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Cervical Epidural Injection: Indications, Techniques, and Nursing Considerations

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Abstract

Background: Cervical radiculopathy is a common cause of neck and upper-extremity pain, often resulting from degenerative cervical spine conditions. While many patients respond to conservative management, a substantial proportion experience persistent symptoms requiring interventional treatment. Cervical epidural corticosteroid injections have emerged as a widely used option for short-term pain relief in refractory cases.

Aim: This article aims to review the indications, anatomical considerations, procedural techniques, complications, and nursing roles associated with cervical epidural corticosteroid injections in the management of cervical radiculopathy.

Methods: A narrative review approach was used, integrating anatomical knowledge, clinical indications, injection techniques, imaging guidance, complication profiles, and interprofessional nursing responsibilities. Evidence from clinical studies and established procedural practices was synthesized to provide a comprehensive clinical overview.

Results: Cervical epidural injections, particularly via the interlaminar approach, demonstrate effective short-term pain relief for selected patients, with approximately half achieving significant symptom reduction for up to three months. Fluoroscopic guidance enhances procedural accuracy and safety. Although generally safe, these injections are associated with potential complications, especially with transforaminal techniques, underscoring the importance of meticulous patient selection and skilled execution. Nursing involvement is critical in pre-procedural preparation, intra-procedural monitoring, and post-procedural care.

Conclusion: Cervical epidural corticosteroid injections represent a valuable interventional modality for cervical radiculopathy when conservative therapies fail. Optimal outcomes depend on appropriate patient selection, precise technique, and coordinated interprofessional care.

Keywords: Cervical epidural injection; Cervical radiculopathy; Pain management; Interlaminar approach; Nursing care

Introduction

Cervical epidural injections are an established interventional approach for managing cervical radiculopathy, particularly in patients who do not achieve adequate symptom relief through conservative measures. Standard non-invasive therapies include rest, non-steroidal anti-inflammatory drugs (NSAIDs), cervical immobilization with collars, and structured physical therapy programs. When these interventions fail to produce significant improvement after a period of six to eight weeks, cervical epidural injections may be considered, provided there is no evidence of progressive neurological compromise. Cervical radiculopathy demonstrates a notable epidemiologic pattern, affecting approximately 107 per 100,000 men and 63 per 100,000 women annually, with the highest incidence observed in individuals aged between 40 and 60 years [1][2][3]. Although many cases of cervical radiculopathy resolve spontaneously or with

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conservative management, interventional procedures such as epidural steroid injections have been shown to provide significant short-term symptom relief in refractory cases. Clinical evidence suggests that roughly 50% of patients report at least a 50% reduction in pain lasting up to three months following epidural administration [4][5][6]. Standard treatment protocols generally involve an initial injection, which may be followed by one or two subsequent injections at intervals of two to four weeks, depending on symptom persistence and patient response [7]. The most common etiologies include degenerative disc disease, cervical spondylolisthesis, and spinal stenosis, with nerve root compression being the principal mechanism for pain and neurological symptoms [2][8]. Among the available injection techniques, the transforaminal approach allows more precise delivery of medication to the affected nerve root. However, this method is associated with a higher risk profile, including potential complications such as infection, spinal headaches, nerve injury, and, in rare cases, catastrophic outcomes such as paralysis or death [9][10]. Catheter-based techniques, which utilize a 20-gauge catheter advanced via a loss-of-resistance syringe, provide access to higher cervical levels and can be particularly valuable for interventions near the cervicothoracic junction. These methods allow targeted delivery of therapeutic agents while minimizing systemic exposure and optimizing clinical efficacy, making them a critical tool in the management of complex cervical radiculopathy.

Anatomy and Physiology

Cervical epidural injections are administered into the epidural space, a potential anatomical compartment located between the vertebral canal and the dural sac. This space provides access to the cervical nerve roots, which, when compressed or inflamed, contribute to radicular pain in the neck, shoulder, and upper extremities. The therapeutic goal of epidural corticosteroid injections is to reduce inflammation, edema, and nociceptive signaling at the site of nerve root compression, thereby alleviating pain and improving functional outcomes. In patients with cervical radiculopathy, inflammatory changes, rather than pure mechanical compression, are often the predominant driver of symptoms. Elevation of inflammatory biomarkers, such as 1T2k VT at the neuroforamina ($P < 0.04$), but not along the spinal cord, supports the use of localized corticosteroid therapy as a targeted intervention [11][12]. Understanding cervical spine anatomy is therefore essential to ensure accurate needle placement, maximize therapeutic efficacy, and minimize the risk of complications, especially since the posterior epidural space above the C7-T1 level is relatively limited. The posterior epidural space assumes a triangular configuration, extending longitudinally from the foramen magnum to the sacral hiatus. Internally, it is bounded by the dura mater, which encases the spinal cord, dorsal root ganglia, and nerve root sleeves. Externally, the epidural space is confined by the vertebral canal and its periosteal lining. The anterior boundary is formed by the posterior longitudinal ligament, while the posterior boundary is defined by the lamina and ligamentum flavum. Importantly, midline gaps in the ligamentum flavum exist in approximately 50% of individuals, where the interspinous ligament may also be absent, which has implications for midline needle approaches during injection [13]. Laterally, the epidural space is limited by the pedicles and intervertebral foramina. The foramen itself is defined posteriorly by the superior articular process of the facet joint and anteriorly by the intervertebral disk and adjacent vertebral endplate. Within this space lie fat, radicular and cervical arteries, lymphatic channels, arachnoid granules, a venous plexus, and spinal nerve roots. Spinal nerves emerge from the dorsal and ventral rootlets of the spinal cord and exit via the intervertebral foramina, encased in the dural root sleeve. The dura terminates at the level of the dorsal root ganglion proximally, forming the initial segment of the nerve root sheath. Vascular supply to the cervical epidural space is complex, involving contributions from the vertebral artery, ascending cervical artery, subclavian branches, and deep cervical arteries. These vessels penetrate the foramina and bifurcate into anterior and posterior radicular arteries, supplying both neural and meningeal structures [14]. This intricate vascular anatomy underscores the necessity for precise needle placement during cervical epidural injections to avoid arterial injury, intravascular injection, or hemorrhagic complications. Knowledge of epidural fat distribution, nerve root orientation, and ligamentous landmarks is therefore critical for safe and effective administration of corticosteroids and local anesthetics in the management of cervical radiculopathy.

Indications

Cervical epidural injections are primarily indicated for patients experiencing radicular pain or neck pain originating from discogenic pathology, including degenerative disc disease, cervical spondylosis, or herniated intervertebral discs. Clinical presentation often includes sensory disturbances such as numbness, tingling, burning sensations, or dysesthesia following a dermatomal distribution corresponding to the affected nerve root. Prior to intervention, careful assessment of symptom progression is essential. Serial neurological examinations should evaluate motor strength, reflexes, and the presence of upper motor neuron signs to ensure that there is no evidence of acute or worsening neurological compromise. These injections are generally preferred for patients whose pain escalates despite conservative management—including physical therapy, non-steroidal anti-inflammatory drugs, or activity modification—

provided there is no progressive motor deficit. Preprocedural imaging using magnetic resonance imaging (MRI) or computed tomography is critical to confirm stable nerve root compression and to identify anatomical variations or high-risk levels, reducing the risk of complications such as inadvertent high spinal anesthesia, intravascular injection, or cord injury [13][14].

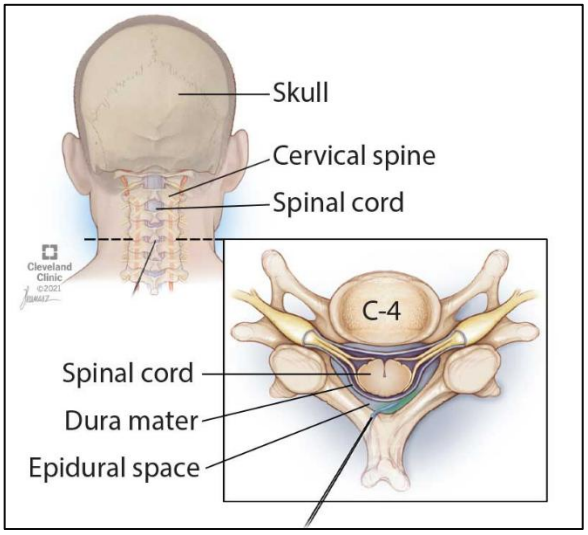

Fig. 1: Cervical Epidural Injection.

Contraindications

Cervical epidural corticosteroid injections carry both absolute and relative contraindications that must be carefully evaluated prior to performing the procedure. Absolute contraindications include the presence of active local or systemic infection, which increases the risk of introducing pathogens into the epidural space and can precipitate epidural abscess or meningitis. Patients with uncontrolled coagulopathy, including those on oral anticoagulants or with underlying bleeding disorders, are at elevated risk of epidural hematoma formation, which may lead to permanent neurological compromise. Progressive neurological deficits, such as worsening motor weakness or sensory loss, constitute another absolute contraindication, as these patients require urgent surgical evaluation rather than conservative interventional management. High-grade cervical spondylolisthesis or critical spinal stenosis that threatens cord integrity also precludes the use of cervical epidural injections until surgical stabilization can be performed. Uncontrolled hyperglycemia is a further consideration, particularly when corticosteroids are used, as they may exacerbate glycemic instability. Relative contraindications include poorly controlled chronic conditions, such as hypertension or diabetes mellitus, which may increase procedural risk. Pregnancy is considered a relative contraindication due to the potential teratogenic effects of fluoroscopic radiation and systemic corticosteroids. Other factors, such as severe anatomical variations, prior cervical spine surgery, or patient inability to cooperate during the procedure, also necessitate careful evaluation. Overall, meticulous patient selection based on a comprehensive medical history, current comorbidities, and pre-procedural imaging is essential to minimize complications and optimize procedural outcomes. Proper counseling regarding risks, benefits, and alternatives is a critical component of pre-procedural preparation [14][15].

Equipment

Cervical epidural corticosteroid injections require specialized equipment to ensure precise delivery and patient safety. Topical anesthetics, typically lidocaine, are applied to minimize procedural discomfort and facilitate accurate needle placement. The selection of an appropriate needle is crucial: a Tuohy epidural needle (17–20 gauge) is standard for interlaminar approaches, whereas a Quincke spinal needle (22–25 gauge) is often used for transforaminal injections to allow precise targeting of the nerve root. Syringes with low resistance facilitate controlled delivery of the injectate, which generally comprises preservative-free corticosteroids, local anesthetic, and sometimes saline. Corticosteroids may be particulate or non-particulate depending on the approach and target anatomy, with non-particulate formulations favored for transforaminal injections to reduce the risk of embolic complications. Fluoroscopic imaging is essential for real-time needle guidance, with a C-arm positioned to obtain multiple projections. Contrast dye is used to confirm epidural space placement and ensure accurate spread of medication. Radiation safety requires all personnel in the procedure room to wear lead aprons and thyroid shields, with proper monitoring of cumulative exposure. Optional adjunct equipment may include nerve stimulators or ultrasound devices for anatomic localization, although fluoroscopy remains the primary imaging modality. Hemostatic materials and standard sterile instruments are also required for site preparation and sterile field maintenance. Ensuring all equipment is functional and accessible prior to initiation is critical to maintaining procedural efficiency, accuracy, and patient safety [14].

Personnel

Cervical epidural injections necessitate a multidisciplinary team to ensure procedural safety and effectiveness. The primary operator is typically a pain management specialist, often trained in anesthesiology, physical medicine, and rehabilitation, with competency in interventional spine procedures. Neurosurgeons, orthopedic spine surgeons, and interventional radiologists may also perform these procedures in select settings. A radiologic technologist operates the C-arm, facilitating imaging acquisition and optimizing needle visualization, although the proceduralist maintains control over needle trajectory. A circulating nurse, physician assistant, or medical assistant supports patient monitoring, documentation, and sterile field

management, delivering instruments and supplies as needed. Although most cervical epidural injections are performed with minimal or no sedation, personnel trained in procedural sedation must be available when sedation is indicated. Continuous monitoring of vital signs and readiness to manage emergent complications, including high cervical block, airway compromise, or cardiovascular instability, is essential. Equipment for immediate resuscitation, including a crash cart, must be accessible. Post-procedure monitoring depends on sedation status; patients who receive sedatives require extended observation for respiratory depression, hemodynamic instability, or delayed neurological changes. Effective interprofessional communication is critical, particularly in recognizing early signs of neurological compromise, hemodynamic instability, or adverse reactions to corticosteroids, ensuring timely intervention and patient safety [14].

Preparation

Pre-procedural preparation for cervical epidural injections is essential to maximize safety and efficacy. Patient positioning is critical: supine or prone positioning with the neck slightly flexed allows optimal access to the epidural space. Sedation is minimized to permit continuous patient feedback, as sudden paresthesia or motor response may indicate needle proximity to neural structures. Prior imaging, ideally MRI or CT, is mandatory to identify anatomical variations, the degree and level of nerve root compression, and to rule out conditions such as severe spinal stenosis or tumor. In patients with contraindications to MRI, myelography or computed tomography can provide alternative visualization of the epidural space. Electrodiagnostic studies may supplement imaging when diagnostic uncertainty exists. Aseptic technique is strictly maintained, with the proceduralist and all personnel donning sterile gowns, gloves, and masks. The skin overlying the targeted cervical level is disinfected thoroughly, and local anesthesia is infiltrated along the planned needle trajectory. Fluoroscopic guidance is used throughout needle advancement, with intermittent imaging to confirm alignment and final positioning. Contrast dye is injected to verify epidural spread, followed by the administration of the corticosteroid and anesthetic mixture. Post-injection, the patient is monitored for vital sign stability, neurological integrity, and potential adverse reactions. Clear post-procedural instructions are provided regarding activity restrictions, warning signs of complications, and follow-up schedules to optimize outcomes.

Technique or Treatment

Cervical epidural corticosteroid injections are primarily performed under fluoroscopic guidance to ensure accurate delivery of medication into the epidural space and to minimize the risk of complications.[15][17] Fluoroscopy provides real-time imaging that allows the clinician to visualize bony landmarks, guide needle trajectory, and confirm correct positioning. Although computed tomography (CT) fluoroscopy offers superior resolution and more detailed anatomical visualization, its use is limited due to high radiation exposure to both the patient and the operator, making it impractical for routine clinical practice.[18][19] Patient positioning is a critical component of the procedure. The patient is typically placed in a prone position with arms positioned comfortably at the sides and the head supported in slight flexion. This positioning facilitates optimal exposure of the cervical interlaminar spaces and widens the posterior elements of the cervical spine, providing safer access to the epidural space. Sterile preparation of the injection site is mandatory to reduce the risk of infection, with agents such as iodine-based solutions or chlorhexidine applied carefully to cover the posterior cervical skin over the target level. The most frequently employed technique is the interlaminar approach, which involves insertion of a Tuohy needle between the laminae of adjacent vertebrae. The needle is advanced until a “loss of resistance” is felt, indicating penetration through the ligamentum flavum into the epidural space. Once in the epidural space, contrast dye is injected under fluoroscopic control to confirm correct distribution, followed by aspiration to rule out intrathecal or intravascular placement. Only after these verification steps is the corticosteroid administered, typically combined with preservative-free saline and optionally a local anesthetic. Corticosteroid selection depends on the procedure type; particulate steroids, such as triamcinolone, are used cautiously, while non-particulate steroids like dexamethasone are preferred for high-risk procedures due to lower risk of embolic complications. Continuous communication with the patient throughout the procedure is essential to detect early neurological symptoms, which may indicate inadvertent nerve root or spinal cord contact. The C7-T1 level is often preferred for interlaminar injections because the ligamentum flavum is consistently present at this level, providing a safer and more reliable landmark and reducing the risk of complications such as dural puncture or spinal cord injury.

The transforaminal approach provides direct delivery of corticosteroids adjacent to the affected nerve root but carries higher procedural risk and is therefore less commonly used. This approach requires oblique fluoroscopic views to optimize visualization of the neural foramen and associated vascular structures. A fine spinal needle, commonly a Quincke needle, is advanced beneath the pedicle of the superior vertebra into the posterior aspect of the neural foramen. Fluoroscopic angulation of approximately 70° toward the ipsilateral side improves visualization and facilitates safe needle placement while avoiding arterial and venous structures within the foramen.[24] Live contrast

injection is performed to ensure that there is no intravascular spread, and a non-particulate corticosteroid combined with local anesthetic and saline is administered. Patient monitoring during the transforaminal procedure is critical, as inadvertent vascular injection can lead to catastrophic outcomes including spinal cord infarction. Emerging imaging modalities, such as ultrasound-guided cervical epidural injections, have demonstrated potential advantages in select studies. Ultrasound allows visualization of vascular structures in real time, which may reduce the risk of inadvertent arterial puncture and improve procedural safety.[25] However, the utility of ultrasound is limited in the cervical spine for interlaminar approaches due to the obstruction caused by bony elements, which prevent direct visualization of the epidural space. As a result, fluoroscopy remains the standard imaging technique for cervical epidural corticosteroid injections, with ultrasound currently serving as an adjunct or alternative for select transforaminal procedures where vascular mapping is critical. In summary, cervical epidural corticosteroid injection requires careful planning, precise anatomical knowledge, and meticulous technique. Proper patient positioning, strict adherence to sterile protocols, real-time imaging guidance, careful selection of corticosteroid formulation, and continuous patient communication are all critical components that contribute to procedural success and minimize risks. Both interlaminar and transforaminal approaches have distinct advantages and limitations, with fluoroscopy remaining the standard of care, while ultrasound-guided techniques represent an emerging modality with potential safety benefits in select clinical scenarios.

Complications

Cervical epidural corticosteroid injections are generally considered safe, yet complications—although uncommon—can be significant, especially with the transforaminal approach. Serious adverse events such as paralysis, spinal cord injury, or death have been reported, though these occurrences are rare.[4][26][27] The overall complication rate for cervical epidural injections is estimated at approximately 16.8%, encompassing both minor and major adverse outcomes.[28] Complications may arise if the needle inadvertently contacts the spinal cord, nerve roots, or vascular structures, or if contamination occurs during the procedure.[18][29][30] Mechanisms for severe complications remain incompletely understood, but proposed causes include arterial embolism, thrombus formation, arterial vasospasm, aortic dissection leading to hemorrhage, and dural puncture, all of which can precipitate catastrophic neurological sequelae.[27][28][31][32] Potential adverse outcomes include epidural hematoma, spinal abscess, hemorrhage, infarction, or paralysis. Notably, no severe complications have been documented with dexamethasone, suggesting a relative safety advantage of non-particulate corticosteroids. Specific complications differ between the interlaminar and transforaminal approaches. Interlaminar injections carry risks such as dural puncture, nerve root injury, transient paresthesias, vasovagal reactions, epidural hematoma, subdural hematoma, transient blindness, spinal cord injury, epidural abscess, paralysis, and death. Transforaminal injections are associated with increased radicular pain, vasovagal reactions, dural puncture, temporary lightheadedness, transient global amnesia, vertebral artery injury, cerebellar infarction, and death. The most frequently reported minor complications include neck pain (6.7%), headache (1.7%), insomnia (1.7%), and vasovagal reactions (1.5%). The incidence of dural puncture is approximately 0.3% for transforaminal injections, while interlaminar injections show a reported rate of 0.25% to 2.0%. Headache following interlaminar injection has been reported in 4.5% of patients, and transient exacerbation of radicular pain has been noted in up to 18% of cases.[33][34][35][36] Although rare, these complications highlight the importance of careful patient selection, meticulous technique, and immediate availability of emergency care resources.

Clinical Significance

Cervical epidural corticosteroid injections offer targeted intervention for patients with radicular pain due to cervical nerve compression, providing short-term pain relief when conservative therapies fail.[2] The efficacy of these injections is closely related to the etiology and severity of nerve root compression. Studies suggest that up to one-third of patients may experience recurrent radicular symptoms following initial treatment, indicating that repeated injections within a year may provide synergistic benefit in selected cases. Interlaminar injections are supported by more robust evidence compared to transforaminal injections, which carry a higher risk of vascular complications and have more limited data regarding effectiveness.[37][38] Cervical epidural injections are particularly effective for pain caused by cervical disc herniation, central spinal stenosis, and post-surgical syndromes. Randomized controlled trials remain limited in number and quality, especially regarding long-term outcomes. Moderate evidence supports short-term pain relief (<6 weeks), although long-term data remain sparse.[39] Some studies indicate that corticosteroid epidurals provide superior immediate pain reduction compared to local anesthetic alone, yet this effect may not persist beyond three weeks. In one analysis, 24% of patients achieved complete symptom resolution, 40% experienced at least 75% pain reduction, and 32% reported no relief. Among patients with structural abnormalities on imaging, only 35% reported a 50% or greater reduction in pain.[35][40][41] These findings highlight the variability of patient response and underscore the

necessity of comprehensive assessment and individualized treatment planning.

Enhancing Healthcare Team Outcomes

The management of patients undergoing cervical epidural injections requires a coordinated interprofessional approach to ensure safety and optimize outcomes. Comprehensive patient evaluation is essential prior to the procedure, including assessment by a primary care clinician, imaging confirmation of nerve root compression via MRI or CT, and, when indicated, nerve conduction studies or electromyography. Pharmacists should review medications, particularly anticoagulants, that may increase bleeding risk. In cases of severe or progressive neurological deficits, neurosurgical consultation is necessary. The injection itself is typically performed by a trained pain medicine physician, anesthesiologist, interventional neurologist, or physical medicine and rehabilitation specialist. Radiology technicians provide fluoroscopic support, while nursing staff monitor vital signs, maintain the sterile field, and assist with patient positioning and documentation.

Nursing, Allied Health, and Interprofessional Team Interventions

Post-procedure care emphasizes monitoring for adverse events, including neurological deficits, vasovagal reactions, and localized hematoma formation. Patients are typically observed for 20 to 30 minutes, with longer monitoring if sedation was administered. Nursing staff provide education regarding post-injection activity restrictions, analgesic use, and potential warning signs such as new weakness, numbness, or severe pain. Most patients can return to normal activities the following day, though temporary soreness at the injection site is common and may be managed with ice or acetaminophen. Repeated injections, often up to three spaced 1–4 weeks apart, are employed for persistent pain. Physical therapy plays a critical role in post-injection rehabilitation by addressing underlying biomechanical deficits, improving posture, enhancing cervical mobility, and strengthening supporting musculature. Individualized home exercise programs complement clinical therapy to promote long-term spinal health and reduce recurrence risk. By fostering collaboration among physicians, nurses, physical therapists, pharmacists, and radiology staff, the interprofessional team ensures patient safety, maximizes therapeutic benefit, and facilitates recovery from cervical radiculopathy, ultimately improving overall patient outcomes and satisfaction.

Conclusion:

Cervical epidural corticosteroid injections play an important role in the non-surgical management of cervical radiculopathy, particularly for patients who fail to achieve adequate relief through conservative measures. By delivering anti-inflammatory medication directly into the epidural space, these injections target nerve root inflammation and provide meaningful short-term pain reduction, allowing patients to regain function and participate more effectively in rehabilitative therapies. Despite their clinical benefits, cervical epidural injections are technically demanding procedures with potential risks. Complications, although uncommon, can be severe, particularly when transforaminal techniques are used or when anatomical and vascular considerations are not meticulously respected. The use of fluoroscopic guidance, preference for non-particulate corticosteroids in high-risk cases, and adherence to strict aseptic technique are essential to minimize adverse outcomes. Nurses and allied health professionals are integral to the success and safety of cervical epidural injections. Their responsibilities extend from pre-procedure assessment and patient education to vigilant monitoring for neurological or systemic complications following the injection. Collaboration among physicians, nurses, radiology technicians, and rehabilitation specialists ensures comprehensive care and optimal patient outcomes. In summary, cervical epidural corticosteroid injections are an effective adjunct in managing cervical radiculopathy when applied judiciously within an interprofessional framework that emphasizes patient safety, clinical expertise, and evidence-based practice.

References:

1. Iyer S, Kim HJ. Cervical radiculopathy. Current reviews in musculoskeletal medicine. 2016 Sep:9(3):272-80. doi: 10.1007/s12178-016-9349-4.
2. Radhakrishnan K, Litchy WJ, O'Fallon WM, Kurland LT. Epidemiology of cervical radiculopathy. A population-based study from Rochester, Minnesota, 1976 through 1990. Brain : a journal of neurology. 1994 Apr:117 (Pt 2)():32
3. Sampath P, Bendebba M, Davis JD, Ducker T. Outcome in patients with cervical radiculopathy. Prospective, multicenter study with independent clinical review. Spine. 1999 Mar 15:24(6):591-7
4. Engel A, King W, MacVicar J, Standards Division of the International Spine Intervention Society. The effectiveness and risks of fluoroscopically guided cervical transforaminal injections of steroids: a systematic review with comprehensive analysis of the published data. Pain medicine (Malden, Mass.). 2014 Mar:15(3):386-402. doi: 10.1111/pme.12304.
5. Conger A, Cushman DM, Speckman RA, Burnham T, Teramoto M, McCormick ZL. The Effectiveness of Fluoroscopically Guided Cervical Transforaminal Epidural Steroid Injection for the Treatment of Radicular Pain; a Systematic Review and Meta-analysis. Pain

medicine (Malden, Mass.). 2020 Jan 1:21(1):41-54. doi: 10.1093/pm/pnz127.
6. Stephens AR, Bender NR, Snyder JM, Patel RK, El-Hassan R. Evaluating the effectiveness of interlaminar epidural steroid injections for cervical radiculopathy using PROMIS as an outcome measure. Interventional pain medicine. 2024 Dec:3(4):100528. doi: 10.1016/j.inpm.2024.100528.
7. Persson L, Anderberg L. Repetitive transforaminal steroid injections in cervical radiculopathy: a prospective outcome study including 140 patients. Evidence-based spine-care journal. 2012 Aug:3(3):13-20. doi: 10.1055/s-0032-1327805.
8. Kuijper B, Tans JT, Schimsheimer RJ, van der Kallen BF, Beelen A, Nollet F, de Visser M. Degenerative cervical radiculopathy: diagnosis and conservative treatment. A review. European journal of neurology. 2009 Jan:16(1):15-20. doi: 10.1111/j.1468-1331.2008.02365.x.
9. Manchikanti L, Buenaventura RM, Manchikanti KN, Ruan X, Gupta S, Smith HS, Christo PJ, Ward SP. Effectiveness of therapeutic lumbar transforaminal epidural steroid injections in managing lumbar spinal pain. Pain physician. 2012 May-Jun:15(3):E199-245
10. Wadhwa H, Rohde M, Koltsov JCB, Cabell A, Smuck M, Hu SS, Kleimeyer JP. Incidence and risk factors for complications following cervical epidural steroid injections. The spine journal : official journal of the North American Spine Society. 2025 May:25(5):886-902. doi: 10.1016/j.spinee.2024.12.003.
11. Holder EK, Lee H, Raghunandan A, Marshall B, Michalik A, Nguyen M, Saffarian M, Schneider BJ, Smith CC, Tiegs-Heiden CA, Zheng P, Patel J, Levi D, International Pain and Spine Intervention Society's Patient Safety Committee. FACTFINDERS FOR PATIENT SAFETY: Minimizing risks with cervical epidural injections. Interventional pain medicine. 2024 Sep:3(3):100430. doi: 10.1016/j.inpm.2024.100430.
12. Lutke Schipholt IJ, Koop MA, Coppieters MW, van de Giessen EM, Lammerstma AA, Ter Meulen BC, Vleggeert-Lankamp C, van Berckel BNM, Bot J, van Helvoirt H, Depauw PR, Boellaard R, Yaqub M, Scholten-Peeters G. Neuroinflammation at the Neuroforamina and Spinal Cord in Patients with Painful Cervical Radiculopathy and Pain-Free Participants: An [(11)C]DPA713 PET/CT Proof-of-Concept Study. Journal of clinical medicine. 2025 Apr 2:14(7):. doi: 10.3390/jcm14072420.
13. Hogan QH. Epidural anatomy examined by cryomicrotome section. Influence of age, vertebral level, and disease. Regional anesthesia. 1996 Sep-Oct:21(5):395-406
14. Huntoon MA. Anatomy of the cervical intervertebral foramina: vulnerable arteries and ischemic neurologic injuries after transforaminal epidural injections. Pain. 2005 Sep:117(1-2):104-11
15. Rathmell JP, Benzon HT, Dreyfuss P, Huntoon M, Wallace M, Baker R, Riew KD, Rosenquist RW, Aprill C, Rost NS, Buvanendran A, Kreiner DS, Bogduk N, Fourney DR, Fraifeld E, Horn S, Stone J, Vorenkamp K, Lawler G, Summers J, Kloth D, O'Brien D Jr, Tutton S. Safeguards to prevent neurologic complications after epidural steroid injections: consensus opinions from a multidisciplinary working group and national organizations. Anesthesiology. 2015 May:122(5):974-84. doi: 10.1097/ALN.0000000000000614.
16. Huston CW, Slipman CW. Diagnostic selective nerve root blocks: indications and usefulness. Physical medicine and rehabilitation clinics of North America. 2002 Aug:13(3):545-65
17. Benzon HT, Huntoon MA, Rathmell JP. Improving the safety of epidural steroid injections. JAMA. 2015 May 5:313(17):1713-4. doi: 10.1001/jama.2015.2912.
18. Wagner AL. CT fluoroscopic-guided cervical nerve root blocks. AJNR. American journal of neuroradiology. 2005 Jan:26(1):43-4
19. Kranz PG, Raduazo PA. Technique for CT fluoroscopy-guided cervical interlaminar steroid injections. AJR. American journal of roentgenology. 2012 Mar:198(3):675-7. doi: 10.2214/AJR.11.6809.
20. Hashizume K, Fujiwara A, Watanabe K, Kamihara M, Iwasaki S, Yamagami H. A Prospective Comparison of CT-Epidurogram Between Th1-Transforaminal Epidural Injection and Th1/2-Parasagittal Interlaminar Epidural Injection for Cervical Upper Limb Pain. Pain physician. 2019 Mar:22(2):165-176
21. Lee JH, Sim KC, Kwon HJ, Kim JW, Lee G, Cho SS, Choi SS, Leem JG. Effectiveness of lumbar epidural injection in patients with chronic spinal stenosis accompanying redundant nerve roots. Medicine. 2019 Mar:98(9):e14490. doi: 10.1097/MD.0000000000014490.
22. Przkora R, Kinsky MP, Fisher SR, Babl C, Heyde CE, Vasilopoulos T, Kaye AD, Volpi E. Functional Improvements Utilizing the Short Physical Performance Battery (SPPB) in the Elderly after Epidural Steroid Injections. Current pain and headache reports. 2019 Feb 22:23(2):14. doi: 10.1007/s11916-019-0748-2.
23. McCafferty B, Williams R. Epidural steroid injection technique. Techniques in vascular and interventional radiology. 2024 Sep:27(3):100981. doi: 10.1016/j.tvir.2024.100981.
24. Karm MH, Park JY, Kim DH, Cho HS, Lee JY, Kwon K, Suh JH. New Optimal Needle Entry Angle for Cervical Transforaminal Epidural

Steroid Injections: A Retrospective Study. International journal of medical sciences. 2017:14(4):376-381. doi: 10.7150/ijms.17112.
25. Zhang X, Shi H, Zhou J, Xu Y, Pu S, Lv Y, Wu J, Cheng Y, Du D. The effectiveness of ultrasound-guided cervical transforaminal epidural steroid injections in cervical radiculopathy: a prospective pilot study. Journal of pain research. 2019:12():171-177. doi: 10.2147/JPR.S181915.
26. Pountos I, Panteli M, Walters G, Bush D, Giannoudis PV. Safety of Epidural Corticosteroid Injections. Drugs in R&D. 2016 Mar:16(1):19-34. doi: 10.1007/s40268-015-0119-3.
27. Scanlon GC, Moeller-Bertram T, Romanowsky SM, Wallace MS. Cervical transforaminal epidural steroid injections: more dangerous than we think? Spine. 2007 May 15:32(11):1249-56
28. Malhotra G, Abbasi A, Rhee M. Complications of transforaminal cervical epidural steroid injections. Spine. 2009 Apr 1:34(7):731-9. doi: 10.1097/BRS.0b013e318194e247.
29. Rathmell JP, Aprill C, Bogduk N. Cervical transforaminal injection of steroids. Anesthesiology. 2004 Jun:100(6):1595-600
30. Seddio AE, McNamara KF, Gouzoulis MJ, Jabbouri SS, Vasudevan RS, Day W, Ratnasamy PP, Rubio DR, Grauer JN. Comparable Overall Risk of Neurologic Adverse Events Following Cervicothoracic Interlaminar and Transforaminal Epidural Injections: An Analysis of 1.29 Million Patients. Spine. 2024 Oct 11:():. doi: 10.1097/BRS.0000000000005181.
31. Ziai WC, Ardelt AA, Llinas RH. Brainstem stroke following uncomplicated cervical epidural steroid injection. Archives of neurology. 2006 Nov:63(11):1643-6
32. Rozin L, Rozin R, Koehler SA, Shakir A, Ladham S, Barmada M, Dominick J, Wecht CH. Death during transforaminal epidural steroid nerve root block (C7) due to perforation of the left vertebral artery. The American journal of forensic medicine and pathology. 2003 Dec:24(4):351-5
33. Ma DJ, Gilula LA, Riew KD. Complications of fluoroscopically guided extraforaminal cervical nerve blocks. An analysis of 1036 injections. The Journal of bone and joint surgery. American volume. 2005 May:87(5):1025-30
34. Huston CW, Slipman CW, Garvin C. Complications and side effects of cervical and lumbosacral selective nerve root injections. Archives of physical medicine and rehabilitation. 2005 Feb:86(2):277-83
35. Ferrante FM, Wilson SP, Iacobo C, Orav EJ, Rocco AG, Lipson S. Clinical classification as a predictor of therapeutic outcome after cervical epidural steroid injection. Spine. 1993 May:18(6):730-6
36. Siegfried RN. Development of complex regional pain syndrome after a cervical epidural steroid injection. Anesthesiology. 1997 Jun:86(6):1394-6
37. House LM, Barrette K, Mattie R, McCormick ZL. Cervical Epidural Steroid Injection: Techniques and Evidence. Physical medicine and rehabilitation clinics of North America. 2018 Feb:29(1):1-17. doi: 10.1016/j.pmr.2017.08.001.
38. Manchikanti L, Falco FJ, Diwan S, Hirsch JA, Smith HS. Cervical radicular pain: the role of interlaminar and transforaminal epidural injections. Current pain and headache reports. 2014 Jan:18(1):389. doi: 10.1007/s11916-013-0389-9.
39. Abdi S, Datta S, Trescot AM, Schultz DM, Adlaka R, Atluri SL, Smith HS, Manchikanti L. Epidural steroids in the management of chronic spinal pain: a systematic review. Pain physician. 2007 Jan:10(1):185-212
40. Anderberg L, Annertz M, Persson L, Brandt L, Säveland H. Transforaminal steroid injections for the treatment of cervical radiculopathy: a prospective and randomised study. European spine journal : official publication of the European Spine Society, the European Spinal Deformity Society, and the European Section of the Cervical Spine Research Society. 2007 Mar:16(3):321-8
41. Mangar D, Thomas PS. Epidural steroid injections in the treatment of cervical and lumbar pain syndromes. Regional anesthesia. 1991 Jul-Aug:16(4):246