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## Case Report

# Epidural injection-related pneumorrhachis: A case report with cauda equina syndrome ☆,☆☆

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## ABSTRACT

Pneumorrhachis (PR) is an uncommon condition characterized by the accumulation of air within the spinal canal. This finding may occur due to various causes, mostly after trauma and medical procedures. It can manifest with various features depending on the underlying cause, the location, and the extent of the air trapped. Clinically, the symptoms in affected patients can span a spectrum, ranging from being asymptomatic to manifesting as radiculopathies resulting from compression. The pneumorrhachis-related cauda equina syndrome is incredibly rare and typically appears as a large volume of air causing compression or irritation of the nerve roots in the lower spinal cord. In this report, we present a female patient whose cauda equina syndrome developed as a result of accidental extradural pneumorrhachis after epidural injection in the lumbar spine.

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**Abbreviations:** PR, Pneumorrhachis; ESI, epidural steroid injection; CES, cauda equina syndrome; CT, computer tomography; MRI, magnetic resonance imaging; NSAIDs, nonsteroidal anti-inflammatory drugs; LOR, loss of resistance. DSA, Digital subtraction angiography.

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## Introduction

PR is a rare condition that Gordon initially documented in 1977 [1]. PR presents diagnostic challenges due to the variety of clinical manifestations and several potential underlying causes. The condition exhibits a wide range of symptoms, from asymptomatic to profound neurological impairments, depending on the volume and position of air accumulation within the spinal canal [2,3]. Differential diagnosis necessitates assessing spinal trauma, surgical procedures, infectious etiologies, and iatrogenic factors like lumbar puncture.

Epidural injection for treating radicular pain is a common therapeutic approach, and the use of the loss of resistance (LOR) technique is prevalent, potentially leading to PR. However, these cases often present along with minimal symptoms due to a small amount of air accumulation, causing no significant compression. Here, we report a case of a female patient presenting with pneumorrhachis-related cauda equina syndrome after an epidural injection, detailing the imaging features and treatment approach for this rare condition.

## Case presentation

A 76-year-old female patient with chronic low back pain persisted for several years. The pain was exacerbated during locomotion and progressively worsened over time, leading to difficulty in maintaining her usual pace of movement. The patient had a well-controlled blood pressure with a 10-year history of hypertension and no significant medical history, including no prior trauma or surgical interventions. She was diagnosed with degenerative disc disease, and despite treatment with pain medication and physical therapy, the symptoms remained unrelieved. The back pain radiated into the right thigh and lower leg, accompanied by a tingling sensation. Due to these persistent symptoms, the patient was subsequently admitted to the Department of Neurology for further evaluation and management.

During the physical examination, palpation revealed an increased pain sensation in the para-spinal regions and the back of the right thigh and lower leg. The straight right leg sign was positive, indicating nerve root irritation. Additionally, there was mild hypertonia observed in the paravertebral muscles. The forward flexion range of the lumbar spine was decreased, with a Schober test score of 2 cm, indicating limited lumbar flexibility. Motor tests revealed that there was no muscle weakness observed in both legs. However, there was a decreased sensation in the right thigh and lower leg compared to the unaffected areas. The flexion response remained unchanged between the 2 legs.

Radiological findings revealed osteoporosis and lumbar spondylosis with compression of the vertebral bodies L1 and L3, leading to mild spinal canal stenosis. An annular tear was observed in the intervertebral L5/S1 disc. These radiological characteristics fully explain the patient's clinical symptoms. Based on these findings, the patient was diagnosed with lumbar spondylosis, severe osteoporosis with compression of the

vertebral bodies L1 and L3, and a degenerative intervertebral L5/S1 disc (Fig. 1).

The vertebroplasty was performed on the lumbar L1 and L3 to treat pain due to vertebral compress fractures. However, following treatment, the patient continued to exhibit symptoms of spinal stenosis due to disc herniation at L5-S1, which did not respond to conservative treatment. Subsequently, on the third day of hospitalization, an epidural steroid injection (ESI) was administered to the intervertebral L5/S1 disc to alleviate the patient's lower back pain. The medication used consists of 1% Lidocaine for the block test and 1 mL of Diprosan (5 mg Betamethasone dipropionate + 2 mg Betamethasone sodium phosphate). The procedure was performed safely, with no cerebrospinal fluid leakage observed through the spinal needle. However, the day after the ESI procedure, the patient reported a new tingling sensation in the buttocks and perineum, and the level of pain increased, without urinary and fecal retention. No motor and reflex disorders in both lower limbs were detected. These emerging symptoms were inconsistent with previous findings and raised a high suspicion of cauda equina syndrome (CES). A lumbar computer tomography (CT) and magnetic resonance imaging (MRI) were performed for further investigation. These images revealed the presence of an air sac measuring 21 × 14 mm in the epidural space at the L4-L5 level, which were obviously on the CT scan. This unexpected finding led to a diagnosis of epidural pneumorrhachis as the probable cause of CES, resulting from the epidural injection (Figs. 2 and 3).

The patient received a prompt conservative treatment approach, which included bed rest, nonsteroidal anti-inflammatory drugs (NSAIDs), muscle relaxers, and oxygen inhalation therapy. The patient did not experience fever or any symptoms indicating spinal infections throughout the treatment.

Over time, the symptoms of CES gradually improved. Notably, there was a complete recovery in the sensory feeling in the sacral area, and the patient regained the ability to walk independently. The patient's pain symptoms had significantly decreased compared to before treatment. After 1 year of follow-up, the patient had fully recovered, with no remaining symptoms of spinal stenosis.

## Discussion

### Pathogenesis

PR is the phenomenon of air appearing within the spinal canal. Depending on location, PR is classified into epidural and subarachnoid air. The causes of PR can be iatrogenic, spontaneous, or trauma [4,5]. Epidural PR has two main mechanisms: air from outside entering the epidural space through the spinal needle, often occurring after ESI with the LOR technique. Another mechanism involves air migrating from the posterior mediastinum into the epidural space, typically seen in thoracic traumas associated with pneumothorax and pneumomediastinum [6].

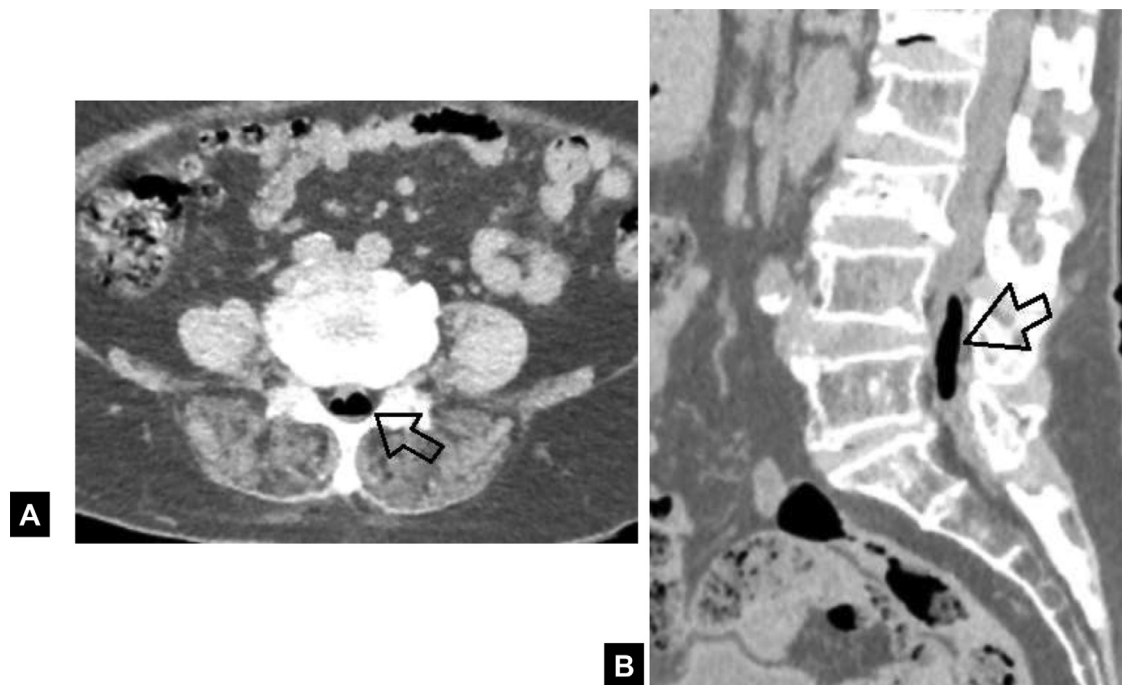


**Fig. 1 – (A)** The CT image and T1W image reveal compression of the vertebral bodies at L1 and L3. **(B)** Axial and sagittal T2W images reveal an annular tear in the intervertebral L5/S1 disc.

### Clinical symptoms

Epidural PR often remains asymptomatic since the air tends to be non-migratory, and resorption can occur naturally. Our patient presented with symptoms of CES after ESI at the L5-S1 disc level. On CT and MRI, we identified an air sac at

the L4-5 level, suggesting PR. Gas accumulation compresses the dura, causing moderate spinal canal stenosis (the cerebrospinal fluid space is moderately obliterated, and some of the cauda equina are aggregated). Therefore, in patients who develop CES after ESI, PR should be considered as one of the potential causes. According to Paik NC (2013), PR following



**Fig. 2 – Axial (A) and sagittal (B) CT image show the presence of an air sac in the epidural space at the L4-L5 level.**

ESI rarely leads to neurological defects. Possible symptoms may include meningeal irritation mimicking meningitis, cervicothoracic multi-radicular pain, radicular pain in the lower abdomen and the legs, low back pain with bilateral lower extremity weakness and paresthesia, left unilateral leg paresthesia and paresis, right unilateral leg paresthesia without motor weakness, prolonged sensory and motor blockade with epidural anesthesia, and unblocked segments during epidural anesthesia [6].

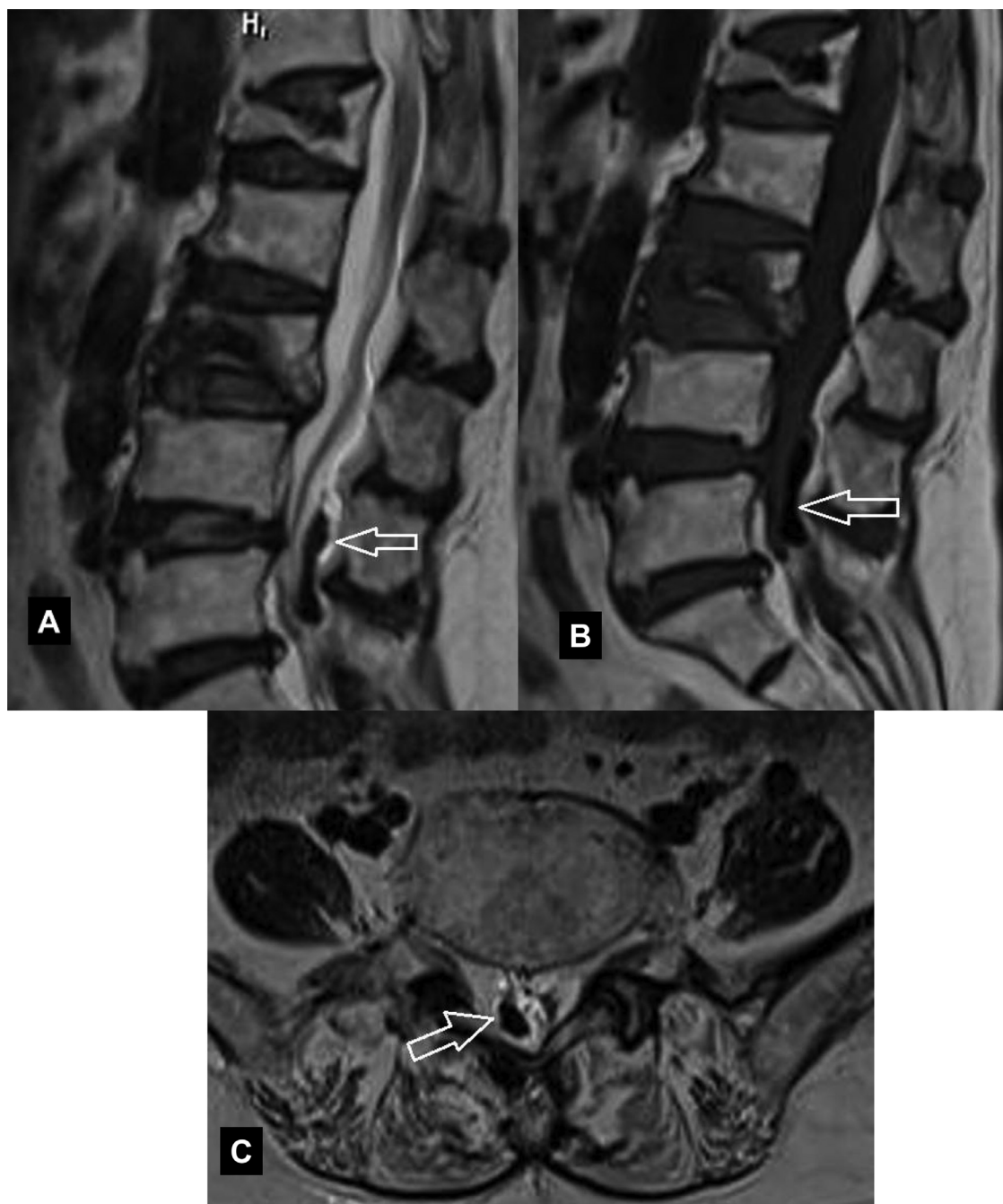
### Diagnosis

Detection of PR is relatively straightforward, as epidural air can be easily diagnosed on MRI and CT scans, with CT being more specific for air density. In clinical practice, symptoms appearing after ESI (increased pain, numbness in the lower limbs ...) can arise due to various causes, for example, nerve root trauma, ligament trauma, infectious processes, the adverse effects of glucocorticoids, and local anesthetics... In our case, following suspicion of gas accumulation on MRI, further CT scans were performed to confirm the diagnosis. As mentioned earlier, PR often remains asymptomatic. In this particular case, we believe that prolonged disc degeneration led to adherence within the epidural space, trapping gas and leading to spinal canal stenosis. The local vein can absorb the air in the subdural space [7]. However, in prolonged disc degeneration, spinal canal compression may impede the local venous blood flow, limiting air absorption. Therefore, in patients with long-term disc herniation, we recommend avoiding lumbar puncture with the LOR technique and instead opting for CT or Digital subtraction angiography (DSA)-guided procedures to minimize the introduction of air into the epidural space.

### Management

Treatment for PR depends on factors such as the underlying cause, severity of symptoms, and degree of spinal cord compression. PR treatment focuses on conservative management since air can be absorbed into the bloodstream and not recur [4,8]. In cases where the condition is asymptomatic or causes only mild discomfort, observation with regular monitoring may suffice. Symptomatic management often involves pain relief through medications like nonsteroidal anti-inflammatory drugs (NSAIDs) and muscle relaxants, along with physical therapy. Conservative measures such as rest and activity modification may also be recommended. In our patient, the neurological symptoms were only mild, without inducing paralysis or weakness in the lower extremities. Our patient was advised to take bed rest, and ministered with NSAIDs, and muscle relaxants. Additionally, the patient received 100% oxygen therapy. The atmospheric pressure of air injected into the subarachnoid space is 760 mmHg. About 100% oxygen therapy eliminates nitrogen from the inhaled air, reducing the venous blood pressure from 656 to 96 mmHg. The pressure differential facilitates faster air diffusion, aiding in volume reduction [6]. After 7 days of treatment, CES symptoms improved. However, if symptoms do not improve or patients have neurological deficits, we should perform decompression of the epidural space. Surgical procedures aim to remove the air from the spinal canal and relieving pressure on the spinal cord, with specific approach to each individual case. Additionally, addressing underlying conditions contributing to pneumorrhachis, such as trauma or infection, is crucial for comprehensive management. Paik NC (2013) reported a case treated with percutaneous CT-guided after unsuccessful conservative treatment, resulting in rapid recovery





**Fig. 3 – T1W sagittal image (A), T2W sagittal image (B) and T2W axial image (C) show partial resolution of gas collection in the epidural space at the L4-L5 level.**

[6]. Shafquat (2020) reported a case of spontaneous PR due to gas escape from a disc fissure. The patient underwent surgery to remove the air from the spinal canal as well as the affected disc due to failed conservative management [2]. Therefore, PR treatment-related CES should be individualized based on neurological symptoms in each patient, starting with conservative management. In elderly patients with pneumorrhachis, long-term management entails regular monitoring, symptom control, and addressing comorbidities. Collaborative efforts among healthcare providers are vital for optimizing treatment outcomes and maintaining patient wellness.

## Conclusion

Pneumorrhachis is a rare condition that requires careful evaluation and management. Clinical awareness of pneumorrhachis remains crucial despite its infrequency, enabling early detection and timely intervention.

It is important to note that the development of epidural pneumorrhachis as a complication of the epidural injection was an unexpected finding. This case highlights the importance of careful monitoring and prompt di-

agnosing of complications in patients undergoing spinal procedures.

Conservative treatment should be attempted first in symptomatic epidural PR, but surgery is often required if symptoms persist. In Vietnam, the lumbar puncture technique with LOR is common, PR can appear, and the symptoms may be overlooked in clinical practice. It is necessary to research to assess the incidence of PR post-ESI and compare it with clinical manifestations.

Finally, we recommend opting for procedures guided by CT or DSA to minimize the risk of PR.

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### Patient consent

We have obtained written informed consent from the patient for the publication of this case report. The patient consented to de-identified clinical information and images being used for this report. The authors of the manuscript retain this informed consent and can provide it to the journal upon specific request.

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### Data availability

The data supporting this article are available from the authors on reasonable request.

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