# Intramedullary air in the high cervical spinal cord after cervical epidural steroid injection

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**Citation**

B Parikh, Z Herschman, P Krief, R Dorain. *Intramedullary air in the high cervical spinal cord after cervical epidural steroid injection*. The Internet Journal of Anesthesiology. 2008 Volume 19 Number 2.

**Abstract**

Cervical epidural steroid injection is accepted as one of several approaches to treat pain in the neck and upper extremities after traumatic nerve root irritation. We describe a case of intramedullary air in the high cervical spinal cord after cervical epidural steroid injection and discuss a possible etiology. A 16 year old female underwent cervical epidural steroid injection for cervical radiculopathy. Two days after the injection she presented with numbness and tingling in her upper and lower extremities. CT scan revealed an air bubble at the C2 level. Management included dexamethasone, gabapentin, and hyperbaric oxygen therapy. The air bubble dissipated and the patient's symptoms resolved.

## INTRODUCTION

Cervical epidural steroid injection is accepted as one of several approaches to treat pain in the neck and upper extremities after traumatic nerve root irritation. [1] The complications from the procedure are technical, infectious, and pharmacological. [2] Technical complications relate to needle placement, needle failures or malfunctions such as breakage. [3] In the realm of placement errors, shallow insertion depth leads to failure to apply the medication to the desired location, too deep an insertion results in dural puncture or cervical cord damage, insertion into nearby structures such as blood vessels is a further problem. Insertion of an epidural needle into the cervical spinal cord would be a traumatic causing profound deficits related to the tract of the needle and associated hemorrhage. [4] We report a case of intramedullary air in the high cervical spinal cord after cervical epidural steroid injection and discuss a potential etiology.

## CASE REPORT

A sixteen year old white female was in a motor vehicle accident as a restrained passenger. There was no major trauma or loss of consciousness. Evaluation for neck and arm pain by cervical MRI revealed a C5/6 disc bulge. After discussion with her and her mother, a cervical epidural steroid injection, suprascapular and cervical plexus blocks bilaterally were performed. She responded well and her symptoms disappeared. She returned seven months later with return of pain in her neck, shoulders and arms with paraspinous neck tenderness/spasm along the cervical spine bilaterally. No other symptoms were reported. It was suggested she have repeat cervical epidural steroid injection and facet joint blocks for the new symptoms of spasm plus suprascapular and superficial cervical plexus blocks. She was evaluated by the anesthesia team. The cervical epidural steroid injection was done under sedation, in the prone position with the neck slightly flexed. A 20 gauge Touhy needle was inserted at the C6/7 interspace under fluoroscopic guidance using a hanging drop technique. The needle was advanced atraumatically until the drop at the hub descended slightly, then advancement stopped. Aspiration revealed no evidence of CSF or blood. Seven ml of Iohexol 300 was slowly injected under fluoroscopic guidance; the solution was free of any gross bubbles. There was an outline of the epidural space and the nerve root sleeves along the C4-T1 regions bilaterally; with no evidence of intrathecal or intravascular injection. This was followed by a separate injection of 10 ml of saline with methylprednisolone acetate 80 mg, again, there were no gross bubbles in the solution. The needle was removed atraumatically. Facet joints, bilaterally, from C3-T1 levels were localized fluoroscopically with a 22 gauge spinal needle placed alongside each facet joint. Aspiration for CSF and blood was negative at each level. Injection of 0.25 ml of contrast showed extra-axial position of the needles at each level; 0.5 ml of saline and Depomedrol was injected at each level. There were no gross bubbles in any of the syringes. The needles were removed atraumatically. The suprascapular and

superficial cervical plexus blocks were performed in the standard fashion using 22 gauge spinal needles with no fluoroscopic evidence of complications. In the recovery room she complained of injection site neck pain and shoulder pain that responded to ice. She was discharged home, with her mother, fully ambulatory without any neurological deficits or complaints.

That evening she left for a retreat and returning 2 days later. Her mother called stating her daughter was now complaining of tingling and numbness in the hands, feet and flanks. On questioning there was no gait instability and no incontinence or other bowel or bladder symptoms. There was no fever or headache. The timing of onset of the symptoms seems to be inexact and changed from recently upon arrival home to a "short" while earlier. From the initial discussion there were no symptoms over the prior day and a half. The mother was instructed to observe the symptoms; should they persist or change to call. A few hours later the emergency department physician of a local hospital called informing of the patient's arrival. On examination, the emergency department physician found no focal or lateralizing findings just the subjective complaints of tingling and numbness of the hands, feet and flanks. As she had a recent procedure, it seemed prudent to perform an imaging study to evaluate if there was any complication from the procedure. A CT scan of the cervical spine was ordered and discovered a 1mm x 0.2mm bubble in the center of the spinal cord at the C2 level (Fig. 1).

**Figure 1**

Figure 1: Cervical CT: Sagittal image; air within the cervical spinal cord parenchyma at the C2-C3 level

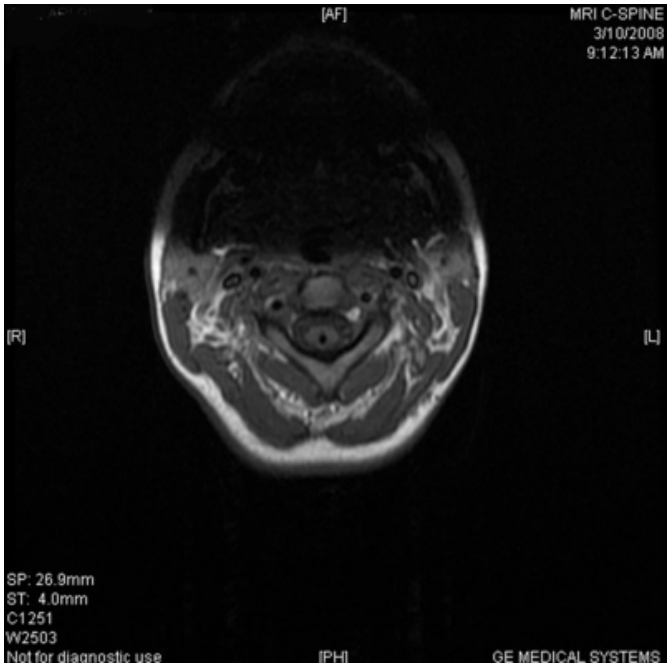

A neurosurgeon was called to evaluate her. Both he and the attending pain physician found no focal deficits despite her complaints of tingling and numbness in the hands, feet and flanks. A discussion as to management resulted in deciding to admit her and not proceed with steroid or hyperbaric therapy. An MRI of the cervical spine was done the following morning (Fig. 2a & Fig. 2b). This confirmed the bubble, its size and location. Additionally, there was some cord swelling from C2-T5 but there were no tracts to suggest any trauma.

**Figure 2**

Figure 2a: Cervical MRI: Sagittal image; air within the cervical spinal cord parenchyma at the C2-C3 level

**Figure 3**

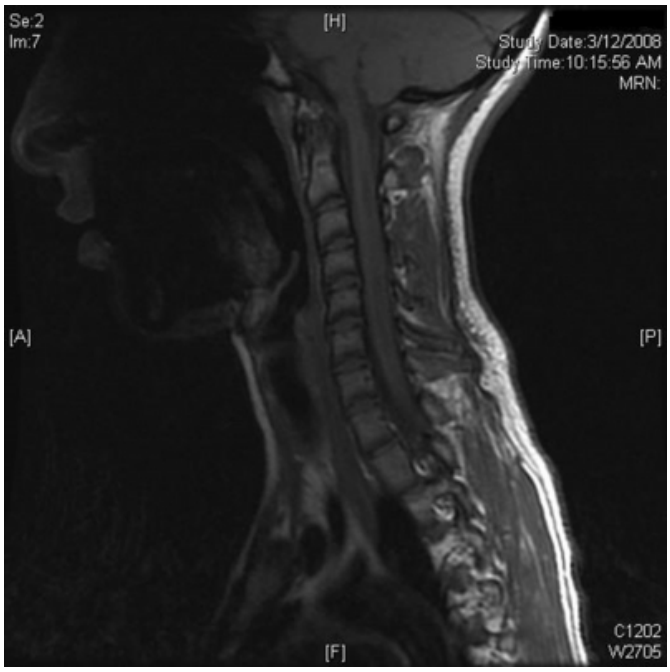
Figure 2b: Cervical MRI: Coronal image; air within the cervical spinal cord parenchyma at the C2-C3 level




At the family's request she was transferred to a children's hospital and admitted to the neurosurgical service. Pertient positive findings on her examination revealed sensation was somewhat inconsistent and patchy. Sensory modalities affected included light touch, pinprick and cold. Vibration / proprioception were not involved. She had diminished pinprick in both upper extremities below the shoulder to the hand, right foot more than left, with intact sensation over the abdomen and chest. Cold sensation was diminished in the right foot more than left and she could not detect cold in her hands.. DTR's were decreased in the upper extremities and brisk in both lower extremities, and no ankle clonus; plantar responses were flexor. The same therapeutic dilemma was posed. She was started on Dexamethasone (IV for 4 days / PO taper for 8 days) and Gabapentin. She underwent hyperbaric oxygen therapy which is the treatment of choice for an air embolism (The dissolution of the gas bubbles by hyperbaric oxygen is governed by Boyle's Law, which states that the volume of gas in an enclosed space is inversely proportional to the pressure exerted on it). [5] Day # 5 after epidural injection, MRI revealed resolution of the air within the cervical spinal cord (Fig. 3). There was abnormal signal involving the cord from C2 - T5 levels; unchanged from the MRI two days earlier. She was discharged home in good condition with improved sensation over her feet and ankles. She was ambulating without difficulty but did complain of neck stiffness on flexion/extension and lateral movement. The reminder of her examination was unchanged.

**Figure 4**

Figure 3: Cervical MRI: Sagittal image; resolved air within cervical spinal cord parenchyma at the C2-C3 level




## DISCUSSION

How a 1mm x 0.2mm air bubble gets to the center of the spinal cord at the C2 level without any evidence of trauma when the neuraxis was entered at C6/7 is uncertain. It's unlikely the facet injections entered the nerve root sleeves as all the needles were extra-axial. With no tract on imaging, needle penetration of the subarachnoid space or cord itself is highly unlikely. The epidurogram showed no spread of contrast in the CSF. The technique used was hanging drop. No syringe had gross air bubbles. The only sources of air could be in the hub when the syringe is attached and micro bubbles developed when the steroid solution is agitated. Even so, how does air get across a presumably intact membrane, into the center of the spinal cord and up 4 to 5 levels?

The only plausible explanation we have is the following. There is a source of air in the micro-bubbles formed when drawing up any medication from a vial. This is even more likely with the commonly used steroid solutions requiring suspension by agitation. Despite a source of air, how does it traverse an intact membrane without a tract? This may have resulted from the small gauge of the needle, a 20 gauge Touhy needle, and an even smaller puncture through the ligamentum flavum. When the meniscus of the hanging drop

disappears it only informs us a puncture through the ligamentum flavum occurred, not suggesting the size of the puncture. The hole may be 20 gauge or miniscule, just enough to allow equalization of pressure and loss of the hanging drop. In the latter situation, a very tiny orifice is formed. As a tiny orifice, the small ligamentum flavum puncture behaves as a constricting nozzle for the pressure being applied behind it, even when injected slowly. The nozzle effect supplies an extremely high pressure to the tissues opposite the orifice thereby forcing the fluid, and the intermixed micro-bubbles, across the membrane. This is similar to the mechanism behind pneumatic inoculation devices for needle-free injections. [6] This would also explain the edema in the cord without evidence of physical trauma. Once within the cord, the bubbles may have coalesced and ascended to the highest level attainable until the time of detection. Performing CT or MRI scans after cervical epidural steroid injections is not commonly suggested. Consequently, we can not estimate how many cervical epidural punctures using 20 gauge Touhy needles would result in an orifice producing such a nozzle effect. It remains unclear how this occurred, but we believe our proposed mechanism quite plausible. If true, it is probably better to use a larger needle for cervical epidural steroid injections as the larger needle would more likely produce a larger puncture in the ligamentum flavum and obviate the possibility of an orificial nozzle effect.

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