncture methods have emerged, usually involving the use of intertubercular groove approach for cervical nerve anterior branch block or radiofrequency, the treatment effect is significantly lower than that of dorsal root ganglion radiofrequency therapy. A few scholars have proposed relatively novel dorsal root ganglion puncture methods, some of which have high puncture risks and are difficult to promote on a large scale, while others cannot meet operational requirements.

In this study, a retrospective analysis of the clinical data of 30 patients who were treated at the pain department of our hospital using the transverse ultrasound-guided approach for cervical DRG block at the level of facet joint column combined with pulsed RF was performed to evaluate the effectiveness and safety of this approach for the treatment of cervical spondylotic radiculopathy.

Material and Methods

General Information

This study is a retrospective clinical analysis and has been approved by the Ethics Committee of Taihe Hospital, Hubei University of Medicine (Approval No. 2024KS33). All patients who participated in the retrospective study were anonymous and their case information was kept confidential. Clinical data were retrospectively collected from 30 patients with C4-7 cervical spondylotic radiculopathy who underwent radiofrequency surgery in the pain department between January 2022 and March 2024. The shortest course of the disease was 2 months, and the longest was 20 months, with an average of 11.1 ± 23.1 months. Among them, there were 12 males and 18 females, with the oldest being 79 years old and the youngest being 34 years old, with an average age of 55.7 ± 10.8 years. All patients signed informed consent forms before surgery, fully informing them of the significance of this study and postoperative precautions.

The inclusion criteria for patients were as follows: typical signs of cervical spondylotic radiculopathy, a detailed physical examination, and an imaging examination that supported the diagnosis of cervical spondylotic radiculopathy. All patients underwent spinal surgery consultation before undergoing radiofrequency surgery, and there were no surgical indications or refusal of surgery. All patients had no obvious mental or psychological disorders and could cooperate throughout the experiment and follow-up. All patients with pain caused by peripheral neuropathy or compression were excluded.

The exclusion criteria for patients were as follows: comorbid mental or psychological disorders and inability to express their feelings clearly; severe cardiovascular and pulmonary dysfunction; and cancer. Patients who refused minimally invasive intervention treatment were excluded.

Procedure

The Localization of Cervical Nerve Segments Under Ultrasound

We mainly use ultrasonic positioning and C-arm X-ray machine to confirm the needle tip position. The C-arm X-ray machine also helps us verify the cervical spine segment that was punctured. The corresponding segment can be determined based on the ultrasound imaging characteristics of bony landmarks of the cervical transverse processes.

The C7 transverse process (TP) had no anterior nodule. The anterior and posterior nodules of the C6 TP were very obvious, with the anterior nodule being superior to the posterior nodule forming a U-shaped shape. The groove between C5 nodules was at a wide right angle, and the anterior and posterior nodules were the same height. The groove between C4 nodules was a "V" shape, with the anterior branch of the cervical nerve running in the groove. The structure of the groove between C3 nodules was observed when sliding the probe cranially. An ultrasound machine (mindray L15-3WU) and an 8–12 MHz high-frequency linear array probe were used for this procedure. The patient with the Cosman RFG-4 radiofrequency ablation therapy device was placed in a lateral position, with a round pillow placed on the neck so that the cervical spine was in an extended position. The probe was scanned transversely from the caudally side to the cranial side until the ideal scan section of articular pillar was present. Generally, when the interface where the anterior and posterior nodules had just disappeared, the ultrasound imaging of articular pillar would be visualized. Ultrasound-guided localization was performed using a marker pen to mark the puncture path and insertion point.

Ultrasound-Guided Cervical DRG Block and Radiofrequency

With routine disinfection and draping, an ultrasound probe coated with a coupling agent wrapped in sterile gloves was used. Then, the local anesthesia (2.5 mL of 2% lidocaine hydrochloride+2.5 mL of 0.9% sodium chloride) was performed at the lateral side of the probe (Figures 1 and 2). Notably, local anesthesia should not be injected too deeply; only subcutaneous infiltration anesthesia should be used to avoid affecting subsequent electrical stimulation. Then, a radiofrequency puncture needle (16G, 10 cm, bare end 5 mm) was inserted in-plane with the lateral-medial direction. During the puncture process, the probe was fixed so that the joint column was in the center of the field of view while also displaying the anterior vascular structure and keeping the puncture needle path clearly displayed in the ultrasound scanning section. The puncture needle first reached the lower part of the facet joint column (at the position of the common branch of the posterior branch of the cervical nerve) for motion testing. The corresponding shoulder and back motion response was induced using a motion test within 0.6 mv (2 hz, 1 ms). High-voltage long-term (3 hz, 30 ms) pulse modulation can be used at this location to address the patient's back pain and stiffness. The needle was inserted forward to reach the junction between the TP root and the facet joint column. When a breakthrough sensation occurred, the needle was not inserted, and physiological saline was used to separate and verify the position of the needle tip. If saline spreads in front of the joint column and wraps around the nerve root, the puncture needle will cross the waist part of the joint column and reach the vicinity of the DRG (Figure 3). Exercise testing was conducted using a motion test within 0.6 mv (2 hz, 1 ms). If pain is replicated in the nerve root innervated area, it is indicated that the radiofrequency needle reached the DRG. Subsequently, a high-voltage long-term pulsed radiofrequency was applied for 180 s. At this time, a C-arm X-ray scan was used to verify the position of the needle tip and the relationship between the needle tip and the DRG position. Five milliliters of anti-inflammatory and analgesic solution (2 mL drawn, 20 mg of methylprednisolone, diluted to 10 mL with physiological saline) was slowly injected afterwards, and attention was given to the multiple injection sites.

Figure 1 (**A**) Scanning transverse process level. (**B**) Scanning transverse process head-side movement to the lumbar level of the joint column (nodules disappear after the transverse process and joint column are clear). (**C**) The location of the ultrasound probe.

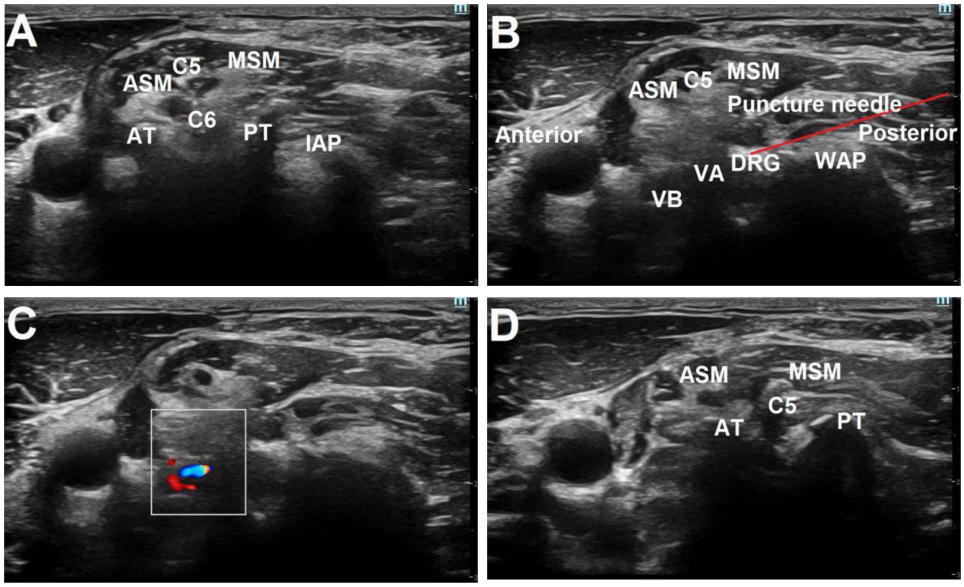

Figure 2 Scanning transverse process level, you can find C5 Anterior branch of nerve root (C5), C6 anterior branch of nerve root (C6), Anterior tuberosity (AT), posterior tuberosity (PT), Anterior scalene muscle (ASM), Middle scalene muscle (MSM) and inferior articular process (IAP). (**A**) Scanning transverse process head-side movement to the lumbar level of the joint column (nodules disappear after the transverse process and joint column are clear), you can find Dorsal root ganglion (DRG), Hooked process of vertebral body (VB), vertebral artery (VA) and the waist of the articular pillar (WAP). The red line indicates the insertion path of the puncture needle. (**B**) and (**C**) Continue to move the probe towards the head side to display the structure (**D**).

Figure 3 Projection verification of the puncture needle position via the arm X-ray machine. (**A**) On the ipsilateral oblique view, the needle tip reaches the anterior edge of the C5–C6 small joint column at the waist (posterior main branch). (**B**) On the same side oblique view, the needle tip slides over the anterior edge of the C5-C6 small joint column at the waist (dorsal root ganglion). (**C**) In the side view, the needle tip is located on the dorsal side of the tail between the C5 and C6 transverse processes.

Results

Thirty patients underwent successful puncture through the facet joint column approach, and all elicited corresponding motor responses within 0.8 mmv. Among them, one patient was verified to have a puncture needle tightly attached to the DRG under C-arm X-ray (Figure 3), 25 patients had a clearly display of the DRG of the neck, and 5 patients had poor visualization of neck DRGs on ultrasound images. After electrical stimulation with a radiofrequency ablation instrument, the DRG was confirmed to be reached in each patient.

The pain in all 30 patients significantly relieved on the second day after surgery. After treatment, the NRS scores of patients at all time points were significantly lower than those before treatment. The NRS scores of patients before treatment and on the second day, 1 week, and 8 weeks after treatment were 6.0 ± 1.7, 2.8 ± 1.1, 1.6 ± 1.1, and 1.3 ± 0.8, respectively. Compared with the NRS scores before treatment, the differences were statistically significant ($P<0.01$, see

Table 1 Comparison of Pain Scores for Pain Relief at Different Time Points (x ± SD)

	Before Treatment	On the Second Day After Surgery	1 week After Surgery	4 weeks After Surgery
NRS score	6.0±1.7	2.8±1.1	1.6±1.1	1.3±0.8

Notes: $P < 0.01$, compared to preoperative.

Tables 1 and 2). The puncture time ranged from 10–16 minutes, with an average of 13.1 ± 1.1 minutes, as shown in Table 3.

During the procedure, there was no nerve injury, hematoma, breathing difficulties, bradycardia, or other serious complications. In two patients, there was a difficulty adjusting the puncture needle due to the insertion site was too lateral, resulting in the needle tip being above the DRG. After the insertion site was adjusted again, the puncture was successful.

Discussion

In this study, all 30 patients were successfully punctured, and there were no complications such as nerve injury, bleeding, or drug ingestion into the blood vessels during surgery. Pain improved significantly on the second day, one week, and eight weeks after surgery, and the radiofrequency efficacy was significant. During surgery, C-arm X-ray was used to verify the anatomical position of the dorsal root ganglion adjacent to the puncture needle tip.

The treatment methods for cervical spondylotic radiculopathy include minimally invasive intervention, physical therapy, traditional Chinese medicine treatment, and surgical intervention. Among them, our minimally invasive interventional treatment method holds an important position. The cause of cervical spondylotic radiculopathy is nerve root compression or inflammation, leading to hyperalgesia and pain hypersensitivity. The dorsal root ganglion is the primary sensory center, so minimally invasive interventions such as nerve block and further radiofrequency therapy on the proximal nerve root or dorsal root ganglion can achieve better and more lasting analgesic effects. Previous studies have often used C-arm X-ray or CT guidance to block and radiofrequency the cervical dorsal root ganglia, confirming the effectiveness of this technique in treating nerve root type cervical spondylosis or cervical nerve root lesions.[6–8] However, C-arm X-ray guided and CT guided treatments generally require special surgical or operational rooms, and sometimes even the support of imaging teams. The above-mentioned instrument guided puncture methods have high requirements for the operator's level, and there is also ionizing radiation damage. In recent years, ultrasound guidance has become a new assistant for minimally invasive treatment in pain departments at all levels of hospitals[9] due to its advantages such as no radiation, real-time dynamic display, and clear display of anatomical structures. Scholars are constantly improving ultrasound-guided puncture methods, attempting to intervene in the proximal nerve root or dorsal root ganglion. Among all the methods reported so far, we have found that these puncture methods have certain issues. Scholars have proposed that puncturing the dorsal root ganglion from the front of the patient's neck carries a risk of damaging large blood vessels in the neck, requiring experienced operators, making it difficult to promote on a large scale, especially in primary hospitals. Some scholars suggest using a lateral approach to puncture the dorsal root ganglion from the head to the tail of the intervertebral foramen. However, we noticed that the cervical dorsal root nerve is located at the tail and posterior side of the intervertebral foramen, making it difficult to reach the dorsal root ganglion. The head of the intervertebral foramen is mainly composed of connective tissue and venous plexus, and puncture increases the risk of bleeding. At present, ultrasound-guided treatment of cervical dorsal root ganglia mostly uses needle insertion through the intertubercular groove. In fact, it is difficult to reach the anatomically significant dorsal root ganglia through the intertubercular groove approach. The intervention is on the anterior branch of the cervical nerve, and only a small amount of medication can reach the dorsal root ganglia through simple injection. The treatment effect is not as good as the true dorsal root ganglia, and there is a risk of nerve damage.[10] Scholars have reported that using ultrasound-guided lateral approach for radiofrequency in the dorsal root ganglia can indeed reach the cervical dorsal root ganglia. However, this method requires high manual and tactile requirements for the operator, and there is a risk of injury to the nerve root sleeve, spinal cord, and important blood vessels due to excessive puncture depth. Based on the above clinical situation, it is necessary to design

Table 2 Patient Basic Information and Clinical Parameters

Case No.	Gender / Age (Year)	Pain Duration (Months)	Occupation	Concomitant Diseases		Pre-Treatment	Post-Treatment 1, Day	Post-Treatment1, Weeks	Post-Treatment8, Weeks
1	39	1.0	Office worker	None	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	Loxoprofen sodium 60 mg. po.bid	None	None
					NRS scores	8	4	5	3
2	73	36.0	Retiree	Diabetes	Treatment	Loxoprofen sodium 60 mg. po.bid	None	None	None
					NRS scores	3	3	2	0
3	57	0.2	Office worker	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.bid	Loxoprofen sodium 60 mg. po.bid	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	4	3	3	2
4	50	12.0	Office worker	None	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	4	2	3	3
5	57	12.0	Office worker	Diabetes	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	Loxoprofen sodium 60 mg. po.bid	None	None
					NRS scores	8	4	3	0
6	75	12.0	Retiree	Diabetes	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Tramadol Hydrochloride Tablets 50 mg.po.tid	None
					NRS scores	3	0	4	1

7	60	36.0	Retiree	Hypertension and Diabetes	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	Loxoprofen sodium 60 mg. po.qd	Loxoprofen sodium 60 mg.po.bid	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid
					NRS scores	9	3	6	8
8	65	6.0	Retiree	Diabetes	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	None	Loxoprofen sodium 60 mg.po.bid	Loxoprofen sodium 60 mg. po.qd
					NRS scores	7	2	4	3
9	51	12.0	Teacher	None	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	Loxoprofen sodium 60 mg. po.bid	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	8	4	3	2
10	53	12.0	Office worker	None	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	Loxoprofen sodium 60 mg. po.qd	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	5	3	4	1
11	66	0.6	Retiree	Diabetes	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	None	None	None
					NRS scores	5	2	3	2
12	50	6.0	Teacher	Hypertension and Diabetes	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	Loxoprofen sodium 60 mg. po.bid	None	Loxoprofen sodium 60 mg. po.qd
					NRS scores	9	3	2	3

(*Continued*)

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Table 2 (Continued).

Case No.	Gender / Age (Year)	Pain Duration (Months)	Occupation	Concomitant Diseases		Pre-Treatment	Post-Treatment 1, Day	Post-Treatment1, Weeks	Post-Treatment8, Weeks
13	56	120.0	Office worker	Diabetes	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	None	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	5	2	3	2
14	49	36.0	Office worker	Hypertension	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	Loxoprofen sodium 60 mg. po.bid	None	None
					NRS scores	6	3	2	0
15	60	0.6	Retiree	None	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	None	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	5	2	4	1
16	49	0.2	Doctor	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.tid	Loxoprofen sodium 60 mg. po.qd	None	Loxoprofen sodium 60 mg. po.qd
					NRS scores	5	3	2	3
17	39	1.0	Doctor	None	Treatment	Loxoprofen sodium 60 mg. po.bid	None	None	None
					NRS scores	4	2	0	2
18	52	6.0	Office worker	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.bid	None	None	None
					NRS scores	6	0	2	1

19	42	1.0	Farmer	None	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	None	None	None
					NRS scores	5	0	1	2
20	71	0.2	Retiree	Diabetes and coronary heart disease	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Tramadol Hydrochloride Tablets 50 mg.po.bid	None
					NRS scores	5	2	3	0
21	57	5.0	Office worker	Diabetes	Treatment		None	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	9	1	3	1
22	47	1.0	Office worker	None	Treatment	Oxycodone 5mg-acetaminophen 325mg Tablets.po.tid	None	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	9	2	3	2
23	34	2.0	Farmer	None	Treatment	Tramadol Hydrochloride Tablets 50 mg.po.bid	None	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	5	0	4	1
24	79	1.0	Retiree	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Tramadol Hydrochloride Tablets 50 mg.po.bid	None
					NRS scores	6	1	3	3

(*Continued*)

https://doi.org/10.2147/JPR.S479986

Table 2 (Continued).

Case No.	Gender / Age (Year)	Pain Duration (Months)	Occupation	Concomitant Diseases		Pre-Treatment	Post-Treatment 1, Day	Post-Treatment1, Weeks	Post-Treatment8, Weeks
25	50	0.2	Office worker	Diabetes	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Loxoprofen sodium 60 mg.po.bid	None
					NRS scores	5	2	4	2
26	50	2.0	Farmer	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.tid	None	None	None
					NRS scores	4	0	2	1
27	59	1.0	Office worker	None	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	7	1	3	0
28	54	6.0	Office worker	None	Treatment	Loxoprofen sodium 60 mg. po.bid	None	Loxoprofen sodium 60 mg.po.qd	None
					NRS scores	6	2	3	2
29	68	0.5	Farmer	Hypertension	Treatment	Loxoprofen sodium 60 mg. po.bid	None	None	None
					NRS scores	3	2	1	2
30	59	6.0	Farmer	None	Treatment	Loxoprofen sodium 60 mg. po.bid	None	None	None
					NRS scores	7	2	2	5

Table 3 Comparison of Surgical Duration Among Patients

	10–12 min	12–14 min	14–16 min	More than 16 min
Number of patients	4	22	3	1

a puncture method that can accurately puncture the position of the cervical dorsal root ganglia, and is easy to operate, master, and promote clinically.

Due to the fact that the cervical 3 to cervical 7 dorsal root ganglia are located on the posterior one-third of the intervertebral foramen and lean towards the dorsal side, there is more loose connective tissue and blood vessels on the head side of the intervertebral foramen. When puncturing from the head side of the cervical intervertebral foramen through a lateral approach, it not only deviates from the dorsal root ganglia but also increases the risk of puncture bleeding. This study used a lateral position, posterior approach, and puncture towards the caudal part of the intervertebral foramen. This not only makes it easy to reach the location of the dorsal root ganglion, reduces the risk of vascular puncture, but also achieves "one stone, three birds". Firstly, the puncture reaches the lower back of the joint column and can be performed with posterior medial branch block and radiofrequency; Continue to insert the needle to the junction of the upper edge of the transverse process root and the joint column, and perform posterior main branch block and radiofrequency; Slide over the anterior edge of the joint column, which enters the caudal part of the intervertebral foramen. Cervical dorsal root ganglion block can be performed here. If dorsal root ganglion radiofrequency is performed, sensory and motor tests can be performed, and the needle tip position can be fine tuned to ensure it is adjacent to the dorsal root ganglion. Continue to insert the needle as deep as possible within 3–5mm to avoid damaging the dorsal root ganglion and the anterior vertebral artery. This study adopts a brand new puncture pathway, which has the following advantages. Firstly, puncture from the lower part of the joint column is safer. From an anatomical perspective, needle insertion at this location can minimize damage to the vertebral artery and dorsal root ganglia. When sliding over the lower part of the joint column during the needle insertion process, there will be a very obvious sense of emptiness. By injecting physiological saline to check whether it wraps around the dorsal root ganglion, the needle tip position can be verified to be in place, and by retracting, it can be confirmed whether the vertebral artery is damaged; Secondly, under real-time ultrasound guidance, when reaching the lower back of the joint column, radiofrequency can be performed on the posterior medial branch of the cervical nerve at this position. When reaching the upper edge of the transverse process root and the junction of the joint column, radiofrequency can be performed on the main branch of the posterior cervical nerve, crossing the upper edge of the transverse process root and the junction of the joint column, and then reaching the posterior side of the intervertebral foramen. At this point, radiofrequency can be performed on the dorsal root ganglion; Finally, the approach from the posterior to anterior through the lumbar joint column, with the needle tip perpendicular to the dorsal root ganglion, not only reduces the risk of injury to the dorsal root ganglion and penetration of the dural sac, but is also more suitable for pulse radiofrequency requirements.

In this method of puncture, attention should be paid to avoiding excessive puncture that may cause damage to the vertebral artery and nerves. Before surgery, carefully scan the puncture target area, design the puncture line, and during the operation, place the lumbar part of the joint column, vertebral artery, and dorsal root segment in the center of the field of view. After touching the bone surface of the lumbar part of the joint column, use physiological saline to verify the position of the needle tip. Repeatedly confirm that the needle tip is in the lumbar part of the joint column, where posterior branch shooting frequency can be performed. Under ultrasound scanning, the position relationship between the dorsal root ganglion and the vertebral artery was confirmed again. When sliding over the joint column, a sense of emptiness appeared in the lower back. Physiological saline was used to separate the dorsal root ganglion, which can reduce nerve irritation. Connect sensory and motor electrical stimulation, and slowly insert the needle according to the patient's response until the patient's usual pain is replicated. It should be noted that the depth of needle insertion should be strictly controlled at this time to avoid damaging nerves and vertebral arteries.

This study also has certain limitations. It is a retrospective study with a small sample size and relatively single evaluation indicators. In the future, we plan to further evaluate the advantages of this puncture method by increasing the

sample size, increasing evaluation indicators, setting up a control group, and extending follow-up time. Secondly, the patients in this study were all operated by experienced physicians, and it cannot be ruled out that the occurrence of complications and poor efficacy may be due to the lack of operator experience.

Abbreviations

DRG, dorsal root ganglion; NRS, numerical rating scale.

Data Sharing Statement

We agree to share all the data for this article. The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics Approval and Informed Consent

This study is a retrospective clinical analysis and has been approved by the Ethics Committee of Taihe Hospital, Hubei University of Medicine (Approval No. 2024KS33).

Consent for Publication

We all agree to share all the data for this article. The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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