Minimizing Risk with Cervical Interlaminar Epidural Injections: Five Key Considerations

Eric K. Holder, MD; Mathew Saffarian, DO; Clark C. Smith, MD, MPH; Patricia Zheng, MD; and David Levi, MD on behalf of the International Pain and Spine Intervention Society's Patient Safety Committee

1Yale University School of Medicine, Department of Orthopedics and Rehabilitation, New Haven, Connecticut, USA; 2Michigan State University, Department of Physical Medicine and Rehabilitation, East Lansing, Michigan, USA; 3Columbia University Medical Center, Rehabilitation and Regenerative Medicine, New York, New York, USA; 4University of California, San Francisco, Department of Orthopaedic Surgery, San Francisco, California, USA; 5Jordan Young Institute, Virginia Beach, Virginia, USA

Introduction

A cervical interlaminar epidural steroid injection (CILESI) involves passing a needle within an interlaminar window through the ligamentum flavum (LF) to allow for sufficient needle tip access of the dorsal cervical epidural space for safe delivery of medication [1]. The indication for CILESI is to treat cervical radicular pain, most commonly caused by cervical osteoligamentous degenerative changes and intervertebral disc herniations resulting in nerve root impingement [2]. CILESIs are utilized more commonly than cervical transforaminal epidural injections (CTFESIs) for the therapeutic management of cervical radicular pain [3].

There is a risk of complications with either approach that, in rare circumstances, may result in serious morbidity and even mortality. Analysis of the American Society of Anesthesiologists’ closed claim database from 2005-2008 identified 20 cases of spinal cord injury attributed to CILESIs [4]. Furthermore, while CILESIs are generally regarded as safe with appropriate procedural planning and technique, there always remains a small risk of epidural hematoma [1].

Anatomical Considerations and Needle Access

**Myth #1:** There is no intrinsic difference in risk when performing CILESIs in the upper versus lower cervical spine.

**Fact:** CILESIs should be performed at C6-C7 or below, with C7-T1 as the preferred access point due to the more generous dorsal epidural space at this level compared to the more cephalad interlaminar segments. This reduces the risk of the minor complication of dural puncture and the major complication of spinal cord injury due to inadvertent needle placement.

The epidural space in the cervical spine is less capacious than in the thoracolumbar spine [1]. As one ascends the cervical spine, the anatomic proximity of the dural sac and spinal cord to the point of interlaminar needle access narrows, reducing the margin for error and increasing procedural risk [1,5-7]. Even at C7-T1, the normal depth of the posterior epidural space is less than 2-3 mm [1]. Cross-sectional imaging should be performed and reviewed before any CILESI to confirm sufficient epidural space for appropriate needle placement [7].

Although some authors have documented the safety of performing CILESI above the level of C6-C7 [8], current recommendations are that CILESIs should be performed at the C7-T1 level ideally and not higher than the C6-C7 level [1, 5-7]. One argument for attempting a CILESI at a higher cervical level is to ensure coverage of the medication at the site of pathology. However, evaluation of cervical radiculopathy distribution patterns has shown that involvement of the C7 nerve root in isolation is most common, followed by C6 and a combination of C5 and C6 [2]. In one study, a 5 mL volume injected at C7-T1 spread cephalad to the C5 vertebral level 100% of the time, the C4 vertebral level 92.9% of the time, and the C2 vertebral level 69.1% of the time, justifying the utility of the C7-T1 approach [9]. Epidural catheters have been used to reach higher cervical levels; however, this practice appears to be no more effective than standard C7-T1 ILESI and may confer an increased risk of epidural hematoma with catheter placement and removal [10,11].
Myth #2: Ligamentum flavum (LF) gaps are uncommon in the cervical spine and are not a risk factor for CILESI aberrant needle placement.

Fact: LF gaps are most prevalent in the midline cervical spine. This can result in diminished tactile feedback with loss of resistance (LOR), increasing the risk for inadvertent dural puncture or spinal cord injury. Based on current evidence, needle placement in the paramedian portion of the interlaminar space is safest to avoid LF gaps.

Cadaveric studies have shown that gaps in the LF are consistently localized to the midline and preferentially affect the cervical spine [12-16]. Cadaveric studies have also illustrated variable rates of midline gaps. One study determined that the rates of midline LF gaps in the lower cervical spine (C5-C6 to C7-T1) ranged from 51-74% [16]. Another cadaveric study determined that the incidence of midline gaps in the LF from C3-T2 ranged from 87-100% [14].

Similar, in-vivo MRI characterization of the lower cervical spine (C5-C6 to C7-T1) confirmed that all LF gaps were localized to the midline with varying partial to full-thickness LF gap morphologies [13]. Cadaveric and MRI in-vivo analyses have demonstrated that LF gaps occur more commonly in the caudal and middle thirds of the midline interlaminar space than in the cephalic third of the interlaminar space [13-15].

MRI evaluation with axial T2-weighted spin echo sequences has demonstrated that the highest rate of full-thickness midline LF gaps occur at the C7-T1 level: 53% in the cephalic portion and 71.4% in both the middle and caudal portions [13]. For comparison, the rate of full-thickness midline LF gaps at the C6-C7 level was 28% in the cephalic portion and 24% in the middle and caudal portions [13]. Partial-thickness LF gaps were more common than full-thickness midline LF gaps at the C6-C7 level, unlike the C7-T1 level, where full-thickness midline gaps predominate [13].

Additionally, the average width of full-thickness midline LF gaps is most pronounced at the C7-T1 level (~1.7 mm (SD 0.64 mm)) as compared to C6-C7 (~1.29 mm (SD 0.58 mm)) [13]. Based on the best evidence, a paramedian approach, rather than accessing the midline portion of the interlaminar space, is a safer approach to avoid LF gaps [13-16].

Myth #3: The anteroposterior (AP) view and loss of resistance (LOR) technique allow for reliably safe needle placement.

Fact: An optimal AP trajectory view and the physician’s ability to discern engagement in the LF and subsequent LOR are crucial. Confirmation of minimal needle insertion depth relative to the ventral margin of the lamina with either a lateral or contralateral oblique (CLO) safety view is critical to minimize the risk of inadvertently inserting the needle too ventral.

Multiplanar imaging minimizes procedural risk. Initial needle placement necessitates an ideal AP trajectory view that optimizes the interlaminar access window and allows for coronal plane recognition of midline versus right or left paramedian needle placement. LOR provides the physician crucial tactile feedback that the needle has traversed the LF and entered the epidural space. In the cervical spine, the LF is less robust than in the lumbar spine, requiring the physician to be keenly aware of subtle tactile changes indicating epidural access [1,13]. As discussed, LF deficiencies are common in the cervical spine. It has been previously shown that there is a 53% false LOR rate when relying solely on LOR and not utilizing a depth view to confirm needle placement before injecting contrast [17]. Thus, true lateral (90° oblique) or CLO (oblique opposite the needle tip) views are considered necessary “safety” views to confirm appropriate needle depth throughout the procedure, including before injecting contrast medium or medication [18].
The use of a true lateral versus CLO view often depends on several factors, including physician training and preference. Several studies have illustrated the superiority of the CLO view [19-21]. If the needle tip epidural access point is midline (within lateral margins of the spinous process), a lateral view may prove adequate to gauge depth [1]. However, poor visualization of the needle tip in lateral view in the lower cervical spine is common, and the CLO view is often necessary to confirm appropriate depth of needle placement [20,21].

A CLO safety view is generally recommended, especially when the needle tip lies lateral to the midline or if the lateral view is obscured by the silhouette of the shoulders [1]. It has been demonstrated that using the CLO view, first-attempt procedural success rates are significantly higher with fewer needle passes, and the view also allows for better needle tip visualization than the lateral view [19]. The CLO view provides a reliable radiographic landmark, and the epidural needle tip position is most consistently visualized at or just beyond the ventral laminar margin at the ventral interlaminar line, which reduces procedural risk [19, 20]. Due to these factors, the CLO view instead of the lateral view is favored to mitigate the risk of aberrant needle placement in most circumstances [5,19-21].

Sedation

**Myth #4: CILESI is safe to perform on patients receiving deep sedation.**

**Fact:** There have been closed claims and case reports of patients who have suffered catastrophic neurologic injuries while receiving CILESIs under deep sedation. If sedation is administered, the least amount necessary should be utilized to ensure the patient can provide verbal feedback during the procedure.

Analysis of closed claims and multiple case reports have demonstrated that there is an association between spinal cord injury and patients undergoing cervical epidural injection under deep sedation [4,12,22,23]. Patient feedback regarding any unusual sensations, traveling symptoms, worsening pain, or paresthesia is paramount to procedural safety and may be compromised with deep sedation. Reports of such symptoms should warrant pause, re-evaluation of needle positioning, and consideration for abandoning the procedure [1]. If symptoms do not subside but persist, the procedure should be abandoned [1]. Two reported cases illustrate the catastrophic effect of spinal cord damage during CILESIs initially performed at C5-C6 (repositioned to C6-C7) in patients receiving IV sedation, with both patients suffering permanent neurologic injury [22]. Similarly, a patient underwent a C5-C6 ILESI under deep sedation, resulting in the patient’s inability to provide feedback, and unfortunately, an intramedullary injection was performed. This resulted in hemiparesis and facial sensory loss [23]. Analysis of malpractice claims data from 2005-2008 has shown general anesthesia or sedation was used in 67% of cervical procedure claims with spinal cord injuries [4]. Conversely, a retrospective study of 2,494 cases found no statistical difference in the frequency of adverse events between patients who received moderate (conscious) sedation and no sedation, suggesting mild to moderate sedation is associated with low rates of adverse events when following established protocols [24].

International Pain and Spine Intervention Society (IPSIS) and American Society of Anesthesiologists guidelines state that routine use of sedation is not indicated [1,25]. A combined consensus opinion from a multidisciplinary working group and national organizations reached complete consensus from all 13 participating organizations that “moderate-to-heavy sedation is not recommended for ESIs, but if light sedation is used, the patient should remain able to communicate pain or other adverse sensations or events”[7].

If sedation is to be utilized due to legitimate patient factors, the patient should be adequately alert to provide warning of any undue sensations throughout the procedure [1]. In extreme and rare cases, such as in patients incapable of remaining still due to a movement disorder, deep sedation may be required [1]. However, the risk/benefit profile should be heavily weighed, and the patient should be informed of the additional inherent risk. Additional information on IPSIS recommendations on this topic can be found in the “Conscious Sedation” FactFinder [26] and IPSIS guidelines 2nd edition [5].
Anticoagulants/Antiplatelets

**Myth #5:** Anticoagulation and antiplatelet (ACAP) therapy should be withheld before CILESIs due to the increased risk of epidural hematoma (EH), regardless of the medical indication for the use of ACAP therapy.

**Fact:** CILESIs are an elective procedure; therefore, necessity and likelihood of benefit must be foremost considerations. Current guidelines recommend holding ACAP therapy before CILESIs due to the potentially catastrophic complications associated with EH formation. However, there is also a risk of severe systemic complications with ceasing ACAP in specific clinical scenarios. The treating physician is obligated to determine if the procedure is indicated and can ultimately decide to delay the intervention or not perform the procedure if the benefit does not outweigh the risks.

There is an inherent risk of EH whenever a CILESI is performed. The posterior spinal canal is a space of low pressure, and the epidural veins are plentiful [1]. As a result, there is a risk that even an appropriately placed needle may cause iatrogenic injury to the epidural veins and consequently result in an EH [1]. The EH could subsequently result in acute spinal cord compression with devastating neurologic effects. The risk of performing CILESI on patients taking ACAP therapy requires a “risk versus risk” assessment [27]. The incidence of EH due to CILESIs is not known [6]. The risk of clinically significant EH after ILESI appears to be low; however, based on the available literature, it is estimated that continuing anticoagulants increases the risk of EH by a factor of three [1]. The clinical significance of this risk is potentially severe, including death [1,5,6,28]. Conversely, ceasing ACAP therapy raises the risk of ischemic thrombotic or embolic complications that could also be severe, including death, albeit the likelihood also appears low [1,5,27].

The evidence on handling this scenario is primarily based on expert opinion of society working groups utilizing the available sparse evidence. As indicated by the IPSIS guidelines, “any change in the patient’s regimen of medication should be undertaken in consultation with the physician responsible for their prescription, in case there are insights, considerations or precautions of which the physician or patient is unaware” [1]. The prescribing physician may not understand the bleeding risks inherent to the specific spine intervention [27]. Likewise, the interventionist may not have an appreciation of why continuation of the ACAP therapy is essential. Ultimately, the performing interventionist should make all efforts to collaborate with the prescribing physician to be astutely aware of the nuances of each patient’s clinical scenario to estimate most rationally what is safest for the patient based on the best current evidence. A well-informed discussion of all the potential risks and alternative options should be held with the patient. Several reports in the literature illustrate the catastrophic effects of EH in patients after CILESI [28-34]; however, there remains a lack of evidence regarding the true incidence of clinically pertinent EH after CILESI [35]. Equally, there remains a lack of evidence regarding the true incidence of thromboembolic events with holding ACAP therapy for CILESIs.

The second edition of the *Interventional Spine and Pain Procedures in Patients on Antiplatelet and Anticoagulant Medications Guidelines* categorizes CILESI(s) as an intermediate risk for the potential of serious bleeding without the use of ACAP(s) [36]. If performed on patients on ACAP therapy, the working group advocates that CILESI should be considered high risk for serious bleeding [36]. These guidelines recommend holding all ACAP and fibrinolytic agents for specified timeframes before CILESI [36]. As it pertains to CILESIs and Non-Aspirins (ASA) NSAIDs/ASA use, these guidelines indicate that “consideration” should be given to the discontinuation of these medications due to “specific anatomical configurations (that) may increase the risk and consequences of procedural bleeding.” If the decision is made to hold ASA, the length of discontinuation can be adjusted, depending on whether ASA use is for primary or secondary prevention, as specified in these guidelines. The IPSIS guidelines 2nd edition indicate that non-ASA NSAIDs/ASA do not need to be held [1].
Conversely, a recent retrospective study evaluated 591 patients taking ACAP(s) who received cervical or thoracic interlaminar epidural steroid injections (IL-CTESI) [31]. In this study, 351 patients stopped their ACAP therapy before the procedure, and 240 patients continued their ACAP medications. The authors found no clinically relevant incidents of EH in either group [1]. This study provides the largest cohort to date evaluating the risk of clinically relevant EH in patients undergoing CILESIs. However, the results of this study should be viewed cautiously since the number of injections included in the study is much lower than would be required to reliably capture and quantify this complication based on current estimates of the rate of EH after percutaneous epidural access (estimated at 1:190,000) [37]. Ultimately, the risk of ischemic embolic/thrombotic complications with holding ACAP versus the risk of EH with continuing ACAP in patients undergoing CILESIs warrants continued investigation.

Summary

- CILESIs should only be performed at C6-C7 or below, with C7-T1 as the preferred access point based on an anatomic review of the cervical dorsal epidural space.
- Spinal LF gaps are most commonly found in the midline cervical spine. The gaps most commonly involve the middle and inferior thirds of the midline interlaminar LF.
- Based on the best evidence, a paramedian approach, rather than accessing the midline portion of the interlaminar space, is the better approach to avoid LF gaps.
- If LF engagement and LOR are not clearly appreciated and the epidural needle tip position appears at or just beyond the ventral laminar margin at the ventral interlaminar line, early contrast medium administration is recommended to confirm the location.
- Multiplanar fluoroscopic imaging is recommended to minimize procedural risk.
- The CLO view appears more reliable in providing better needle visualization than the lateral view.
- As indicated in the IPSIS guidelines 2nd edition and by the American Society of Anesthesiologists, routine use of sedation is not indicated.
- There have been closed claims and case reports of patients who have suffered catastrophic neurologic injuries while receiving CILESIs under deep sedation.
- If sedation is required due to patient-related factors, the least amount necessary should be utilized to allow the patient to provide verbal feedback during the procedure.
- CILESIs are elective procedures; therefore, necessity and the likelihood of benefit must be foremost considerations. Current guidelines recommend holding ACAP therapy before CILESIs due to the potentially catastrophic complications associated with EH formation. However, there is also a risk of severe systemic complications with ceasing ACAP in specific clinical scenarios. The treating physician is obligated to determine if the procedure is indicated and can ultimately decide to delay the intervention or not perform the procedure if the benefit does not outweigh the risks.
- When the interventionalist determines that ACAP medication should be held to achieve the safest outcome, documented input from the prescribing physician in agreement with this decision is recommended.

References


