

General

The Utility of Caudal Epidural Steroid Injections: A Comprehensive Review

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Purpose of Review

Caudal epidural steroid injections (ESIs) remain an important treatment option for lumbar radicular pain and other spinal pain disorders. Although transforaminal and interlaminar approaches are more commonly used in practice, the caudal approach offers unique technical and safety advantages in select patient populations. This review summarizes the current literature regarding the safety profile, technical considerations, efficacy, and clinical utility of caudal ESIs.

Recent Findings

Recent literature supports the role of caudal ESIs as a safe and effective alternative epidural access route, particularly in patients with prior lumbar surgery, severe scoliosis, extensive degenerative disease, or altered spinal anatomy. Compared to interlaminar approaches, caudal injections demonstrate a substantially lower risk of inadvertent dural puncture related to anatomic distance from the thecal sac. Catastrophic neurologic complications associated with epidural steroid injections have been reported primarily with transforaminal and cervical interlaminar approaches rather than the caudal route. Multiple systematic reviews and guideline statements report comparable efficacy between caudal, interlaminar, and transforaminal approaches for lumbar radicular pain and post-laminectomy syndrome. Image guidance with fluoroscopy or ultrasound has improved technical success and procedural safety.

Summary

Caudal epidural steroid injection remains a valuable technique for the interventional pain physician. Its favorable safety profile, technical feasibility in complex anatomy, and utility in post-surgical patients make it an important alternative when interlaminar or transforaminal access is difficult or higher risk. While limitations include the need for larger injectate volumes and potential variability in cephalad spread of medication, current evidence supports the continued role of caudal ESIs in appropriately selected patients. Future studies should focus on long-term comparative outcomes and identification of patient populations most likely to benefit from the caudal approach.

INTRODUCTION

Low back pain is a highly prevalent condition, affecting up to 80% of the global population at some point in their lifetime. It remains one of the leading causes of functional limitation and work absenteeism.¹ Lumbar radiculopathy, commonly from disc herniations or stenosis, is a frequent diagnosis associated with greater disability, pain, and healthcare resource utilization compared to axial low back pain alone.¹⁻³ Epidural steroid injections (ESIs) are among

the most frequently performed interventional procedures used in the treatment of spinal radicular pain, with millions of injections administered annually in the United States.⁴⁻⁶ Three principal approaches to accessing the epidural space are interlaminar, transforaminal, and caudal.^{7,8} Among these, the caudal approach, first described by Sicard in 1901, delivers medication into the epidural space via the sacral hiatus through the sacrococcygeal ligament.^{7,9} While the transforaminal route has yielded the most robust efficacy data for target-specific delivery, the caudal approach

offers distinct advantages in safety, technical feasibility, and applicability to complex anatomical scenarios, as further explored in this review.

HISTORICAL CONTEXT AND TECHNIQUE

The caudal epidural injection is the oldest of the three epidural approaches.¹⁰ The technique involves inserting a needle through the sacral hiatus to gain entrance to the epidural space. Anatomically, the sacral hiatus is bounded by the sacral cornua laterally and covered by the sacrococcygeal ligament.^{11,12}

The apex of the sacral hiatus most commonly lies at the level of S4, and the base at S5. This allows for safe needle placement and access to the epidural space without risking dural puncture. However, aggressive needle placement and advancement beyond the S3 level can increase the risk of dural puncture.¹³

When performed without image guidance, caudal epidural injections in adults may have relatively high failure rates, primarily due to anatomic variability of the sacral hiatus.¹¹ The use of fluoroscopic and ultrasound guidance has significantly improved the accuracy and success of caudal epidural injections. Fluoroscopy remains the gold standard because it allows confirmation of both needle placement and epidural contrast spread in real time. However, ultrasound guidance has also been shown to be highly effective for identifying the sacral hiatus and accurately guiding needle entry into the caudal epidural space, while avoiding radiation exposure.¹¹ A study by Park et al comparing ultrasound-guided and fluoroscopy-guided injections for lower back pain found no differences in pain relief, procedure time, complications, or patient satisfaction between the two modalities.¹⁴

SAFETY PROFILE

The caudal approach is widely considered the safest of the three lumbar epidural injection techniques.⁷⁻⁹ Several features contribute to this favorable safety profile.

REDUCED RISK OF DURAL PUNCTURE

A critical advantage of the caudal approach is substantially lower risk of inadvertent dural puncture compared to interlaminar injections. The thecal sac typically terminates at the S2 level, and the caudal needle enters the epidural space well below this point at the sacral hiatus.¹¹⁻¹⁴

In a prospective evaluation of over 10,000 fluoroscopically directed epidural injections, Manchikanti et al. reported that dural puncture occurred in 0.5% of all procedures overall, with rates of 1.0% for cervical interlaminar, 0.8% for lumbar interlaminar, and 1.3% for thoracic interlaminar injections.¹⁵ Notably, there were no dural punctures reported for caudal or lumbar transforaminal ESIs in this series.¹⁵ Similarly, a multi-institutional study of 16,638 consecutive procedures found that dural punctures occurred more commonly after interlaminar ESI (0.2%) than after transforaminal ESI (0.04%).¹⁶

This inherent anatomic separation from the thecal sac makes the caudal approach particularly attractive when minimizing the risk of dural puncture is a priority.¹³

OVERALL COMPLICATION RATES

The overall incidence of complications from ESIs ranges from 2.4% to 16.8%, with the most reported adverse effects being increased pain, injection site pain, and persistent numbness.^{1,17} Serious complications such as epidural hematoma, epidural abscess, nerve root injury, and paralysis are rare across all approaches.¹⁸

Catastrophic events such as cord infarction, paralysis, and death have been reported primarily after transforaminal cervical and lumbar ESIs and cervical interlaminar ESIs, but not after caudal injections.¹⁹⁻²³ Minor adverse events reported after caudal injections include transient local pain, non-specific headache, nausea, and intravascular spread of contrast, all of which are self-limiting.⁸ In a retrospective comparative study of caudal versus transforaminal ESI for chronic pain after spinal surgery, no adverse complications were reported in either group.²⁴

A survey study of interventional pain physicians who perform caudal epidural steroid injections (ESIs) by Brown et al. found that, among 86 respondents, none reported experiencing a major permanent neurological complication related to the procedure.⁹

ADVANTAGE IN POST-SURGICAL PATIENTS

One of the most clinically significant advantages of the caudal approach is its utility in patients with prior lumbar decompression surgery. The American Society of Pain and Neuroscience (ASPN) guidelines specifically note that the caudal approach “may be advantageous in patients with previous spine surgeries, such as a lumbar fusion or laminectomy, in which cases it may be unsafe or anatomically impossible to utilize the interlaminar or transforaminal approach.”²⁵ Following a laminectomy, the posterior bony landmarks commonly used for interlaminar epidural injections may be altered or absent. Additionally, disruption or removal of the ligamentum flavum can eliminate the tactile loss-of-resistance endpoint typically relied upon for safe epidural access.^{7,26,27} Postoperative epidural fibrosis and scar tissue may further distort or obliterate the posterior epidural space, increasing the risk of inadvertent dural puncture and reducing the predictability of epidural medication spread and delivery.²⁸

The caudal approach bypasses these concerns by accessing the epidural space through the sacral hiatus, which is anatomically remote from the surgical site and unaffected by prior lumbar decompression.²⁵ A systematic review by Conn et al. found Level II-1 or II-2 evidence supporting caudal epidural injections for the management of chronic pain in post-lumbar laminectomy syndrome.²⁹ The ASPN guidelines similarly report Level II evidence for caudal ESI in post-surgical syndrome.²⁵ A randomized, double-blind, active-control trial by Manchikanti et al. specifically evaluated fluoroscopically guided caudal epidural injections for

post-lumbar surgery syndrome and demonstrated that 59% of patients receiving steroids and 53% receiving local anesthetic alone showed significant improvement at 12 months, with relief sustained at 2-year follow-up.³⁰

UTILITY IN ALTERED ANATOMY AND SIGNIFICANT SCOLIOSIS

The caudal approach also offers a distinct technical advantage in patients with altered spinal anatomy, including significant scoliosis, degenerative changes, and congenital anomalies. In patients with severe scoliosis, the rotational and lateral deformity of the lumbar spine can make identification of the interlaminar window extremely challenging, and the distorted anatomy increases the risk of complications with both interlaminar and transforaminal approaches.^{31,32} Similarly, calcified interlaminar spaces, prominent osteophytes, extensive posterior fusion hardware, or other anatomic barriers may limit access through conventional lumbar interlaminar or transforaminal routes, making the caudal approach a useful alternative.

The sacral hiatus, being located below the level of the lumbar curvature, is generally unaffected by scoliotic deformity of the lumbar and thoracolumbar spine. This makes the caudal approach technically feasible even when the lumbar interlaminar and transforaminal windows are inaccessible due to rotational deformity, osteophyte formation, or facet hypertrophy. William et al. emphasized that the choice of epidural injection technique should be individualized based on the patient's clinical symptoms, underlying pathology, anatomy, and the specific risks and advantages associated with each approach.³³ In patients with significant scoliosis or other anatomic distortions of the lumbar spine, the caudal approach provides reliable epidural access without the need to navigate through distorted bony anatomy.

EFFICACY DATA

The efficacy of caudal ESIs has been evaluated across multiple pathologies. A Cochrane systematic review of 25 placebo-controlled trials found moderate-quality evidence that epidural corticosteroid injections are effective for lumbosacral radicular pain, though the effects are small and short-term.⁸ The 2025 American Academy of Neurology (AAN) systematic review found no significant difference among interlaminar, transforaminal, and caudal ESIs in short- or long-term pain or disability outcomes.¹

A comprehensive systematic review and meta-analysis of the three routes of epidural injection in lumbar disc herniation found Level II evidence for the caudal approach with steroids or local anesthetic alone for both short- and long-term relief.³⁴ For lumbar spinal stenosis, the ASPN guidelines report Level II–III evidence for caudal approaches.²⁵ A recent retrospective cohort study comparing ultrasound-guided caudal ESI to tramadol-based therapy in patients with borderline surgical lumbar spinal stenosis demonstrated significantly greater improvement in pain

(VAS) and disability (ODI) at 1 and 3 months with caudal ESI. However, the pain benefit diminished by 6 months, while functional gains persisted.³⁵

A retrospective series of 40 caudal epidural injections demonstrated favorable short-term safety and efficacy outcomes, with no reported dural punctures, infections, or permanent neurologic complications. Among patients with follow-up data, 88.9% achieved at least 50% pain relief; however, outcomes were primarily assessed at approximately 2 weeks post-procedure, limiting conclusions regarding long-term efficacy.³⁶

In the post-surgical population, a retrospective comparative study found that caudal and transforaminal ESI produced similar pain reduction and functional improvement at 1, 3, and 6 months following injection for chronic pain after spinal surgery, with the caudal approach associated with shorter procedure time and higher patient satisfaction.²⁴

CONSIDERATIONS AND LIMITATIONS

Despite its technical and safety advantages, the caudal approach has several limitations. Adequate cephalad spread of medication to the target pathology often requires relatively large injectate volumes, typically ranging from 10–20 mL, which may reduce steroid concentration at the intended site of pathology.^{37,38} In some cases, this limitation can be addressed by advancing an epidural catheter through a larger needle to deliver medication closer to the target level.^{39,40} However, catheter-based techniques may increase procedural complexity and duration, increase patient discomfort, and introduce additional risks, such as catheter-related complications, including catheter shearing or breakage.⁴¹

Anatomic variations of the sacral hiatus, including absent hiatus (reported in approximately 6.9% of specimens), shallow canal depth, and impalpable cornua, can make needle placement challenging without image guidance.¹² Additionally, intravascular uptake has been reported in a significant portion of caudal injections, necessitating the use of contrast confirmation under fluoroscopy or careful aspiration.^{42,43}

Despite these limitations, the caudal approach is generally considered the safest of the three epidural injection techniques. Reported adverse events in clinical studies are predominantly minor and transient, including headache, localized injection-site pain, and nausea, while large retrospective series have demonstrated very low rates of serious complications. Notably, the catastrophic vascular and neurologic complications reported with epidural steroid injections, including spinal cord infarction, paralysis, and death, have been primarily associated with transforaminal and cervical interlaminar approaches rather than the caudal route.

CONCLUSION

The caudal epidural steroid injection remains a valuable tool in the interventional pain physician's armamentarium.

This approach is considered among the safest and technically easiest with fluoroscopy. Its principal advantages include a markedly reduced risk of dural puncture compared to interlaminar approaches, safe applicability in patients with prior lumbar decompression surgery where interlaminar access may be unsafe or impossible, and technical feasibility in patients with significant scoliosis or other anatomic distortions of the lumbar spine. While efficacy data suggest that the caudal approach yields outcomes comparable to those of the interlaminar and transforaminal

routes, its superior safety profile makes it the preferred approach in specific clinical scenarios. Image guidance is recommended to optimize needle placement and minimize complications.

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