Chapter 35
Interlaminar and Caudal Epidural Steroid Injections for the Treatment of Pain in the Rehabilitation Patient

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Introduction/History

The first epidural injection was performed utilizing a caudal approach with administration of cocaine for the treatment of low back pain and sciatica in 1901 [1]. Fifty-one years later, corticosteroids were first injected into the lumbar epidural space for the treatment of lumbar radicular pain [2]. Back and neck pain continue to be prevalent today and represent the first and fourth most common causes of disability in the United States, respectively [1]. Back and neck pathology also represent a significant financial burden in the United States, with the economic impact (directly and indirectly) estimated to be in excess of $86 billion annually [3]. There are numerous modalities utilized in the treatment of spine pain and epidural cortisone injections can be an important part of a multimodal treatment plan.

Glucocorticoids are endogenous molecules that are produced by the adrenal glands and are regulated by the hypothalamic–pituitary–adrenal (HPA) axis [4]. Glucocorticoids have many effects on the human body, but their effect to decrease pro-inflammatory substances can be utilized in order to reduce inflammation. Steroids given intravenously (IV), intramuscularly (IM), or by mouth (PO) may increase the systemic effects of glucocorticoids. Utilization of these medications in the epidural space creates a localized anti-inflammatory response, which minimizes the unwanted systemic effects of the medication.

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Epidural steroid injections can be administered as a single procedure or in a series of up to three; however, more recent evidence does not support the use of "series of three" injections [5]. Additional injections may not be indicated if the initial injection does not relieve symptoms or improve function [6]. Typically, no more than three to four epidural steroid injections should be given during the course of a year, as there are concerns for an increased risk of osteopenia as well as cortisol suppression [7]. There are several approaches to the epidural space including transforaminal, interlaminar (also called translaminar), and caudal (see Figs. 35.1, 35.2, 35.3, 35.4, 35.5, 35.6, 35.7, 35.8 and 35.9). This chapter will cover the cervical, thoracic, and lumbar interlaminar approaches as well as the caudal approach.

Epidural steroid injections introduce glucocorticoids, typically mixed with an anesthetic agent, via spinal needle into the epidural space (a potential space that lies between the ligamentum flavum and the dura) to relieve pain. Generally, it relieves radicular symptoms more than axial symptoms. Pain relief can also be attributed in part to the "wash out" effect, whereby the volume of injected material disperses the inflammatory molecules as well as the anesthetic agent that the steroid is mixed with [8].

Most guidelines recommend utilization of image guidance, typically in the form of fluoroscopy, with use of a non-iodinated contrast agent administered prior to injection of glucocorticoid, to ensure proper needle placement as well as lack of vascular uptake [5]. Image guidance is utilized in conjunction with the "loss of

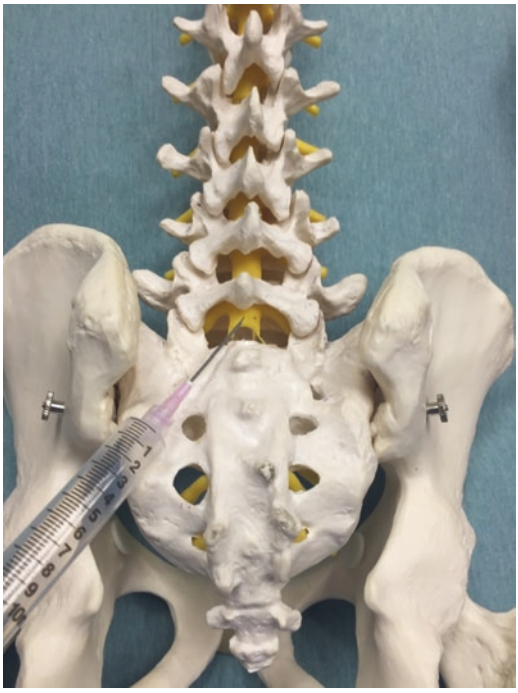

Fig. 35.1 Posterior view of an anatomic model depicting the insertion site for an interlaminar epidural injection at the L5-S1 level

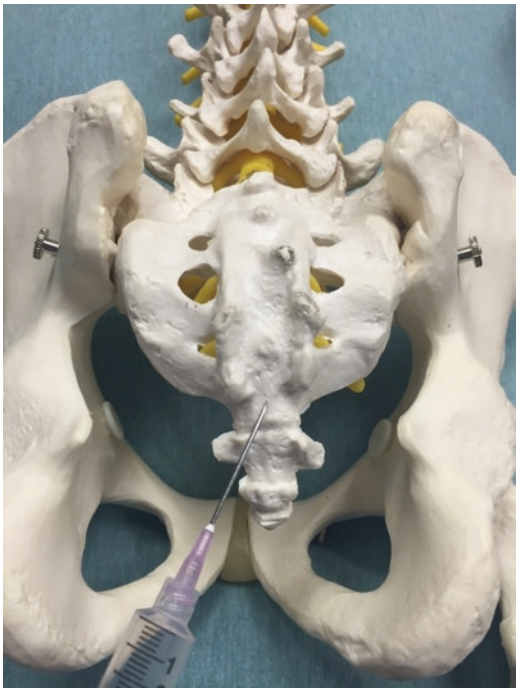

Fig. 35.2 Posterior view of an anatomic model depicting the insertion site for a caudal epidural injection

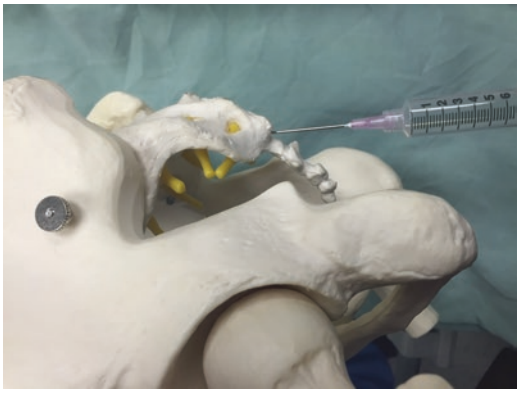

Fig. 35.3 Lateral view of an anatomic model depicting the insertion site for a caudal epidural injection

resistance" technique in interlaminar injections. The loss of resistance method can be performed with a glass or plastic syringe, using either air or saline, or with no syringe at all (hanging drop technique). Guidelines recommend cervical interlaminar injections be performed at the C7-T1 level and no higher than the C6-C7 level, as the cervical epidural space is widest at the C6-T1 levels and gaps in the ligamentum flavum become more common in the ascending cervical levels [9].

Caudal epidural injections can be guided with either fluoroscopy or ultrasound. A caudal epidural injection is considered to be the least specific modality of the

Fig. 35.4 AP fluoroscopic image, post-contrast, of an interlaminar epidural injection at the C7-T1 level

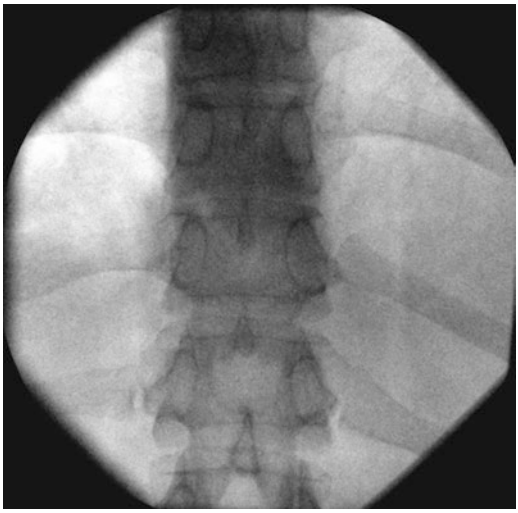

Fig. 35.5 AP fluoroscopic image of the thoracic vertebrae

three epidural options, requiring high volumes of medication to reach the pathological area in the spine [10]. What caudal epidural injections lack in specificity, it makes up for in ease and safety, as these procedures can typically be performed in the outpatient clinic setting under ultrasound guidance with minimal risk of dural puncture [1]. Trained specialists, many with fellowship training in pain and/or interventional spinal procedures, typically perform epidural injections including but not limited to anesthesiologists, physiatrists, and interventional radiologists. Indications for epidural glucocorticoid injections include: acute radiculopathy, subacute/chronic radiculopathy, spinal stenosis, and post-spine surgery syndrome [1].

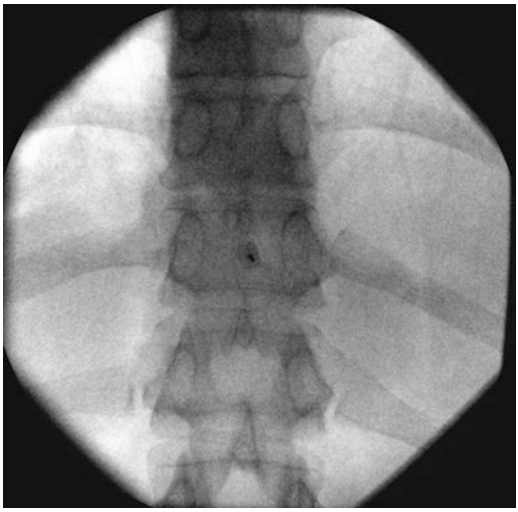

Fig. 35.6 AP fluoroscopic image of the thoracic vertebrae depicting proper interlaminar needle placement at the T10-T11 level

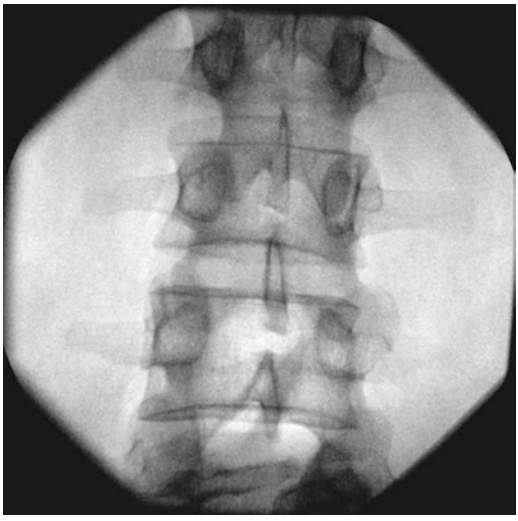

Fig. 35.7 AP fluoroscopic image of the lumbar vertebrae

Multiple glucocorticoid agents have conventionally been utilized for epidural injections, which include dexamethasone, hydrocortisone, methylprednisolone, triamcinolone, and betamethasone. For many interventionalists, the steroid preference is based on personal preference as well as spinal level of the procedure. Triamcinolone and betamethasone have particles that can form aggregates, which can occlude a blood vessel if inadvertent intravascular uptake occurs [11]. Interventionists may prefer dexamethasone, which is non-particulate and thereby does not aggregate, depending on the spinal level injected and/or proximity to the vasculature.

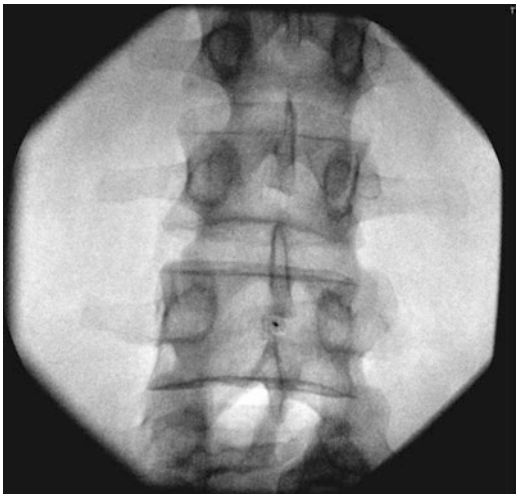

Fig. 35.8 AP fluoroscopic image of the lumbar vertebrae depicting proper interlaminar needle placement at the L3-L4 level

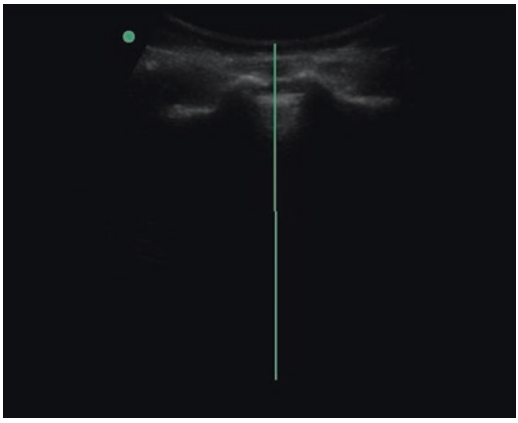

Fig. 35.9 Ultrasound image of the Sacral Cornua and the Sacral Hiatus for placement of caudal epidural steroid injection

Pathophysiology

Anatomy

Spinal nerves roots exit posterolaterally through the neural foramina, above the vertebral level in the cervical spine and below the vertebral level in the thoracic and lumbar spine. Neural impingement can occur from spinal canal and foraminal stenosis, from spondylosis and spondylolisthesis, as well as from disk herniations and other structures compressing the nerve root along the path of exit.

Radiculopathies

Greater than 95% of lumbar disk herniations occur at the L4-L5 and L5-S1 levels, followed by the L3-L4 and L2-L3 levels. Consequently, the L5 and S1 nerve roots are most commonly affected [12]. Additionally, posterolateral disk herniations of the nucleus pulposus are the most common form of disk herniation, as this is the weakest area of the annulus fibrosus. This can result in nerve root irritation proximal to the neural foramen, as it descends in the lateral recess [12]. In contrast, lateral or extra-foraminal herniations affect the nerve root after it exits the neural foramen which can result in nerve root irritation at the same disk level. For example, a far lateral L4-L5 disk herniation would cause L4 neural impingement, not L5 as in posterolateral herniation.

In addition to disk herniation causing foraminal narrowing, spondylosis can also decrease the diameter of the foramen, which results in similar symptomatology. Lastly, central disk herniations, as well as spondylosis and congenital canal stenosis can affect any portion of the spinal canal [12]. It is thought that a localized inflammatory reaction or mechanical compression leads to radicular symptoms. This allows for a potential intervention to halt the inflammatory cascade in acute, subacute, and chronic radiculopathies.

Spinal Stenosis

Much like a radiculopathy, spinal stenosis pain can result from mechanical compression and/or local inflammation of the nerve root. With spinal stenosis, however, nerve root ischemia can also occur, which results from venous congestion and arterial insufficiency. This can lead to symptoms of neurogenic claudication (i.e., leg numbness, heaviness, tingling, pain, and/or weakness with walking and/or standing) [12].

Post-Laminectomy Syndrome (Failed Back Surgery Syndrome)

This chronic pain syndrome, that persists despite surgical intervention predominantly effecting the lumbar spine, has multiple names (e.g., failed back syndrome, post-laminectomy syndrome) and has a constellation of etiologies that result in continued low back and/or leg pain. Typically, the surgery that precedes this syndrome is a spinal fusion or laminectomy and the differential diagnosis of the resulting pain can be grouped based on whether the predominance of pain is in the back or in the leg(s) [13].

Clinical Considerations

Much like any pain complaint, back/neck pain should be evaluated with a thorough history and physical examination, which can often lead to the diagnosis before any additional imaging studies are utilized. “Red Flags” with respect to spinal pain require prompt management to reduce morbidity and mortality. These include, but are not limited to, history of trauma or cancer, suspected fracture, unintentional weight loss, progressive leg weakness, urinary/bowel incontinence, unremitting pain, suspected myelopathy, suspected cauda equina syndrome, and saddle anesthesia [12]. The presence of such signs and symptoms may also indicate the need for a surgical referral.

Based on the history and physical examination, additional diagnostic studies may be warranted to further narrow the differential diagnoses and/or to rule out “Red Flag” pathology. These typically include plain x-ray films, magnetic resonance imaging, computed tomography, myelography, electromyography, and nerve conduction studies. Some form of imaging is recommended prior to considering an injection, especially in the cervical spine, to ensure adequate epidural space for needle placement [9]. Laboratory studies may also be warranted if an inflammatory disease or neoplastic process is suspected [12]. For technical considerations, please see appendix.

Comprehensive Multimodal Approach

Current treatment guidelines recommend using epidural steroid injections as an adjunct to other conservative treatments in an effort to shorten the duration of symptoms and to improve functional outcome. Epidural steroid injections can help to facilitate therapeutic exercise, in the form of patient education, aquatherapy, and physical therapy. Functional movement therapies, as well as directional preference therapies such as the McKenzie method, have been shown to help with acute radicular pain. Other adjuvant options include modalities such as heat, ice, and electrical stimulation as well as medications such as NSAIDs, muscle relaxers, neuropathic pain medications, certain classes of antidepressants, and opioids. In general, long-term opioids are not indicated for spine pain [14, 15]. Research has also shown that earlier “return to work” produces better outcomes in terms of work function and disability [16, 17].

Potential Treatment Complications

Although epidural steroid injections have become a safe and relatively common tool for the interventionist, rare treatment complications do unfortunately occur. Potential complications can be divided into two categories, which include immediate and delayed. The immediate treatment complications can include intravascular

uptake of local anesthetic causing seizures/arrhythmias, spinal headache, nerve injury, hemorrhage (both intraspinal and extraspinal), vasovagal reaction, allergic reaction, and dural puncture. Extremely rare complications may include spinal cord injury, stroke, and death. Delayed complications can include slow hemorrhage, infection, steroid side effects, delayed allergic reaction, CSF leak/spinal headache, and diabetic complications, which are typically in the form of elevated blood glucose levels or difficulty in controlling blood glucose after an injection [18]. Significant hematomas have also been noted in patients with an underlying coagulopathy and those taking anticoagulant medications [19, 20]. The American Society of Regional Anesthesia (ASRA) guidelines recommend holding most prescription anticoagulants prior to axial spinal procedures [21]. Exceptions could be considered for ultrasound-guided caudal injections.

Evidence of Efficacy

Multiple studies have supported the efficacy of interlaminar and caudal epidural steroid injections in patients with cervical, thoracic, and lumbar radicular pain secondary to disk herniation, spinal stenosis, and post-lumbar surgery syndrome [1, 22, 23]. The true short and long-term efficacy of these injections is more controversial, with more recent research showing limited value in the context of lumbar spinal stenosis [24]. These injections have shown benefit in allowing patients to participate in physical therapy, reduce disability/off-work status, and possibly avoid surgery, emergency room visits, and opioid addiction.

Conclusion

Epidural steroid injections can play a role in the context of a multimodal treatment approach to the patient with spinal radicular and occasionally axial pain. The risks and benefits should be weighed and discussed with the patient to create an individualized treatment plan that optimizes symptom relief as well as functional independence.

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Recommended Reading

Atlas of Image-Guided Spinal Procedures, 1st Edition, Furman
Braddom's Physical Medicine & Rehabilitation, 5th Edition, Cifu
Interventional Spine: An Algorithmic Approach, 1st Edition, Slipman
Guidelines: SIS, ASRA, and ODG