TRAUMATIC SPINAL CORD INJURY

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INTRODUCTION

Spinal cord injuries are a known potential complication that may occur during certain interventional spine and pain procedures. The most common etiologies of spinal cord injury complications related to interventional spine procedures are epidural hematoma (see ***Epidural Hematoma Protocol*** [1]), direct needle trauma to the spinal cord itself, damage caused by injection of material into parenchymal tissues of the spinal cord, injectate-related neurotoxicity, and thromboembolic infarction of the spinal cord after intra-arterial injection of particulate steroid (see ***Intra-arterial Injection Protocol*** *[2]*). Proper preparation and procedural technique mitigate against spinal cord injuries in most instances [3].

Iatrogenic needle injury to the spinal cord itself is most common with interlaminar epidural steroid injections at the cervical through L1 vertebral levels. However, cases have been reported following cervical facet-targeted interventions as well. Direct trauma from a misplaced needle can disrupt the spinal cord's structural integrity. Hematoma formation can occur and worsen the neural injury. If spinal cord needle placement is not identified and is followed by intramedullary injection, more extensive, severe, and irreversible spinal cord injury would ensue with inflammation, cellular apoptosis, and demyelination, ultimately impairing neuronal conduction and function [4].

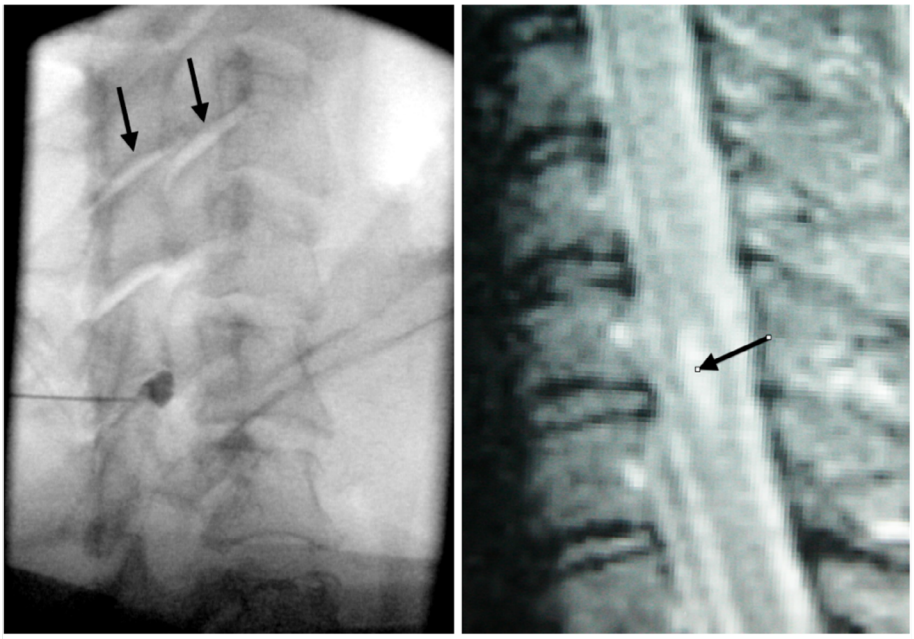
Spinal cord injury following transforaminal epidural injections has also been reported. It is most often attributed not to direct needle trauma but to thromboembolic infarction caused by a particulate steroid-injected artery [4]. Dissection of the vertebral artery has been reported in one case [5]. Vasospasm of critical arteries has also been postulated [5].

Detailed descriptions of the risks of interlaminar and transforaminal injections are available [6].

Of the patients with closed legal claims related to cervical interventions, 59% experienced spinal cord damage [4]. Several cases of direct spinal cord injury have been described in the literature [7-15].

Case # 1: Poor technique during attempted cervical facet joint injection - lateral approach

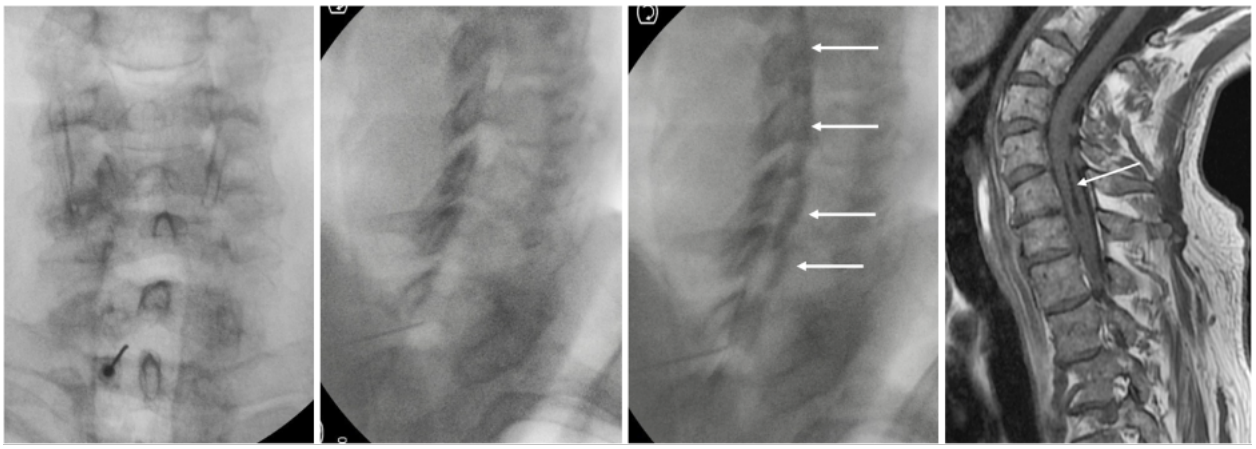
A 58-year-old patient had complained of neck pain for several months. Examination revealed painful, restricted cervical spine movement. No neurological deficits were observed. Several facet joints on the right side were painful to palpation. An intra-articular injection of a steroid and local anesthetic was planned. After contrast medium injection, pain developed in both arms, and shortness of breath occurred.



Case #1: *Left: Fluoroscopic image with the final needle position and contrast distribution. It is striking that this is not a strictly lateral image. The double contour of the joint gaps of the facet joints is visible (arrows). Right: Sagittal T2 MRI image demonstrating the contrast medium in the spinal cord (arrow).*

Case # 2 [3]: Undetected deep needle position

A 69-year-old patient presented with neck pain and paresthesia in C6 and C7 dermatomes. An interlaminar epidural injection with a steroid and local anesthetic was planned. Pain occurred during the administration of contrast medium, prompting procedure termination and hospital transfer for what was initially thought to be a cardiac event. The patient subsequently developed weakness and numbness in both hands (left greater than right).



Case #2: A left parasagittal approach is used for interlaminar injection. In the contralateral oblique image, the needle tip is quite deep to the ventral interlaminar line. Contrast medium injection demonstrates dense contrast medium within the central canal, not in contact with the ventral interlaminar line. On sagittal T1 MRI, the spinal cord shows a hypointense signal, most consistent with blood products from direct cord injection.

DIAGNOSIS

Case #1:
Spinal cord injury and permanent neurological deficit occurred because of the failure to utilize the proper lateral approach technique for cervical facet joint access and injection. The failure to obtain the necessary true lateral and true AP cervical segmental imaging to confirm appropriate needle placement before injecting contrast medium proved disastrous. Proper technique would have prevented this catastrophic outcome [3].

Case #2:
In this case, on pre-procedural sagittal T1-weighted MRI imaging review, adequate dorsal epidural fat was noted at the C7/T1 segment [3]. The left parasagittal approach was appropriate. However, proper, frequent intermittent true AP/contralateral oblique (CLO) imaging and proper loss-of-resistance were not utilized. The failure to recognize intramedullary (spinal cord) needle placement may cause a limited neurological deficit, but further injection of contrast medium or medication will likely worsen the spinal cord injury [3]. Careful technique would have prevented this devastating outcome [3].

EMERGENCY PROTOCOL

The initial symptoms of an acute, traumatic spinal cord injury during an interventional spine procedure are often nonspecific. Symptoms may begin with pain, then progress to sensory disturbances, motor dysfunction, and paralysis. Acute spinal cord injury can be accompanied by potentially life-threatening respiratory and cardiovascular dysfunction, necessitating timely medical intervention to prevent additional neurologic compromise and mitigate morbidity.

Direct trauma from the needle leads to mechanical injury with axon disruption. Hemorrhage may also occur. With a thin needle, the mechanical injury can be very localized, resulting in mild, moderate, or no effect. However, if an intramedullary injection follows, pronounced parenchymal reactions occur. Edema develops, and pro-inflammatory reactions begin, greatly exacerbating the clinical symptoms and resulting in permanent neurological deficit.

Respiratory arrest is of particular concern with an insult to the upper cervical spine, likely during procedures on the upper cervical spine. The phrenic nerve originates from parts of the C3 to C5 nerve roots. Bilateral phrenic nerve palsy leads to respiratory insufficiency. Spinal cord injury in an office-based setting requires a rapid, structured response to prevent further neurological damage and ensure timely transfer to the closest hospital emergency department.

The potential neuroprotective effects of high-dose methylprednisolone to mitigate the inflammatory cascade and secondary injury following acute traumatic spinal cord injuries have been investigated in large randomized controlled studies (NASCIS I, II, and III [National Acute Spinal Cord Injury Studies]) [16]. In 2013, a level 1 recommendation from the Congress of Neurological Surgeons was made against using high-dose methylprednisolone for the acute management of patients with traumatic spinal cord injuries [17]. Using methylprednisolone remains one of the most controversial topics in treating spinal cord injury.

Managing Spinal Cord Injury:

1. Recognition of spinal cord injury
   a. Be attentive to initial symptoms such as unusual pain.
   b. Listen to patient reports of unusual paresthesia or hypoesthesia.
   c. Sudden weakness, paralysis
   d. Loss of bladder/bowel control
2. Stop the procedure.
   a. Cease all procedural activity immediately.
   b. Save the critical fluoroscopic images of the needle position.
3. Call Emergency Medical Services,
   a. Activate emergency medical services (EMS) immediately (call 911 or local equivalent).
   b. Report a suspected spinal cord injury.
   c. Request urgent transport to a hospital with neurological/neurosurgical capabilities.
4. Stabilize the patient.
   a. Monitor and support airway, breathing, and circulation (ABCs).
   b. Augment mean arterial pressure (higher than 85 mmHg) to improve functional outcomes.
   c. Manage the airway, as indicated.
   d. Provide supplemental oxygen.
5. Neurological Assessment
   a. Perform a focused neurological exam.
   b. Assess consciousness level.
   c. Evaluate motor and sensory function in all limbs.
   d. Check reflexes.
   e. Document findings clearly and note the time of onset.
6. Vital Signs Monitoring
   a. Continuously monitor vital signs (blood pressure, heart rate, oxygen saturation).
   b. Be alert with signs of neurogenic shock: hypotension with bradycardia.
7. Prepare for Handoff
   a. Gather all relevant information: procedure performed, time of symptom onset, neurologic status, medications used.
   b. Provide a concise report to EMS upon arrival.
8. Documentation
   a. Thoroughly document all observations, actions taken, times of events, and communication with EMS and the patient.
9. Follow-Up
   a. Notify the patient's emergency contact or family.
   b. Consider debriefing the team and reviewing procedures to prevent future occurrences.

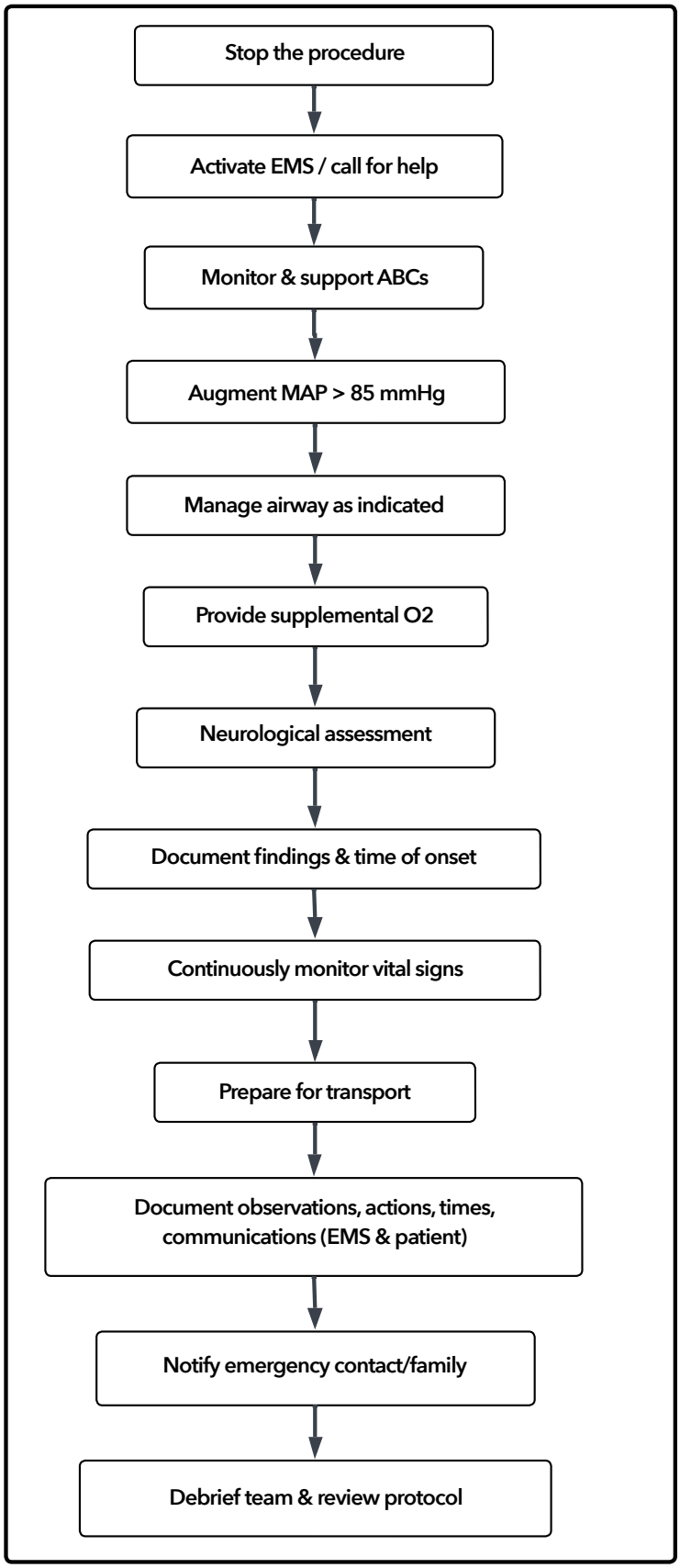
RISK MITIGATION/PREVENTION

- Before performing cervical interlaminar epidural access, review the sagittal T1-weighted MRI images for the presence of epidural fat to decide whether it is possible to access the C7-T1 or T1-T2 dorsal epidural space target safely [3,5,6,18].
- Consider selecting a bony structure as the first target to ensure safe depth control (e.g., the upper edge of the inferior lamina for an interlaminar epidural approach) [3].
- For many patients, CLO imaging is critical for determining the depth of expected loss of resistance [3,19].
- At least two planes (true AP and CLO, or true AP and lateral) are necessary to assess the position of the needle tip [3].
- Regardless of the service site, the facility should be appropriately equipped to manage emergencies (see ***Advance Preparation for Emergencies*** [20]).

KEY CONSIDERATIONS/TAKEAWAYS

- Understanding proper fluoroscopic imaging techniques, including true AP, true lateral, and CLO imaging, is essential.
- While bone contact with the inferior lamina is helpful for depth control during cervical interlaminar access, proper use of loss-of-resistance testing and intermittent true AP/CLO imaging is critical to avoid spinal cord puncture.
- The spinal cord may tolerate a small-gauge needle puncture, but it will never tolerate the injection of any solution.

SUSPECTED TRAUMATIC SPINAL CORD INJURY



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DISCLAIMER

While these Emergency Protocols are intended to identify elements critical to the management of emergencies during interventional pain procedures, they are not intended to be inclusive of all proper emergency management protocols or exclusive of other methods of care reasonably utilized to obtain the same results. Nothing contained in these documents is intended to be used as a substitute for the care and knowledge of the individual clinician. They are guidelines based on evidence-informed expert consensus. IPSIS makes no representation and assumes no responsibility for the accuracy of the information contained or available through this website, and such information is subject to change without notice. Given the individual patient's clinical circumstances and preferences, the clinician's independent medical judgment should always determine patient care and treatment. Practitioners are advised to consider management options in the context of their training, background, and institutional capabilities when selecting recommended treatment options. IPSIS is not responsible, nor does it assume any legal liability or responsibility for the accuracy, completeness, clinical efficacy, or value of any such information or apparatus, product, or process described or referenced through this website or the information contained therein.