Transforaminal Epidural Steroid Injections

16

Todd B. Sitzman

Key Points

- Epidural steroid injections are a clinical and cost-effective method for treating acute and chronic spinal pain.
- Transforaminal epidural injections are a more specific treatment than interlaminal epidural injections for radicular but not axial back pain.
- Many pain medicine specialists believe that cervical transforaminal epidural injections are contraindicated given the relatively high-risk benefit ratio; extra training is necessary to complete these procedures safely.

Introduction

Epidural steroid injections (ESIs) play a fundamental role in the treatment of acute and chronic spinal pain and have shown clinical and cost-effectiveness. This is especially true when used in well-selected patients as part of a conservative, non-surgical rehabilitative program. While the epidural space can be targeted by interlaminar, transforaminal, or caudal approaches, this chapter will focus on transforaminal epidural steroid injections (TFESI) including anatomic considerations, patient selection, technique, and outcome. Complications and risk mitigation will be covered elsewhere.

Anatomic Considerations

Knowledge of spinal anatomy, specifically the epidural space, is of significant importance when deciding upon which approach to utilize for an ESI. The epidural space lies between the osseoligamentous structures of the vertebral canal and the dural membrane shielding the contents of the thecal sac: cerebrospinal fluid, nerve roots, and spinal cord. While the thecal sac extends from the foramen magnum to approximately the S2 level, the epidural space extends to the level of the sacral hiatus at S4 or S5.

The epidural space contains adipose tissue, loose areolar tissue, arteries, lymphatics, and a rich venous plexus network. Contiguous with the thecal sac along its entire spinal course, the epidural space is anatomically divided into posterior and anterior compartments. The pain medicine specialist must fully appreciate the anatomy of the epidural space and how it relates to the ESI technique being considered. The posterior epidural space, typically accessed using an *interlaminar* approach, is bordered anteriorly by the thecal sac and posteriorly by the ligamentum flavum and the laminae. The anterior epidural space, most often accessed by a *transforaminal* approach, is bordered anteriorly by the vertebral body, intervertebral disc, and posterior longitudinal ligament and posteriorly by the thecal sac. The sacral epidural space may be accessed inferiorly by a *caudal* approach via the sacral hiatus. There are relative advantages of using one ESI approach over another depending upon the targeted pain generator, anatomic considerations (e.g., previous spinal surgery, decreased interlaminar space), and medical conditions (e.g., anticoagulation status). Interlaminar and caudal ESI approaches are discussed in other chapters. This chapter will focus on the transforaminal ESI techniques, benefits, cautions, and a review of the literature regarding efficacy over non-transforaminal ESI techniques.

A misperception is that transforaminal ESIs have greater diagnostic and therapeutic specificity than interlaminar ESIs. The relative diagnostic "specificity" of a transforaminal ESI corresponds to radicular pain only – not for axial back pain. A smaller volume of injectate, local anesthetic and corticosteroid, used in the transforaminal ESI approach may be more selective for one spinal nerve level. However,

T.B. Sitzman, M.D., MPH (✉)
Advanced Pain Therapy, PLLC, 7125 Highway 98,
Hattiesburg, MS 39402, USA
e-mail: toddsitzman@msn.com

T.R. Deer et al. (eds.), *Treatment of Chronic Pain by Interventional Approaches: the AMERICAN ACADEMY of PAIN MEDICINE Textbook on Patient Management*, DOI 10.1007/978-1-4939-1824-9_16,
© American Academy of Pain Medicine 2015

the injectate also affects several additional neural structures including the sinuvertebral nerve and dorsal primary ramus and its branches.

Patient Selection

Transforaminal ESIs can have a therapeutic role in the treatment of:

- Disc herniation
- Spinal nerve root compression
- Spinal nerve root irritation – traumatic
- Spinal nerve root inflammation – infectious, e.g., herpes zoster
- Spinal stenosis – foraminal or central canal

There may also be a diagnostic role for TFESIs in patients with radicular pain resulting from nerve root compression or in the planning for decompressive surgery [1, 2]. TFESIs may also benefit patients with radicular symptoms at the level of prior decompressive surgery. TFESIs avoid the potential for false-negative results and complications associated with an interlaminar approach at the site of previous surgery. In such cases, epidural fibrosis and adhesions may hinder the spread of epidural injectate from reaching the intended neural target, and scar tissue may increase the risk of dural puncture associated with interlaminar ESIs [1, 2].

Lumbar Transforaminal Approach

The patient is positioned in the prone position on the fluoroscopic table. An oblique view is obtained, aligning the pedicle of the superior vertebra with the superior articular process of the inferior vertebra. The target site is the 6 o'clock position of the pedicle. The skin over this target site is marked and prepped with an appropriate skin antiseptic. Using sterile technique throughout, the skin and subcutaneous tissues are anesthetized with 1 % lidocaine. A spinal needle is slowly advanced toward the target 6 o'clock position of the pedicle using intermittent fluoroscopic imaging. It is not necessary to advance the needle until bony contact, but imaging in multiple fluoroscopic planes (anterior-posterior, oblique, and lateral) is recommended to ensure proper needle tip position. The "safe triangle" for needle tip location, as visualized on an anterior-posterior fluoroscopic plane, corresponds to the following locations: *base* of the triangle is the inferior border of the pedicle, medial *side* of the triangle is the exiting spinal nerve, and lateral *side* of the triangle is lateral border of the vertebral body. The protection offered by the "safe triangle" relates to neural structures, not to vascular structures including the artery of Adamkiewicz.

Following negative aspiration for blood and cerebrospinal fluid, injection of 1 ml of radiocontrast agent under continuous fluoroscopic visualization should reveal contrast spread medially into the neural foramen and the epidural space. Once proper contrast flow has been determined, injection of local anesthetic and steroid admixture may be injected.

Thoracic Transforaminal Approach

In theory, the transforaminal approach to the thoracic epidural space is similar to the lumbar approach. However, there are anatomic differences that must be appreciated. The pedicles of the thoracic vertebrae are directed posterosuperiorly from the transverse process, and there are two costal articulations that are not present in the lumbar spine. In addition to zygapophysial joints, the head of each rib articulates with a superior costal facet at the posterolateral aspect of the vertebral body – located lateral to the base of the pedicle. A transverse costal facet is located at the lateral border of the transverse process. Visualized in the lateral fluoroscopic view, the relatively large neural foramina are bounded superiorly by the inferior undersurface of the pedicle and inferiorly by the superior articular process of the more caudal vertebra.

The patient is positioned in the prone position on the fluoroscopic table. An ipsilateral oblique view of approximately 20° is needed to visualize the pedicle. The target site is the 6 o'clock position of the pedicle. The skin over this target site is marked and prepped, and local anesthetic is infiltrated. A spinal needle is slowly advanced toward the target 6 o'clock position of the pedicle using intermittent fluoroscopic imaging. Fluoroscopic imaging in the oblique, anterior-posterior, and lateral planes is mandatory to ensure that the needle tip is in the superior aspect of the neural foramen, at the 6 o'clock position of the pedicle. Following negative aspiration for blood and cerebrospinal fluid, injection of 1 ml of radiocontrast agent under continuous fluoroscopic visualization should reveal contrast spread medially into the neural foramen and the epidural space. Once proper contrast flow has been determined, injection of local anesthetic and steroid admixture may be injected.

It is mandatory that radiocontrast injection occur under live fluoroscopy to visualize the possibility of vascular uptake. The *artery of Adamkiewicz* supplies the anterior spinal artery of the spinal cord and usually enters the superior aspect of a single neural foramen on the left from T9 through L4. Therefore, when performing left-sided TFESIs, it is recommended to advance the needle toward a more inferolateral position within the neural foramen than in the lumbar spine. Nevertheless, the location of the artery of Adamkiewicz is variable and can traverse the neural foramen bilaterally from T7 through S1. If fluoroscopic imaging reveals contrast flow anteriorly and at the midline, this usually represents trespass of the artery of Adamkiewicz. The needle should be withdrawn and the TFESI postponed while

observing the patient for signs of anterior spinal artery ischemia. Additionally, only non-particulate corticosteroid should be administered with TFESIs to minimize the risk of embolic vascular occlusion of the anterior spinal artery should an intra-arterial injection occur.

Cervical Transforaminal Approach

The cervical epidural space is extremely vascular and is associated with an increased risk of unrecognized vascular injection. The potential for an intravascular injection, specifically arterial, with a subsequent catastrophic event, demands extreme vigilance when performing cervical TFESIs. In fact, many pain medicine specialists feel that there is no indication for a cervical TFESI given the relatively high-risk benefit ratio. Some practitioners would rather use an upper thoracic interlaminar epidural approach and place a radiopaque catheter up to the cervical treatment region for an inside out transforaminal injection.

Following informed consent, the patient is positioned in either a lateral decubitus position or a supine oblique position with a pillow or wedge placed under the ipsilateral shoulder to maintain this position. An oblique fluoroscopic view is obtained to reveal the target neural foramen. The actual needle target is the posteromedial aspect of the mid-superior articular process in the oblique view. This skin over this site is marked, prepped with antiseptic, and anesthetized with 1 % lidocaine. Using sterile technique throughout, the tip of a spinal needle (usually 22-guage) is slowly advanced until it contacts the superior articular process (SAP). Maintaining needle tip over the bony SAP minimizes the risk of inadvertent advancement through the neural foramen into the subarachnoid space – and the potential for cervical cord contact. Once the needle touches the SAP, it is gently walked ventromedially into the posterior aspect of the foramen. Care should be taken to maintain needle tip location in the mid-portion of the posterior neural foramen as the vertebral artery is usually located anteriorly and other vasculature is located superiorly.

After negative aspiration for blood and cerebrospinal fluid, injection of 0.5 ml of radiocontrast agent under continuous fluoroscopic visualization should reveal contrast spread and an outline of the proximal cervical nerve root. In the anterior-posterior view, the contrast agent should spread medially through the neural foramen into the lateral epidural space. Once proper contrast spread location is confirmed in multiple fluoroscopic planes, the local anesthetic and steroid admixture may be injected.

Complications

Transforaminal ESIs possess the potential for catastrophic complications. In general, these complications result from improper needle placement, infection, local anesthetic effect, or corticosteroid effect.

Needle placement complications include pain at the injection site, nerve root injury, puncture of the dural sac, spinal cord injury, epidural hematoma, and postdural puncture headache [3]. Infection risks may include skin or epidural abscess, meningitis, and osteomyelitis. Local anesthetic complications may include motor block or weakness, hypotension, cardiac arrhythmia, seizure, and allergic reaction. Lastly, corticosteroid effects may be more sensitive in some individuals than others. These adverse effects may include fluid retention, elevated blood pressure, hyperglycemia, suppression of the hypothalamic-pituitary-adrenal axis, Cushing syndrome, steroid myopathy, facial flushing, and allergic reaction.

While the complication rate of TFESIs is reported to relatively low, there is the potential for catastrophic events such as paraplegia, quadriplegia, stroke, and death. The mechanism of action is secondary to intra-arterial injection of particulate steroids into a radicular artery supplying the spinal cord, or with cervical TFESIs, direct trauma, or injection into a cervical radicular artery directly feeding into the anterior spinal artery. Intermittent fluoroscopic imaging may frequently miss intra-arterial uptake of contrast. As a result, not only is continuous fluoroscopic imaging of contrast spread mandatory when performing TFESIs at any spinal level, the use of digital subtraction fluoroscopy is highly advised for all cervical TFESIs.

References

1. Derby R, Kine G, Saal J, et al. Precision percutaneous blocking procedures for localizing spine pain: II. The lumbar neuraxial compartment. Pain Dig. 1993;3:175–83.
2. Dooley JF, McBroom RJ, Taguchi T, et al. Nerve root irritation in the diagnosis of radicular pain. Spine. 1988;13:79–83.
3. Verrills P, Nowesenitz G, Barnard A. Penetration of cervical radicular artery during a transforaminal epidural injection. Pain Med. 2010;11:229–31.