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Selective Nerve Block-Guided Unilateral Biportal Endoscopic Bilateral T10 Rhizotomy for Refractory Intercostal Neuralgia Caused by Cement Leakage after Percutaneous Vertebroplasty: A Case Report and Literature Review

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Case Report

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Abstract

Background: Symptomatic cement leakage after percutaneous vertebroplasty (PVP) is uncommon but may cause severe radicular pain or neurological deficits when the leaked cement involves the spinal canal or neural foramen. Thoracic foraminal cement leakage presenting as refractory intercostal neuralgia is particularly rare, and identifying the responsible nerve root can be challenging when multiple adjacent foramina are involved.

Case presentation: An 83-year-old woman underwent PVP for fresh osteoporotic compression fractures of T10 and L5. Her preoperative low back pain resolved completely after PVP; however, she immediately developed severe bilateral intercostal neuralgia radiating from the costal arches to the periumbilical region, with a visual analog scale score of 8. Computed tomography showed cement leakage into the bilateral T9/10 and T10/11 foraminal regions. Because imaging alone could not reliably determine the symptomatic level, staged bilateral selective nerve block was performed. Bilateral T9/10 foraminal block did not relieve the pain, whereas bilateral T10/11 foraminal block produced marked pain relief, indicating that the bilateral T10 nerve roots were responsible. After failed conservative treatment, unilateral biportal endoscopic bilateral T10 nerve root transection was performed. Intraoperatively, only a limited amount of cement that obstructed nerve root exposure was removed, followed by targeted transection of the bilateral T10 nerve roots under endoscopic visualization. The patient's intercostal neuralgia resolved immediately after surgery, and no recurrence or major surgery-related complication was observed at the 3-month follow-up.

Conclusion: In patients with symptomatic cement leakage after PVP, imaging findings may not always correspond to the responsible pain-generating level, especially when multiple adjacent foramina are involved. Selective nerve block may provide useful functional evidence for identifying the symptomatic nerve root. For carefully selected patients with refractory thoracic radicular pain, unilateral biportal endoscopic nerve root transection may represent an individualized salvage option when complete cement removal is unnecessary or associated with excessive surgical risk. However, because nerve root transection is irreversible, strict patient selection, reliable localization, adequate risk assessment, and informed consent are essential.

Introduction

Osteoporotic vertebral compression fractures (OVCFs) are among the most common fragility fractures in elderly patients and may lead to persistent back pain, reduced mobility, and markedly impaired quality of life [1]. Percutaneous vertebroplasty (PVP), which involves injection of polymethylmethacrylate (PMMA) bone cement into the fractured vertebral body to restore vertebral stability and relieve pain, has become an important minimally invasive treatment for OVCFs [2, 3]. Although PVP is generally safe and effective, cement leakage remains one of the most common procedure-related complications. Recent systematic reviews have reported radiographic cement leakage rates of 20%-40%, although most cases are clinically asymptomatic [4, 5]. When cement enters the spinal canal, lateral recess, or neural foramen, however, it may compress neural structures and cause radicular pain, sensory disturbance, or even neurological deficits [6, 7].

Symptomatic cement leakage is uncommon, but once neural structures are involved, further surgical intervention may be required [6, 8]. Foraminal cement leakage is particularly clinically relevant because of the limited anatomical space within the neural foramen; even a small amount of cement may compress the exiting nerve root and result in refractory neuropathic pain [7, 9]. Thoracic foraminal cement leakage is even rarer. Its clinical manifestations mainly include intercostal neuralgia or thoracoabdominal radiating pain along the corresponding thoracic nerve segment, which can be confused with visceral disorders, postherpetic neuralgia, or other types of neuropathic pain, thereby increasing diagnostic difficulty [6, 10]. In addition, when cement leakage is present at multiple adjacent levels, imaging findings and clinical symptoms may not always correspond precisely, and CT or MRI alone may be insufficient to determine the responsible level.

Selective nerve block (SNB) is an important diagnostic tool for radicular pain. By temporarily blocking conduction of the suspected nerve root, SNB can help localize the responsible nerve and guide subsequent surgical planning. However, reports regarding the use of SNB to identify the symptomatic level in patients with cement leakage after PVP remain limited, particularly for thoracic nerve root involvement [11].

For patients with symptomatic cement leakage requiring surgical intervention, conventional open decompression and cement removal can effectively relieve neural compression but are often associated with greater soft-tissue injury and perioperative risk [6, 8]. With advances in spinal endoscopy, percutaneous endoscopic surgery has increasingly been used to treat symptomatic cement leakage and has shown favorable clinical outcomes [12, 13]. Unilateral biportal endoscopy (UBE) combines a high-definition endoscopic view with the use of conventional spinal instruments, allowing precise decompression and nerve management with limited surgical trauma. It has been widely applied in degenerative spinal disorders and nerve root decompression [14, 15]. Nevertheless, reports on UBE for foraminal cement leakage after PVP remain scarce, and the use of UBE-assisted thoracic nerve root transection for refractory intercostal neuralgia is even more rarely described.

Here, we report an elderly patient who developed bilateral refractory intercostal neuralgia after PVP. Preoperative imaging showed cement occupying the bilateral T9/10 and T10/11 neural foramina. After the responsible level was identified by SNB, bilateral T10 nerve root transection was performed under UBE guidance, leading to immediate postoperative pain relief and satisfactory follow-up outcomes. We also review the relevant literature to discuss the diagnostic approach and minimally invasive surgical strategy for symptomatic cement leakage, with the aim of providing a reference for the management of similar cases.

1 Case Presentation

1.1 Patient information

An 83-year-old woman was admitted on September 7, 2022, because of low back pain for 2 days. She had no obvious history of trauma. Lumbar flexion and extension were markedly limited, and obvious tenderness and percussion pain were present over the thoracolumbar and lower lumbar spinous processes and interspinous spaces. Sensation, muscle strength, and muscle tone in both lower limbs were normal, with no lower-limb radiating pain or pathological reflexes.

The patient had a history of multiple OVCFs and previous PVP procedures: PVP for an L2 vertebral fracture in June 2015, PVP for an L1 vertebral fracture in February 2019, PVP for T11 and T12 vertebral fractures in December 2019, and PVP for an L3 vertebral fracture in November 2021.

After admission, thoracolumbar MRI showed compression deformities and reduced vertebral height at T10 and L5. Fat-suppressed sequences demonstrated obvious high-signal bone marrow edema in both vertebral bodies, suggesting fresh osteoporotic vertebral compression fractures of T10 and L5. Previous fractures and postoperative cement augmentation changes were noted from T11 to L3 (Fig. 1). Laboratory tests showed hemoglobin 114 g/L, C-reactive protein 44.61 mg/L, erythrocyte sedimentation rate 33 mm/h, albumin 37.5 g/L, serum potassium 3.96 mmol/L, serum sodium 136.1 mmol/L, and serum calcium 2.33 mmol/L. Based on the clinical symptoms, physical findings, and imaging manifestations, the patient was diagnosed with osteoporotic compression fractures of T10 and L5 with multilevel post-vertebroplasty changes.

1.2 PVP and postoperative intercostal neuralgia

On September 9, 2022, the patient underwent PVP of the T10 and L5 vertebrae under local anesthesia. Under C-arm fluoroscopic guidance, bilateral transpedicular puncture was performed, and puncture needles were placed into the T10 and L5 vertebral bodies. Approximately 5 mL of PMMA cement was injected into L5, and fluoroscopy showed a small

amount of cement leakage into the cranial intervertebral disc. Approximately 4 mL of cement was injected into T10. During injection, cement leakage toward the posterior vertebral body and neural foramen was observed, and further injection was immediately stopped.

Pain intensity was assessed using a previously published 10-cm visual analog scale (VAS), anchored by 0 for no pain and 10 for the worst imaginable pain [16]. After PVP, the original low back pain resolved completely, and the VAS score decreased from 9 preoperatively to 0. However, severe bilateral intercostal neuralgia developed immediately. The pain radiated in a band-like pattern from the bilateral costal arches along the thoracoabdominal wall to the periumbilical region and was accompanied by numbness in the corresponding area, with a VAS score of 8. Sensation, muscle strength, and muscle tone in both lower limbs remained normal, and no spinal cord injury or lower-limb neurological deficit was observed.

Thoracolumbar CT was performed on September 12, 2022. Coronal, sagittal, and axial images showed posterolateral extension of cement within the T10 vertebral body. Cement was present in the bilateral T9/10 and T10/11 foraminal regions, with part of the cement entering or lying adjacent to the neural foramina and exiting nerve root region (Fig. 2). Based on the timing of pain onset, segmental pain distribution, and CT findings, the newly developed refractory intercostal neuralgia was considered to be related to foraminal cement leakage after PVP. However, because cement occupied the bilateral neural foramina at two adjacent levels, T9/10 and T10/11, imaging alone was insufficient to determine the symptomatic responsible nerve root.

1.3 Selective nerve block for localization of the responsible nerve root

After analgesic, anti-edema, and neurotrophic conservative treatment, the bilateral intercostal neuralgia did not improve, and the VAS score for intercostal neuralgia remained 8. To further identify the responsible level, bilateral segmental SNB was performed under local anesthesia and C-arm fluoroscopic guidance on September 20, 2022.

First, the puncture needles were placed near the bilateral T9/10 foramina, and 1 mL of 1% lidocaine hydrochloride was injected on each side. After injection, the patient was asked to turn over and perform activities that could reproduce the original pain. No obvious relief of bilateral thoracoabdominal radiating pain was observed.

Subsequently, the puncture needles were placed near the bilateral T10/11 foramina, and 1 mL of 1% lidocaine hydrochloride was injected on each side. After the block, the original band-like pain radiating from the bilateral costal arches to the periumbilical region was markedly relieved. Anteroposterior and lateral fluoroscopy confirmed that the needle tips were located near the target foramina bilaterally (Fig. 3). Based on the differential responses after blocking two adjacent levels, the bilateral T10 nerve roots were identified as the symptomatic responsible nerve roots, and the surgical level and nerve management strategy were determined accordingly.

1.4 Surgical technique

The patient had severe pain that was refractory to conservative treatment. CT suggested multilevel bilateral foraminal cement occupation, and SNB further confirmed the bilateral T10 nerve roots as the symptomatic responsible nerve roots. After comprehensive evaluation, bilateral T10 nerve root transection under UBE guidance was planned. The surgical purpose and potential risks, including postoperative local sensory loss, numbness, neuropathic pain, bleeding, infection, dural injury, and neurological deterioration, were fully explained to the patient and her family, and written informed consent was obtained.

On September 25, 2022, the patient was placed in the prone position under general anesthesia. The T10 pedicle and T10/11 foramen were localized using anteroposterior C-arm fluoroscopy. For surface localization, a line parallel to the longitudinal axis of the trunk was drawn 1.5 cm lateral to the tangent line of the outer margin of the T10 pedicle and

defined as line A. A line tangent to the inferior margin of the T10 pedicle was defined as line B, which was perpendicular to the longitudinal axis of the trunk. The intersection of lines A and B was defined as point C. The viewing and working portals were marked 1.5 cm cranial and caudal to point C along line A, respectively (Fig. 4A).

After routine disinfection and draping, approximately 0.5-cm and 1.0-cm skin incisions were made at the viewing and working portal sites, respectively. The soft tissue was sequentially dissected, and the viewing and working portals were established. The bilateral procedures were performed using a mirror-image technique; the main surgical steps are described for one side.

Under continuous saline irrigation, the endoscope and instruments were advanced toward the lateral margin of the T10 lamina and isthmus. Soft tissue obscuring the operative field was removed using an endoscopic radiofrequency electrode, and the lateral margin of the T10 isthmus, the superior articular process of T11, and the target foraminal region were gradually exposed (Fig. 4B). C-arm fluoroscopy was repeated to confirm the responsible level and target point.

A high-speed drill and lamina rongeur were used to remove a limited amount of bone from the lateral margin of the T10 isthmus and part of the T11 superior articular process to enlarge the foraminal working space (Fig. 4C). Endoscopic exploration revealed irregular white cement fragments within the foramen. The cement was densely adherent to the surrounding soft tissue and occupied the region required for nerve root exposure (Fig. 4D). Only a small amount of cement that interfered with surgical field establishment and nerve root exposure was removed; the purpose of surgery was not complete removal of all cement within the foramen.

After partial removal of the obstructing soft tissue and a small amount of cement, the involved T10 nerve root was gradually exposed and identified (Fig. 4E). After confirming the course of the nerve root and its relationship with surrounding tissues, the T10 nerve root was managed and transected proximal to the ganglion to avoid persistent or recurrent postoperative pain caused by residual neural conduction. Complete transection was confirmed endoscopically, meticulous hemostasis was performed, and the operative field was checked to ensure the absence of active bleeding (Fig. 4F). The contralateral T10 nerve root was exposed and transected using the same technique, with corresponding adjustments in the surgeon's position and the directions of the viewing and working portals.

1.5 Postoperative management and follow-up

After recovery from anesthesia, the preoperative bilateral intercostal neuralgia disappeared immediately, and the VAS score for intercostal neuralgia decreased from 8 preoperatively to 0. The patient did not develop lower-limb sensory or motor abnormalities or other new neurological deficits. Routine analgesic, anti-edema, and supportive treatments were administered postoperatively. The incision healed well, and the patient was discharged on postoperative day 4.

During follow-up, the band-like radiating pain from the bilateral costal arches to the periumbilical region did not recur, and the patient's daily activity and quality of life improved markedly. At the final follow-up 3 months after surgery, the VAS scores for both low back pain and intercostal neuralgia were 0, with no pain recurrence, wound infection, cerebrospinal fluid leakage, spinal cord injury, or other serious surgery-related complications. Changes in VAS scores for low back pain and intercostal neuralgia at different treatment stages are shown in Table 1.

Table 1
Changes in VAS scores for low back pain and intercostal neuralgia at different treatment stages

Assessment time point	VAS score for low back pain	VAS score for intercostal neuralgia
Initial admission, before PVP	9	0
New-onset intercostal neuralgia after PVP	0	8
After conservative treatment and SNB localization, before UBE	0	8
Immediately after UBE	0	0
Final follow-up 3 months after surgery	0	0

Note: Pain intensity was assessed using the visual analog scale (VAS), ranging from 0, indicating no pain, to 10, indicating the worst imaginable pain. PVP, percutaneous vertebroplasty; SNB, selective nerve block; UBE, unilateral biportal endoscopy.

The main diagnostic and therapeutic features of this case included bilateral foraminal cement occupation at two adjacent thoracic levels, identification of the symptomatic responsible nerve roots using bilateral segmental SNB, and UBE-guided limited removal of cement that interfered with nerve root exposure followed by bilateral T10 nerve root transection. Representative surgical reports of symptomatic cement leakage and their comparison with the present case are summarized in Table 2.

Table 2
Representative surgical studies of symptomatic cement leakage and comparison with the present case

Author and year	Source and lesion site of cement	Main clinical manifestations	Preoperative diagnosis or localization	Surgical procedure	Cement and nerve management	Clinical outcome
Senturk et al., 2018 [12]	Intraspinal cement leakage after lumbar PVP	Radicular pain and corresponding neurological symptoms	CT combined with clinical symptoms and neurological examination	Minimally invasive translaminar endoscopic surgery	Endoscopic exposure and removal of leaked cement with neural decompression	Marked postoperative relief of radicular symptoms
Wu et al., 2019 [13]	Foraminal cement leakage after lumbar PVP	Lower-limb radiating pain caused by exiting nerve root compression	CT showing foraminal cement occupation and its relationship with the nerve root	Full-endoscopic lumbar foraminoplasty and decompression	Foraminal enlargement and removal of symptomatic cement with nerve root decompression	Marked postoperative relief of radiating pain
Li et al., 2020 [20]	Massive cement leakage from L5 after PKP into the L5/S1 epidural space and spinal canal	Severe low back pain, left lower-limb radiating pain, and muscle weakness	Radiographs and CT showing massive intraspinal cement compressing neural structures	Posterior open decompression	Piecewise removal of epidural and intraspinal cement with neural decompression	Improved radiating pain and neurological function without further deterioration during follow-up
Jing et al., 2021 [6]	Delayed cement leakage after PVP compressing a lumbar nerve root	Delayed onset of low back and leg pain with radicular symptoms	CT showing cement leakage and its relationship with the nerve root	Posterior decompression and cement removal	Removal of cement compressing the nerve root with neural decompression	Marked postoperative relief of radicular pain
Moon et al., 2025 [15]	Cement leakage after cement-augmented pedicle screw fixation causing neural compression	Radicular pain or related neurological symptoms	CT and MRI combined with neurological examination	UBE exploration and neural decompression	UBE-guided management of leaked cement and neural decompression under direct visualization	Improvement of postoperative neurological symptoms
Present case	Cement occupation in the bilateral T9/10 and T10/11 foramina after T10 PVP	Refractory intercostal neuralgia radiating from the bilateral costal arches along the thoracoabdominal wall to the periumbilical	CT showing bilateral foraminal cement occupation at adjacent levels; bilateral T9/10 SNB ineffective;	SNB-guided UBE-assisted bilateral T10 nerve root transection	Limited removal of cement that interfered with nerve root exposure, followed by exposure and transection of the bilateral	Intercostal neuralgia decreased immediately from VAS 8 to 0; no recurrence at 3-month follow-up

Note: PVP, percutaneous vertebroplasty; PKP, percutaneous kyphoplasty; UBE, unilateral biportal endoscopy; VAS, visual analog scale. The studies listed are representative reports of surgical treatment for symptomatic cement leakage rather than all studies included in a systematic review.

Author and year	Source and lesion site of cement	Main clinical manifestations	Preoperative diagnosis or localization	Surgical procedure	Cement and nerve management	Clinical outcome
		region; VAS score 8	bilateral T10/11 block markedly relieved pain		T10 nerve roots	

Note: PVP, percutaneous vertebroplasty; PKP, percutaneous kyphoplasty; UBE, unilateral biportal endoscopy; VAS, visual analog scale. The studies listed are representative reports of surgical treatment for symptomatic cement leakage rather than all studies included in a systematic review.

2 Discussion

2.1 Clinical characteristics and diagnosis of symptomatic cement leakage

Cement leakage is one of the most common procedure-related complications of PVP. Its reported incidence varies considerably depending on the imaging modality, cement viscosity, injection technique, and definition of leakage [4, 5]. Compared with plain radiography, CT is more sensitive for detecting small amounts of cement leakage and delineating its spatial distribution; therefore, CT is more suitable for postoperative assessment of symptomatic cement leakage [7, 9].

Cement may spread through defects in the vertebral cortex, intervertebral disc fissures, basivertebral veins, or segmental veins into the intervertebral disc, paravertebral soft tissue, venous system, spinal canal, lateral recess, or neural foramen. Most cement leakage is asymptomatic. However, when cement enters the spinal canal or neural foramen and directly contacts the spinal cord, dural sac, or nerve root, mechanical compression, local thermal injury, chemical irritation, and secondary inflammatory responses may lead to radicular pain, sensory disturbance, muscle weakness, and, in severe cases, paraplegia [4–8, 17]. Ratliff et al. [17] reported an early case of simultaneous nerve root and spinal cord compression caused by PMMA cement after vertebroplasty, emphasizing that although symptomatic cement leakage is rare, it can cause severe neurological injury.

Cement-related neurological symptoms may occur immediately after surgery or develop in a delayed fashion. Immediate onset is usually associated with direct cement migration into the spinal canal or neural foramen, whereas delayed onset may be related to local inflammation, scar adhesion, cement fragment migration, or continuous neural compression [6]. Therefore, new neurological symptoms after PVP that differ from the preoperative pain in nature, distribution, or provocation pattern should raise strong suspicion for symptomatic cement leakage.

In the present case, the patient mainly had low back pain before PVP and had no intercostal neuralgia. After PVP, the VAS score for low back pain decreased from 9 to 0, indicating effective control of fracture-related pain by vertebral augmentation. However, the patient immediately developed band-like pain radiating from the bilateral costal arches along the thoracoabdominal wall to the periumbilical region, with a VAS score of 8. The nature and distribution of this pain were markedly different from those of the preoperative pain. CT demonstrated posterolateral extension of cement within the T10 vertebral body and cement occupation of the bilateral T9/10 and T10/11 foramina. Based on the timing of symptom onset, thoracic dermatomal distribution, and imaging findings, the new pain was considered to be associated with foraminal cement leakage after PVP rather than the original vertebral fracture pain.

The clinical manifestations of thoracic nerve root involvement differ from those of typical lower-limb radiating pain caused by lumbar nerve root compression. Patients usually present with band-like, burning, stabbing, or electric shock-

like pain along the corresponding intercostal space or thoracoabdominal wall, often with numbness or paresthesia, whereas muscle strength and sensation in the lower limbs may remain completely normal. These symptoms can be confused with postherpetic neuralgia, costochondritis, thoracoabdominal visceral disease, and other neuropathic pain conditions. Therefore, for patients with new segmental thoracoabdominal radiating pain after PVP, the diagnosis should be based on a comprehensive assessment of the medical history, dermatomal distribution, neurological examination, and thin-slice CT multiplanar reconstruction. CT can not only show the location and extent of cement leakage but also evaluate the spatial relationship between the cement and the pedicle, neural foramen, spinal canal, and nerve exit zone, making it an important imaging modality for the diagnosis of symptomatic cement leakage [7, 9].

2.2 Value of selective nerve root block in localization of the responsible level

An imaging abnormality does not necessarily represent the symptomatic responsible level. Elderly patients with OVCFs often have multilevel vertebral fractures, previous vertebral augmentation changes, foraminal stenosis, and degenerative spinal disease. When cement leakage is present at multiple adjacent levels, determining the operative level solely on the basis of cement volume, extent of leakage, or radiographic severity may result in incorrect localization, an unnecessarily expanded surgical field, or residual postoperative symptoms.

Selective nerve root block involves injection of a small amount of local anesthetic around the suspected nerve root to temporarily block its sensory conduction. It can be used to evaluate the causal relationship between an imaging abnormality and the patient's typical pain [11]. If the original pain is markedly relieved or disappears after the block, the corresponding nerve root may be the symptomatic responsible nerve root. If symptoms do not change after a standardized block, the responsible level or other pain sources should be reassessed.

In this case, CT showed bilateral foraminal cement occupation at two adjacent levels, T9/10 and T10/11, and imaging alone could not determine the responsible nerve root. After bilateral T9/10 foraminal block, the original thoracoabdominal pain was not obviously relieved. In contrast, bilateral T10/11 foraminal block markedly reduced the typical pain radiating from the bilateral costal arches to the periumbilical region, supporting the bilateral T10 nerve roots as the symptomatic responsible nerve roots. This segmental and sequential blocking strategy created an internal self-control, reduced intervention at nonresponsible levels, and provided functional evidence for subsequent bilateral T10 nerve root management.

It should be noted that selective nerve root block is not absolutely reliable. In a prospective controlled study, Yeom et al. [18] reported a sensitivity of 57%, specificity of 86%, and accuracy of 73% for diagnostic selective nerve root block, indicating limited diagnostic performance. A systematic review by Beynon et al. [19] also noted that the available studies were few, used inconsistent reference standards, and showed substantial heterogeneity. Spread of local anesthetic to adjacent nerve roots, the epidural space, or paravertebral tissue may cause false-positive results, whereas inaccurate needle placement, insufficient drug volume, severe perineural adhesion, or complex pain sources may lead to false-negative results.

Therefore, selective nerve root block should not be regarded as an independent gold standard for localization of the responsible level. Instead, it should be used as an adjunctive functional verification method in addition to clinical symptoms, dermatomal distribution, and imaging findings. In the present case, a small dose of local anesthetic was used to sequentially block adjacent suspected levels, and changes in the typical pain were compared. This approach may reduce the influence of nonselective drug spread and subjective pain fluctuation. Nevertheless, because no placebo block was performed and the positive result was not repeatedly verified, its localization value should still be interpreted cautiously.

2.3 Treatment strategy for symptomatic cement leakage

Asymptomatic cement leakage usually does not require specific surgical intervention and may be managed with clinical and radiographic follow-up. For patients with mild pain and no progressive neurological deterioration, conservative treatment, including analgesics, anti-inflammatory agents, neurotrophic drugs, short-term corticosteroids, or nerve block, can be attempted initially. When patients develop persistent severe pain, progressive muscle weakness, symptoms of spinal cord compression, or symptoms that fail to improve after standardized conservative treatment, timely surgical intervention should be considered [6, 8].

The primary goals of surgery are to relieve neural compression, control pain, and preserve spinal stability whenever possible. Conventional open laminectomy, foraminotomy, and cement removal can provide adequate exposure and are suitable for patients with extensive cement leakage into the spinal canal, intradural cement leakage, obvious spinal cord or cauda equina compression, or a need for concomitant spinal stabilization [8, 20]. Li et al. [20] reported a patient with massive cement leakage into the L5/S1 spinal canal after PKP who underwent open decompression and epidural cement removal, with marked improvement in radiating pain and neurological function.

However, patients with OVCFs are usually elderly and often have severe osteoporosis and multiple cardiopulmonary comorbidities. Extensive paraspinal muscle stripping and laminectomy or facetectomy during open surgery may increase the risk of intraoperative bleeding, postoperative pain, infection, and iatrogenic instability. Therefore, when cement is relatively localized, the responsible neural structure is clearly identified, and internal fixation is not required, minimally invasive endoscopic surgery has gradually become a viable alternative.

Senturk et al. [12] reported the use of a minimally invasive translaminar endoscopic approach for cement leakage after PVP, with endoscopic visualization, removal of leaked cement, and neural decompression. Wu et al. [13] described full-endoscopic lumbar foraminoplasty for foraminal cement leakage causing exiting nerve root impingement. Chu et al. [21] reported percutaneous endoscopic retrieval of intraspinal cement leakage, with postoperative improvement in pain and neurological function. These studies suggest that in patients with localized cement and a clearly defined target of neural compression, translaminar or transforaminal endoscopic surgery can remove cement and decompress the nerve while reducing soft-tissue injury [12, 13, 21]. Representative studies and their comparison with the present case are summarized in Table 2.

2.4 Rationale for bilateral T10 nerve root transection

The main difference between the present case and most previously reported cases is that the surgical goal was not complete removal of all leaked cement. Instead, after limited removal of cement that interfered with nerve root exposure, bilateral T10 nerve root transection was performed. This individualized strategy was developed after comprehensive consideration of the patient's symptoms, cement distribution, SNB results, and surgical risk.

First, the patient's main clinical problem was bilateral persistent severe intercostal neuralgia rather than spinal cord compression or lower-limb motor dysfunction. CT showed that cement occupied the bilateral T9/10 and T10/11 foraminal regions and was closely related to the surrounding soft tissue and neural structures. If complete removal of all cement had been set as the surgical goal, extensive bilateral foraminoplasty and additional removal of the facet joint and pedicle bone might have been required, thereby increasing the risks of dural injury, nerve traction, bleeding, and postoperative instability.

Second, after bilateral T10/11 foraminal selective nerve root block, the patient's typical thoracoabdominal pain was markedly relieved, suggesting that the bilateral T10 nerve roots played a key role in pain transmission. Therefore, nerve root transection in this case was not performed solely on the basis of radiographic cement occupation. Rather, it was a targeted treatment of the responsible nerve roots aimed at interrupting persistent pain transmission, supported by concordant symptom distribution, CT findings, and functional block results.

Third, thoracic nerve roots differ functionally from lumbosacral nerve roots. The T10 nerve root mainly contributes to sensation in the corresponding thoracoabdominal dermatome and local muscle innervation. Transection may cause local sensory reduction, numbness, or abdominal wall muscle dysfunction but usually does not directly result in major lower-limb motor deficit. For elderly patients with severe pain refractory to conservative treatment whose primary therapeutic goal is relief of refractory neuralgia, transection of the symptomatic thoracic nerve root may be considered an individualized salvage option, provided that informed consent is fully obtained and the responsible nerve root is strictly confirmed.

Nevertheless, nerve root transection is irreversible and should not be considered a routine treatment for symptomatic cement leakage. The indications should be strictly limited to persistent and severe pain; clear imaging abnormalities in the corresponding nerve root region; failure of standardized conservative treatment; a clearly positive response to selective nerve root block; absence of critical limb motor function carried by the involved nerve root; and full patient understanding of the potential risks, including postoperative local numbness, sensory loss, neuroma-related pain, pain recurrence, and abdominal wall functional changes.

In the present case, the VAS score for intercostal neuralgia decreased immediately from 8 to 0 after UBE, and no recurrence was observed at the final follow-up 3 months postoperatively, suggesting that this strategy may be feasible in strictly selected patients. However, the favorable outcome of a single case cannot establish superiority of nerve root transection over cement removal alone, neural decompression, radiofrequency treatment, or neuromodulation. Its long-term safety and scope of application require validation in more cases with longer follow-up.

2.5 Role and technical characteristics of UBE in this case

UBE uses independent viewing and working portals and provides a clear, magnified operative field under continuous saline irrigation. It also allows the use of conventional spinal instruments, such as a high-speed drill, lamina rongeur, nerve dissector, and radiofrequency electrode, thereby combining the visualization advantages of endoscopy with relatively high instrument maneuverability [22, 23]. Compared with uniportal endoscopy limited by a working sheath, UBE allows the viewing direction and instrument trajectory to be adjusted relatively independently and is therefore more suitable for managing irregular, hard cement fragments that are densely adherent to surrounding soft tissue.

Kaneko et al. [14] applied UBE for decompression of radiculopathy after vertebral compression fracture, suggesting that this technique can achieve foraminal and nerve root decompression with limited bony resection. Moon et al. [15] further reported UBE for the management of cement-related neural compression after cement-augmented pedicle screw fixation, indicating its potential application in cement-related complications. Pao et al. [22] summarized the surgical workflow and clinical application of UBE decompression and noted that the independent biportal design facilitates flexible use of conventional spinal instruments. A systematic review by Lin et al. [23] showed favorable early clinical outcomes of UBE for degenerative lumbar disease, although the existing evidence is still mainly derived from retrospective studies and case series, and evidence for its use in special cement-related complications remains limited.

In the present case, UBE had three main roles. First, the magnified endoscopic view helped identify the relationship among foraminal cement, the nerve root, and surrounding soft tissue. Second, the independent working portal facilitated limited foraminal enlargement and removal of a small amount of cement using a high-speed drill and rongeur, thereby creating a safe space for nerve root exposure. Third, T10 nerve root dissection and transection could be performed under direct visualization, reducing blind traction and unintended injury to nontarget tissues.

Thus, the core value of UBE in this case was not complete removal of leaked cement but adequate and clear exposure of the nerve root with limited tissue injury, followed by precise targeted nerve management. For bilateral lesions, the surgeon can treat the responsible nerve root on each side using bilateral mirror-image portals, avoiding extensive bilateral paraspinal muscle stripping associated with conventional open surgery.

UBE is not risk-free. Reported complications include dural tear, epidural hematoma, nerve root injury, inadequate decompression, infection, and postoperative segmental instability [23, 24]. The thoracic neural foramen is narrower than the lumbar foramen and is adjacent to the spinal cord, dura, segmental vessels, and pleura, leaving a limited margin for error. When using a drill to remove bone or cement, the instrument tip should always remain within the endoscopic field of view to avoid injury to the nerve, dura, or pleura caused by instrument slippage or cement fragment migration. For cement densely adherent to the nerve root, forced complete removal should be avoided; the primary goal should be safe exposure and completion of the planned nerve procedure.

In addition, appropriate irrigation pressure and unobstructed outflow should be maintained to reduce soft-tissue edema, elevation of epidural pressure, and extravasation of irrigation fluid. Thoracic UBE requires advanced spatial orientation, bimanual coordination, endoscopic anatomical recognition, and complication management skills. It should therefore be performed by a surgical team experienced in both UBE and thoracic spine surgery.

2.6 Differences from previous reports and clinical implications

Previous surgical reports of symptomatic cement leakage have mainly focused on the lumbar spine, and the treatment goal has typically been complete or sufficient cement removal with decompression of the nerve root, cauda equina, or spinal cord [8, 12, 13, 20, 21]. The present case has several distinctive features: bilateral refractory intercostal neuralgia after thoracic PVP; bilateral foraminal cement occupation at two adjacent levels on CT; identification of the responsible nerve roots by bilateral segmental selective nerve root block; and UBE-guided limited removal of obstructing cement followed by bilateral T10 nerve root transection.

This case provides several clinical implications. First, when band-like thoracoabdominal pain with a distribution clearly different from the original low back pain occurs after PVP, thoracic foraminal cement leakage should be suspected and should not simply be attributed to postoperative inflammatory irritation or the primary fracture pain.

Second, radiographic cement occupation does not necessarily indicate the symptomatic responsible level. When abnormalities are present at multiple adjacent levels, surgical planning should integrate the patient's typical dermatomal pain distribution, CT-defined cement location, and selective nerve root block results, rather than relying solely on the most severe radiographic level.

Third, the surgical goal for symptomatic cement leakage should be individualized. When cement is localized and can be safely removed, endoscopic or open decompressive removal should be prioritized. However, when cement is extensive and densely adherent to neural tissue or scar, and complete removal may substantially increase tissue injury, radiographic complete removal should not be pursued mechanically. The surgical strategy should be designed around the patient's primary symptoms and the responsible neural structure.

Fourth, UBE can provide a clear operative view and flexible instrument maneuverability in complex foraminal regions, but its clinical value depends on strict patient selection and surgeon experience. Nerve root transection should be considered only as a salvage option for very few carefully evaluated patients with refractory thoracic radicular pain and should not be extrapolated from this single case as a routine treatment.

2.7 Limitations

This study has several limitations. First, it is a single case report with a limited level of evidence; therefore, it cannot demonstrate that selective nerve root block-guided UBE-assisted nerve root transection is superior to open decompression, uniportal full-endoscopic cement removal, radiofrequency ablation, or other pain interventions.

Second, the diagnostic accuracy of selective nerve root block is limited. Although sequential blocking of adjacent levels and internal self-control were used in this case, no placebo block was performed and the positive result was not

repeatedly verified. Therefore, the influence of local anesthetic spread, subjective pain fluctuation, and placebo effects cannot be completely excluded.

Third, bilateral T10 nerve root transection is irreversible, and large-scale studies of the same etiology and surgical strategy are lacking. Potential long-term risks include local sensory loss, persistent numbness, paresthesia, neuroma-related pain, abdominal wall muscle dysfunction, and pain recurrence. Although pain control was satisfactory at the final follow-up 3 months after surgery, standardized quantitative examination of thoracoabdominal wall sensation, neuropathic pain scales, and abdominal wall muscle function assessment were not performed.

In addition, clinical efficacy was evaluated mainly using the VAS score. Quality of life, sleep quality, analgesic use, and neuropathic pain-related scales were not systematically recorded, and the dimensions of efficacy assessment were therefore limited. Postoperative CT parameters were not used to quantitatively evaluate the residual cement volume, extent of foraminal enlargement, or proportion of the facet joint preserved.

Finally, because the patient was elderly, pain relief may have been influenced by individual pain perception, perioperative medications, and the natural disease course. Future studies should accumulate more cases and extend the follow-up period, with particular attention to pain recurrence, local sensory changes, abdominal wall function, spinal stability, and quality of life. The indications and outcomes of endoscopic decompression with cement removal alone versus nerve root transection should also be compared to further define the clinical boundaries of this technique.

3 Conclusion

Thoracic radicular pain caused by foraminal cement leakage after PVP is rare. When cement occupation is present at multiple adjacent levels, radiographic abnormalities may not completely correspond to the symptomatic responsible level. Segmental selective nerve root block can serve as a supplement to clinical symptoms and imaging findings, providing functional evidence for localization of the responsible nerve root and surgical planning.

For patients with severe pain refractory to standardized conservative treatment and a clearly positive selective nerve root block result, UBE can provide a clear view of the neural foramen and nerve root with limited soft-tissue and bony injury, allowing precise targeted management. In this case, limited removal of cement that interfered with exposure was followed by UBE-guided bilateral T10 nerve root transection. The patient experienced immediate relief of intercostal neuralgia, with no recurrence at the final follow-up 3 months postoperatively.

It should be emphasized that thoracic nerve root transection is an irreversible, individualized salvage treatment and should not be used as a routine strategy for symptomatic cement leakage. Its application should be based on strict patient selection, reliable localization of the responsible nerve root, comprehensive risk assessment, and fully informed consent. The long-term safety, indications, and generalizability of this treatment strategy require further validation in more cases with long-term follow-up.

Abbreviations

CT: Computed tomography

MRI: Magnetic resonance imaging

OVCF: Osteoporotic vertebral compression fracture

PVP: Percutaneous vertebroplasty

PKP: Percutaneous kyphoplasty

PMMA: Polymethylmethacrylate

SNB: Selective nerve block

SNRB: Selective nerve root block

UBE: Unilateral biportal endoscopy

VAS: Visual analog scale

Declarations

Clinical trial number

Not applicable.

Ethics approval and consent to participate

This retrospective study was conducted in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments. The study protocol was reviewed and approved by the Ethics Committee of the Affiliated 960th Hospital of the PLA (Approval No. 2024009). Given the retrospective design and the use of anonymized clinical data, the requirement for informed consent to participate was waived by the Ethics Committee of the Affiliated 960th Hospital of the PLA in accordance with relevant national regulations. No oral consent was required according to the institutional ethical policy.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and any accompanying clinical details and images.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to institutional regulations regarding patient data confidentiality, but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Fuxin Wang and Zheng Zhang contributed equally to this work. Fuxin Wang, Zheng Zhang, and Ruoxian Song designed the study. Xin Xu, Le Shen and Xinmei Li collected the clinical and imaging data. Fuxin Wang analyzed and interpreted the clinical data and drafted the manuscript. Zheng Zhang participated in imaging review and data verification. Xin Xu and Le Shen contributed to clinical data management, figure preparation, and manuscript organization. Ruoxian Song supervised the study, critically revised the manuscript, and approved the final version for submission. All authors read and approved the final manuscript.

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Figures

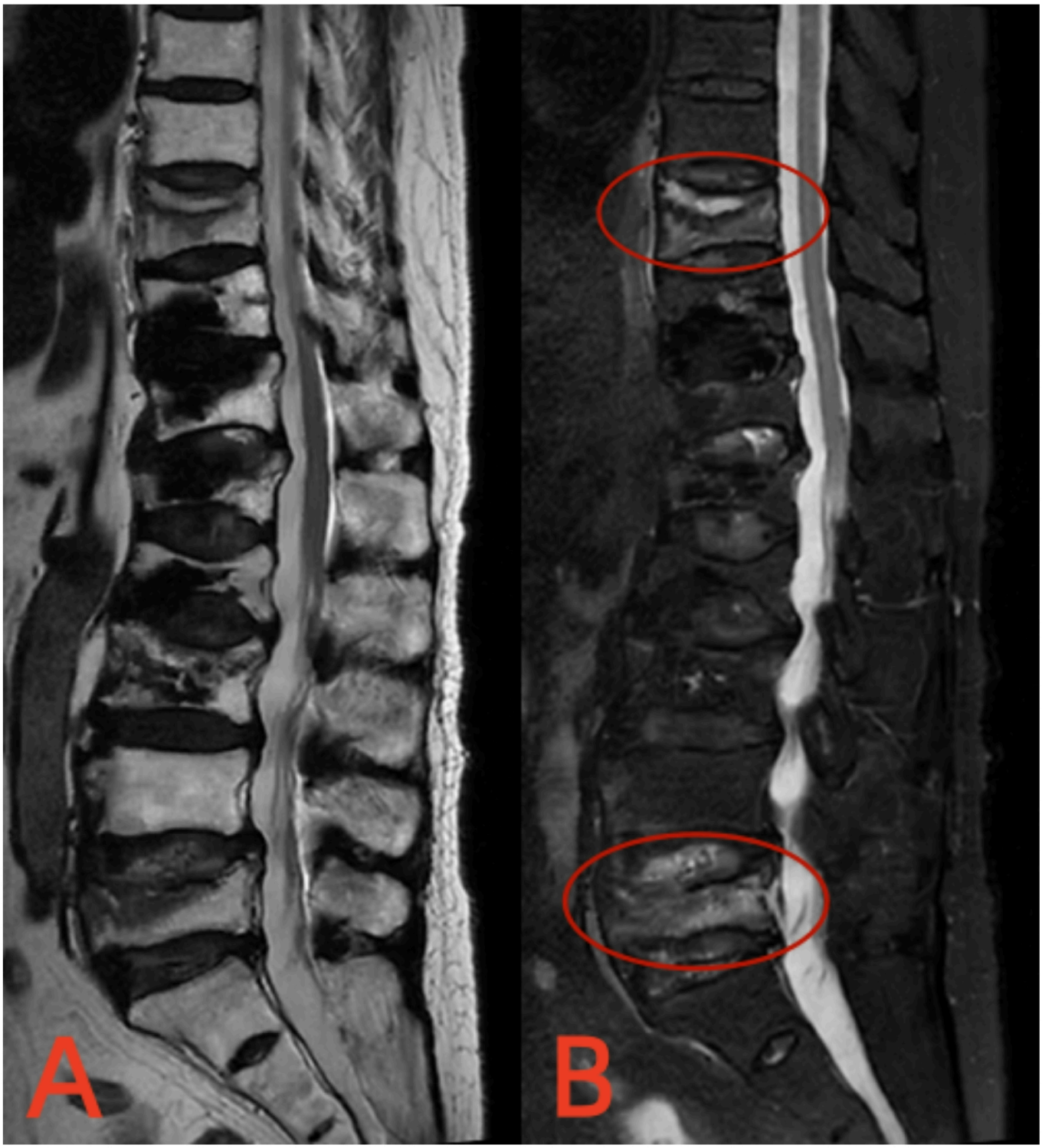


Figure 1

Preoperative magnetic resonance imaging showing fresh osteoporotic compression fractures of the T10 and L5 vertebrae.

(A) Sagittal T2-weighted image showing compression deformity and decreased vertebral body height at T10 and L5. (B) Sagittal fat-suppressed T2-weighted image showing high-signal bone marrow edema in the T10 and L5 vertebral bodies, indicating fresh osteoporotic vertebral compression fractures.

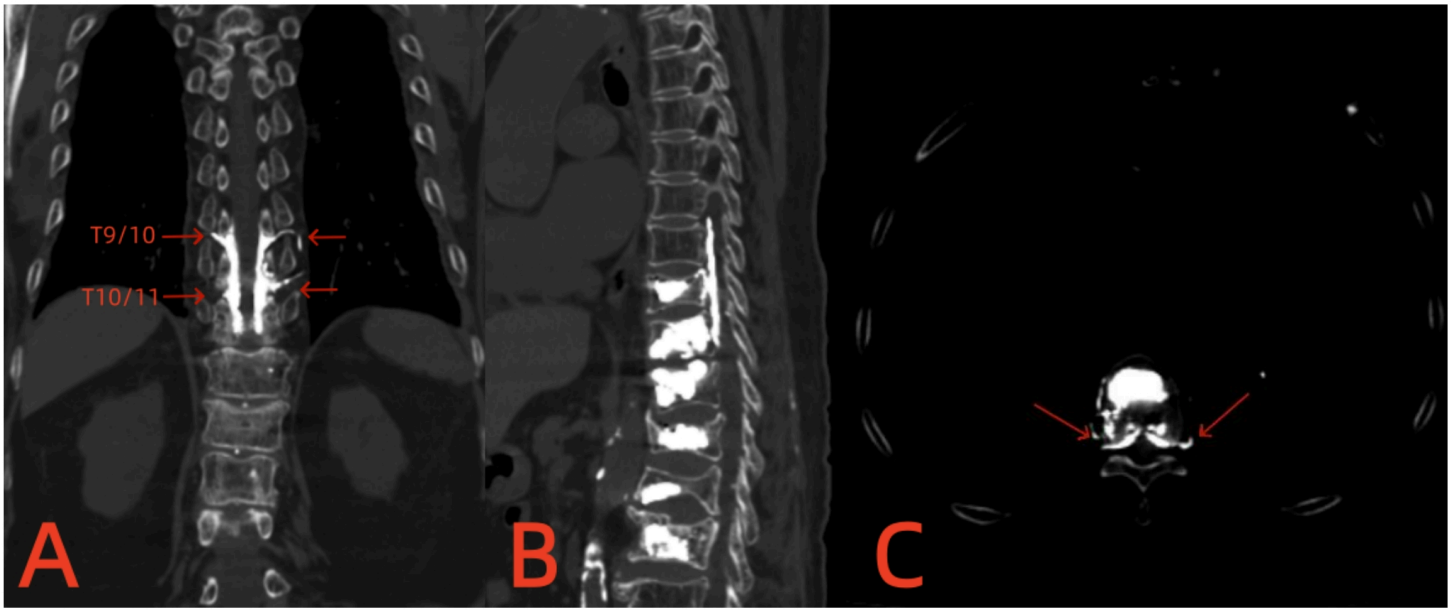


Figure 2

Postoperative CT after percutaneous vertebroplasty showing cement leakage into the bilateral foraminal regions.

(A) Coronal CT reconstruction showing cement distribution within the T10 vertebral body and extension of cement into the bilateral T9/10 and T10/11 foraminal regions; arrows indicate the leakage sites. (B) Sagittal CT reconstruction showing cement within the T10 vertebral body and its extension toward the posterior vertebral body and neural foramen. (C) Axial CT image showing cement adjacent to and entering the bilateral foraminal regions; arrows indicate bilateral cement leakage.

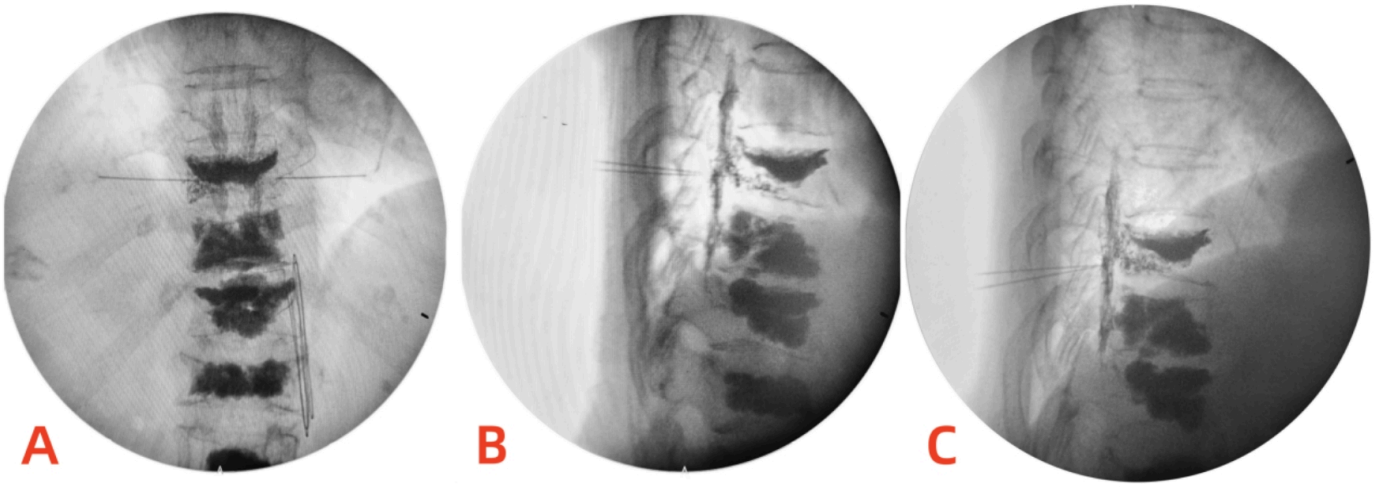


Figure 3

Fluoroscopy-guided bilateral selective block of the target thoracic nerve roots.

(A) Anteroposterior fluoroscopy showing the bilateral needle tips located near the target thoracic foramina. (B, C) Lateral fluoroscopy further confirming the spatial relationship between the needle tips and the corresponding neural foramina.

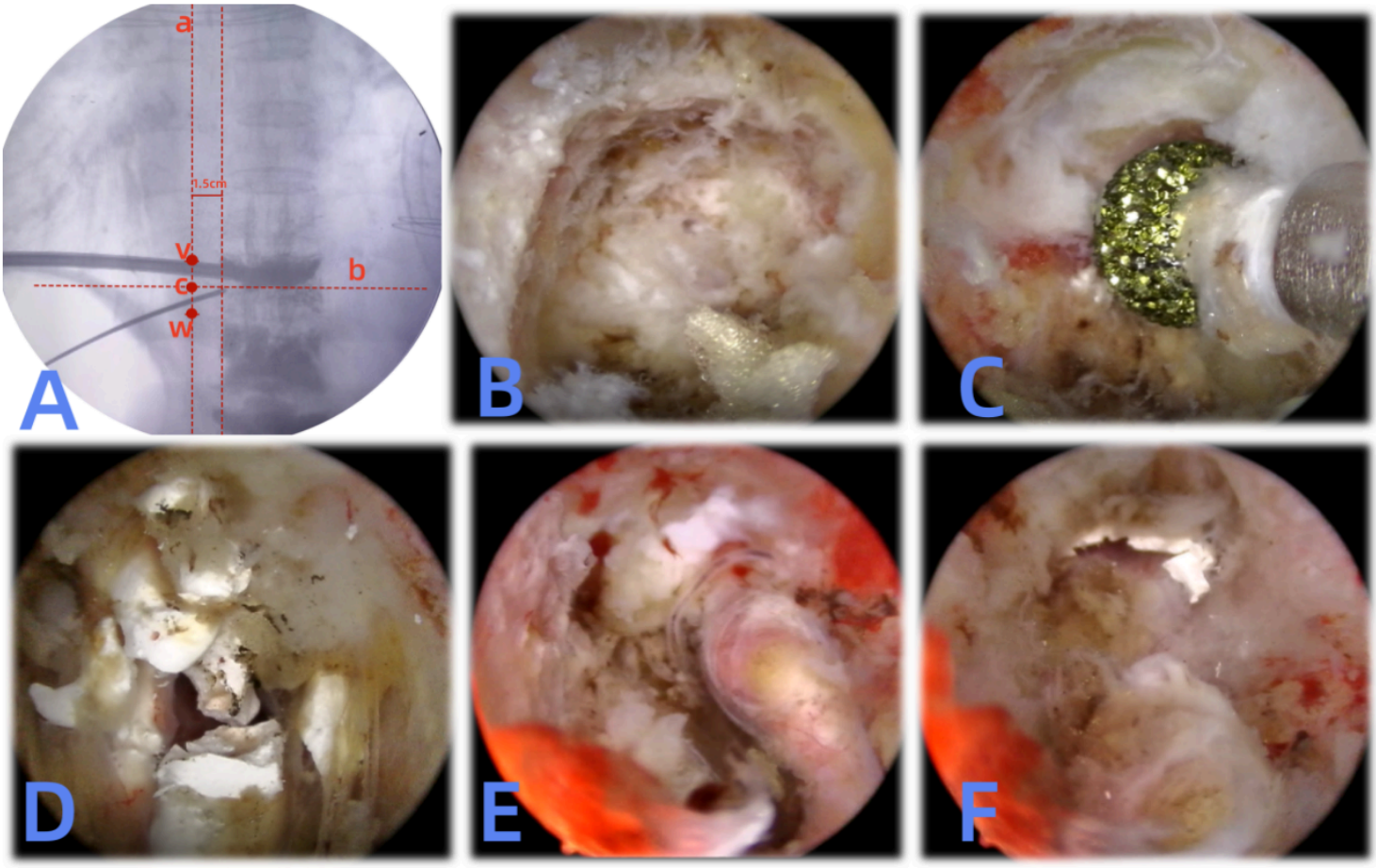


Figure 4

Portal design and main intraoperative steps of UBE-assisted thoracic nerve root transection.

(A) Intraoperative fluoroscopic surface localization and schematic design of the viewing and working portals. (B) Initial endoscopic exposure of the target foraminal region. (C) Removal of obstructing soft tissue and partial bony structures to enlarge the working space. (D) Endoscopic identification of leaked cement fragments in the foraminal region. (E) Exposure and identification of the involved thoracic nerve root after limited cement removal. (F) Final endoscopic view after transection of the involved thoracic nerve root.