INTRADURAL OR INTRATHECAL LOCAL ANESTHETIC INJECTION

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INTRODUCTION

An intradural (formerly called subdural) or intrathecal local anesthetic injection can occur during routine epidural steroid injections due to either anatomic or technical factors. Anatomic factors that may contribute to unintentional intradural or intrathecal needle placement during interlaminar access include a lack of midline fusion of the ligamentum flavum, ligamentum flavum frailty, and central canal stenosis. An anatomic factor that may contribute to unintentional intradural or intrathecal needle placement during transforaminal access includes laterally positioned dural sleeves or periradicular nerve root sheath dilatation. Technical factors that may lead to unintentional needle placement include medial placement of the needle tip during the transforaminal approach and deep placement during the interlaminar approach [1]. In addition, before performing an interlaminar epidural injection, a review of pre-procedure advanced imaging is indicated to ensure adequate epidural space at the target level. An absence of a sufficient epidural space may increase the risk of an intradural or intrathecal local anesthetic injection [2]. The risk of intradural or intrathecal injection is much higher with interlaminar compared to transforaminal epidural access [3].

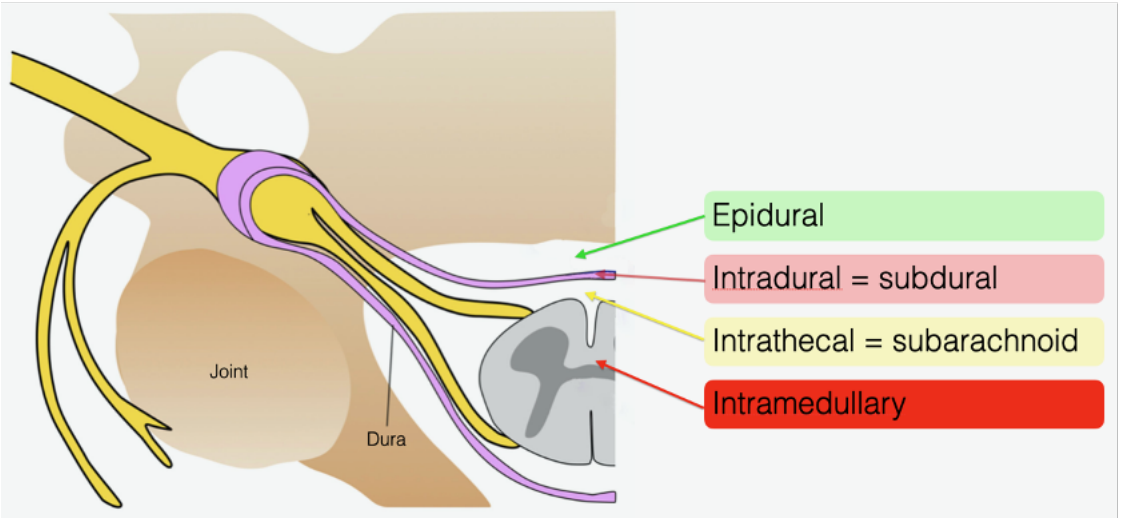


Illustration provided courtesy of Stephan Klessinger, MD, PhD.

There is no uniform naming convention for the various spaces in the spinal canal. However, it is important to precisely define the needle position relative to the anatomy, as the effects of unintended needle placement vary significantly. For interlaminar epidural access, the needle tip should be positioned between the ligamentum flavum and the outermost layer of the dura. For transforaminal epidural access, the needle tip should not be advanced beyond the uncinate line in the cervical spine and at or just lateral to the six o'clock position of the pedicle in the lumbar spine in a true AP view. Injecting contrast medium using multiplanar real-time fluoroscopy is necessary to confirm the proper epidural needle tip location. Aberrant contrast medium flow patterns occur with intradural and intrathecal (subarachnoid) needle placement [1]:

Intradural

In the spine, the inner border cell layer of the dura mater is tightly adherent to the outer arachnoid barrier cell layer. As a result, there is no defined subdural space, which differs from cerebral anatomy, where such a space does exist. Needle placement between the dural layers, followed by injectate administration, is referred to as an intradural injection. Injected fluid can cleave the dural layers longitudinally and circumferentially, thereby filling the potential space between dural layers and compressing nearby structures [4].

Two distinct contrast patterns can occur during intradural injection of contrast medium. One pattern is globular, representing a localized space-occupying lesion that may compress adjacent neural structures. If this is unrecognized, subsequent injection of local anesthetic will enlarge the intradural space-occupying fluid collection. In addition to potential complications from neural compression, anesthesia of adjacent structures may also occur. The other intradural pattern is circumferential, which appears as two linear contrast medium lines outlining the dural space. The development of parallel longitudinal lines indicates rapid cleaving of the intradural tissue planes, allowing even small volumes of injectate to distribute proximally along the neuraxis. If intradural injection is not appropriately recognized and a local anesthetic is injected, a rapidly ascending anesthetic block may occur as late as 30 minutes after injection, which can result in respiratory compromise if the cervical spine is affected [1,5].

Intrathecal (subarachnoid)

An injection into the cerebrospinal fluid space is referred to as intrathecal or subarachnoid. Unintentional intrathecal contrast medium injection results in a myelographic pattern. If the myelogram is not appropriately recognized and intrathecal injection of local anesthetic occurs, spinal anesthesia will occur. The effects of this will depend on the spinal segment involved. The depth of spinal anesthesia and the extent of spinal cord involvement will depend on the volume and concentration of the anesthetic. Anesthesia affecting the cervical and thoracic spinal cord can result in cardiovascular collapse due to involvement of nerves regulating respiratory muscles and visceral vascular tone. In severe cases, this may require initiating basic life support (BLS) and advanced cardiac life support (ACLS). If spinal anesthesia ascends to the brain stem, altered mental status may also occur. Spinal anesthesia involving the thoracic and lumbar spine results in motor and sensory block affecting the lower extremities.

TYPICAL PRESENTATION

Case #1:

A 52-year-old woman presented to the clinic with right-sided cervical radicular pain. The pain radiated into her fifth digit and did not respond to a 6-week course of physical therapy, nor had she improved with 2 months of pregabalin and duloxetine. She stated that the pain was limiting her ability to perform daily activities, including driving. She worked as a receptionist and frequently took breaks due to the pain. She was worried about losing her job. An MRI showed a right-sided disc herniation compressing the exiting C8 nerve root.

After informed consent, the patient agreed to undergo a C7-T1 interlaminar epidural steroid injection. The patient was placed prone on the fluoroscopic table. After the usual initial procedural steps, the physician performed saline loss-of-resistance testing to locate the dorsal epidural space and, based on a single AP image, determined that the subsequently injected contrast medium was epidural. He then injected a mixture of 10 mg/ml dexamethasone and 2 ml of 2% lidocaine. The needle was removed, and 30 seconds later, the patient became apneic. The patient's heart rate suddenly dropped to 30 beats per minute, and her blood pressure lowered to 80/30.

Case #2:

A 24-year-old male athlete presented to the clinic with a 3-week history of severe, burning pain in the right lower extremity. The pain radiated into the big toe on the right, and the patient reported that he was no longer able to sit comfortably or run. He was training for a marathon and was worried that he would miss the race.

A lumbar MRI was ordered, which showed a large disc herniation at L4/L5 compressing the lateral recess and the central canal. The physician offered the patient an interlaminar epidural steroid injection at the level of compression, and after informed consent, the patient agreed.

The patient was placed prone on the fluoroscopy table, and the procedure was performed using the technique described in the IPSIS Technical Manual [1], except that the physician performed a hurried saline loss-of-resistance test, injected 2 ml of contrast medium, and determined the spread to be epidural based on a single AP view. He then injected a combination of 40 mg/ml methylprednisolone and 2 ml of 2% lidocaine. The needle was removed, and 30 seconds later, the patient noted that he was unable to feel or move his lower extremities. His blood pressure dropped slightly to 100/50 with a stable HR and normal oxygen saturation.

DIAGNOSIS

In both cases, a single AP view was used to verify needle location and contrast medium pattern. A single AP view, in the absence of a lateral or contralateral oblique (CLO) view, is unable to accurately assess the needle depth [6]. Failure to use an appropriate fluoroscopic view to assess needle depth risks the needle being superficial to the target or advancing beyond the epidural space into the intradural or intrathecal space.

Assessing contrast medium patterns in a CLO view can provide additional important information that may be missed in an AP view [7]. In this view, intrathecal spread may be identified by the absence of a dense contrast medium band along the ventral interlaminar line (VILL) and a homogeneous contrast medium pattern within the spinal canal. Intradural spread will demonstrate a similar globular pattern or "tram track" sign in the AP and CLO views. When intradural or intrathecal contrast medium patterns are recognized, injection of a local anesthetic agent or steroid preparation should not be performed. If a globular intradural pattern is seen, an attempt should be made to gently aspirate the contrast medium to reduce the size of the fluid collection. Further distinctions between intrathecal and epidural contrast medium spread patterns are outlined in the *IPSIS Technical Manual* [1].

EMERGENCY PROTOCOL

1. If the intradural or intrathecal injection results in apnea, immediately stop the procedure and call for help. In the office setting, call emergency medical services (EMS) (911 or local equivalent) and explain the nature of the emergency. In a hospital setting, call for a rapid response or code team.
2. If prone, roll the patient to the supine position to initiate BLS/ACLS, as indicated.
3. Immediately begin bag-mask ventilation with high-flow oxygen until spontaneous ventilation resumes. Continue monitoring. Place a peripheral intravenous catheter and initiate intravenous fluids (either normal saline or Lactated Ringer's solution) to minimize complications associated with hypotension.
4. If the patient is medically stable, perform a detailed neurological examination to determine the spinal level of blockade.
5. Review procedural images to determine if the contrast medium demonstrated an intrathecal or intradural pattern. Refer to the **IPSIS *Technical Manual*** for details on differentiating among epidural, intradural, and intrathecal contrast medium flow patterns [1]. If an intramedullary injection is suspected, please refer to the "**Traumatic Spinal Cord Injury**" emergency protocol [8].
6. Assuming confirmation of intrathecal or intradural injection and a medically stable patient, reassure the patient that the effects will wear off.
7. If a long-acting local anesthetic is used, the patient will require observation for up to 12 hours and may require urinary catheterization due to the inability to void. If a short-acting local anesthetic is used, the patient may require observation until the symptoms have subsided, which may be several hours.
8. Notify the patient's emergency contact or family.
9. Consider debriefing the team and reviewing procedures to prevent future occurrences.

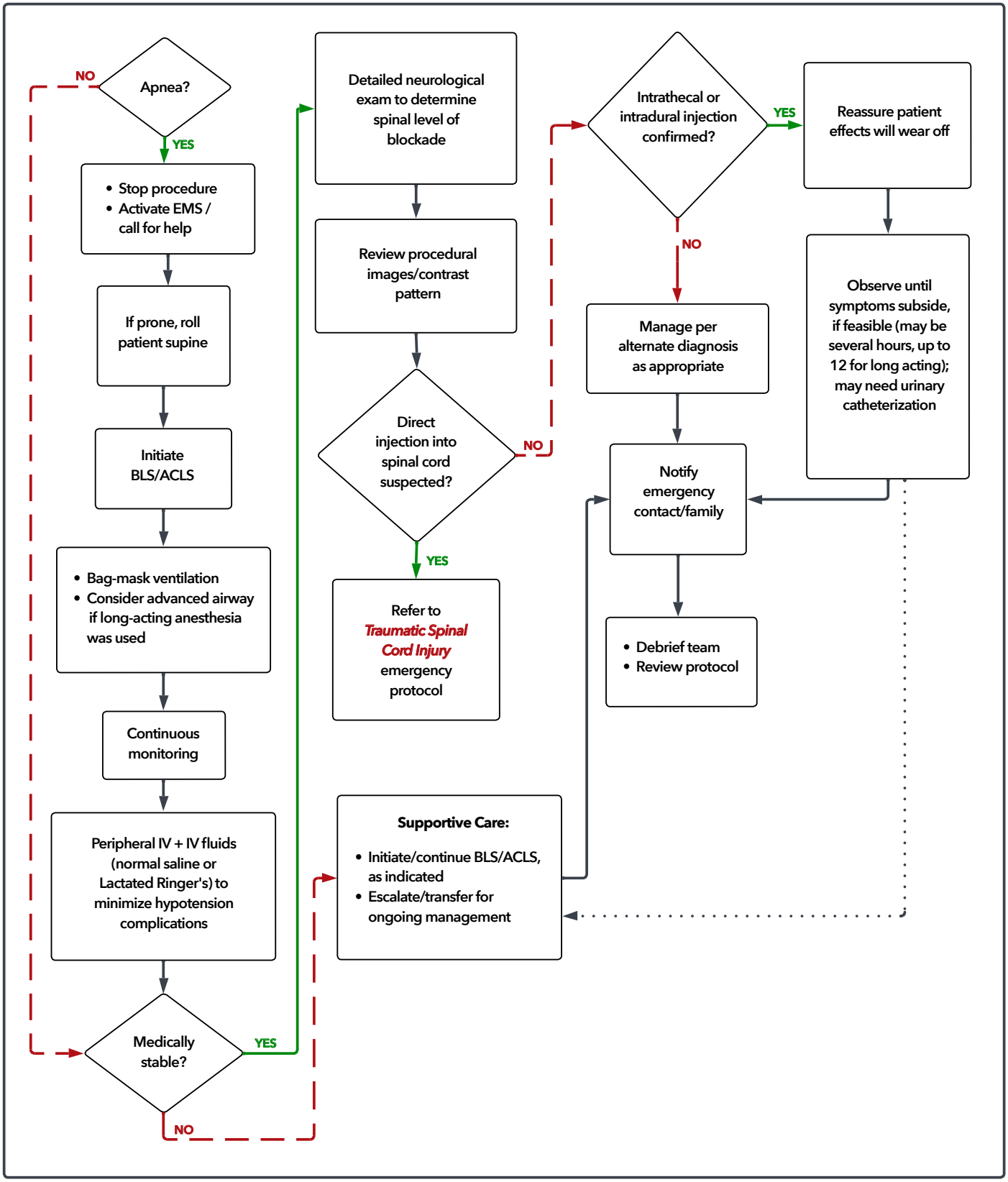
RISK MITIGATION/PREVENTION

- Proper use of multiplanar fluoroscopic views (AP and either CLO or lateral) is vital for assessing needle position before administering any injectate.
- For cervical transforaminal epidural access, the needle tip should not pass medial to the uncinate line to avoid entry into the central canal.
- For lumbar transforaminal epidural access, the needle tip should stay lateral to the mid-point of the pedicle to avoid entry into the central canal [1].
- For interlaminar epidural access, the appropriate use of CLO or lateral imaging, combined with proper loss-of-resistance testing, facilitates accurate needle placement in the epidural space [1]. The CLO depth view is preferred over the lateral depth view in most cases [7].
- Diligent review of contrast medium flow patterns in both frontal (AP) and depth views facilitates accurate identification of contrast medium spread (appropriate epidural spread or aberrant intrathecal or intradural spread).
- If the contrast medium spread pattern is intrathecal or intradural, the procedure should be aborted.
- Use of short-acting anesthetics is recommended for all epidural steroid injections to mitigate the duration of sequelae following unintentional intradural or intrathecal injection. Smaller-volume, lower-concentration anesthetic injectates should be used to mitigate segmental spread and depth of anesthesia that may occur with an unintentional intrathecal or intradural injection [1].
- All team members in the fluoroscopy suite should be trained in BLS. BLS/ACLS protocols should be followed in the event of cardiovascular collapse.
- Regardless of the service site, the facility should be appropriately equipped to manage emergencies (see ***Advance Preparation for Emergencies*** [9]).

KEY CONSIDERATIONS/TAKEAWAYS

- Intradural or intrathecal injection during epidural steroid injections is more common with interlaminar than transforaminal approaches.
- Appropriate use of multiple different fluoroscopic views to accurately determine needle position is required before injecting contrast medium.
- Proper interpretation of contrast medium patterns should include both the AP view and a depth view (preferably CLO) with interlaminar injections.
- For transforaminal injections, the AP view is the most critical for identifying intradural or intrathecal contrast medium patterns, though lateral or CLO views may help confirm an aberrant flow pattern seen on the AP view.
- If an intrathecal or intradural pattern is recognized, the procedure should be aborted.
- If intradural or intrathecal injection occurs, is not recognized on post-contrast imaging, and an anesthetic is injected, the depth of spinal anesthesia and amount of the spinal cord involved will depend on the volume and concentration of the anesthetic.
- Intrathecal or intradural local anesthetic spread to the cervical spine or upper thoracic spine may result in cardiopulmonary collapse.
- If the injected local anesthetic ascends to the brain stem, altered mental status or seizures may occur.
- Intrathecal or intradural anesthetic spread involving the thoracic and lumbar spine may result in motor and sensory block affecting the lower extremities.
- If local anesthetic agents are considered for epidural steroid injections, short-acting agents in low concentrations should be used to minimize the duration of possible intradural or intrathecal injection sequelae.

SUSPECTED INTRADURAL OR INTRATHECAL INJECTION



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