MICHAEL KAPLAN, MD
RICHARD DERBY, JR, MD

Useful in conjunction with medication and physical modalities

Epidural corticosteroid injections: When, why, and how

ABSTRACT: Epidural corticosteroid injections have a role in managing radicular pain, but well-designed studies have yet to validate their use in other spinal pain syndromes. We recommend them to relieve persistent pain, reduce inflammation, and facilitate physical therapy. They may also provide diagnostic confirmation of a painful lesion when performed selectively at a target nerve or site. We prefer a transforaminal approach under fluoroscopic guidance using contrast, especially for single-level lesions. When several levels are involved, an interlaminar injection may be appropriate. Patient self-evaluation is essential after each epidural injection, and electrodiagnostic or imaging studies are recommended. Prospective, controlled trials are under way to determine the preferred routes of epidural injection, the most effective regimens of injected corticosteroids, and the appropriate number of injections for specific spinal diagnoses. (J Musculoskel Med. *1998;15(9):39-46)*

This is the sixth in a special series of articles on diagnosis and management of back pain.

Spinal epidural corticosteroid injections are commonly employed in the treatment of acute and chronic neck, thoracic, and low back pain, as well as radicular pain in the arms or legs (Figure 1). While they are a valuable treatment modality in a number of spinal conditions, their primary use is as one component of a comprehensive treatment plan that includes medication and physical therapy; they should not be considered a sole therapy.[1] These injections can provide analgesic and anti-inflammatory effects, reduce stiffness, restore range of motion, and facilitate active therapy. They may also provide diagnostic confirmation that a specific anatomic site is responsible for the patient's pain.

Injection of corticosteroids into the epidural space for treatment of lumbosacral radicular pain was first described in 1952.[2] Since that time, there have been additional reports but few controlled clinical trials. Although the procedure does not have universal acceptance, the medical literature supports its use for the treatment of radicular pain caused by common structural abnormalities, such as lumbar disc herniation and spinal stenosis.[2-4]

Some of the controversies over epidural corticosteroid injections center around such issues as the importance of fluoroscopic guidance, the ideal route of injection (translaminar, transforaminal, or caudal), the mechanism of action, and the indications for and risks of the procedure.[5,6] In this article, we will suggest a practical approach to safe and effective epidural corticosteroid injection therapy based on the literature and our experience.

Dr Kaplan is a physical medicine and rehabilitation specialist in private practice in Laramie, Wyoming. Dr Derby is an anesthesiologist in private practice in Daly City, California, and president of the International Spinal Injection Society.

WHY INJECT INTO THE SPINE?

There is a trend toward nonsurgical management of disc herniations in patients regardless of the presence of radiculopathy. Evidence to support the broad use of a nonsurgical approach is threefold. First, resorption of herniated lumbar disc material has been observed in the absence of operative intervention. Second, low back or radicular pain has been attributed to disc pathology in the absence of frank herniation. Third, imaging studies in a clinically normal population have documented that asymptomatic disc herniations are quite commonplace.[2,7]

The rationale for epidural corticosteroid injection therapy comes

from the pathophysiology of the pain and the mechanism by which corticosteroids act. A complex interaction between biochemical inflammatory mediators from the damaged disc and mechanical factors, such as frank nerve compression, may lead to a painful radiculopathy. Vascular insufficiency, causing hypoxic injury to the nerve root, may also be present.

Studies have shown that phospholipase A_2 (PLA_2), cytokines, and other inflammatory mediators are released from an intact disc following injury.[8] PLA_2, which itself is highly inflammatory, sets in motion the arachidonic acid cascade and the subsequent liberation of leukotrienes and prostaglandins, which are also potent mediators of inflammation. It is reasonable to assume that compression and other mechanical factors acting on a disc will also lead to the release of these substances, which drive the inflammatory response.

This inflammatory cascade is the target of NSAIDs or of oral or epidural corticosteroids that can inhibit prostaglandin synthesis. Epidural corticosteroids are administered into the spinal canal, in the space outside of the thecal sac that contains the nerve roots. This location is adjacent to the herniated disc—the frequent site of contributing pathology in patients with persistent low back pain.

Figure 1 – *Lumbar epidural blocks are most commonly performed using a paramedian approach under fluoroscopic guidance. The interlaminar space is visualized fluoroscopically on an anteroposterior view. A 22- to 18-gauge needle is used. We advance the needle through the ligamentum flavum under direct fluoroscopic vision and identify the epidural space by loss of resistance to injection using normal saline or anesthetic. It is easier to feel the resistance of the ligamentum flavum using larger-gauge needles. The precise depth of the ligamentum flavum can be estimated by first hitting the lamina and then advancing the needle 4 to 5 mm, until firm resistance is felt.*

Epidural corticosteroids act by blocking PLA_2 activity and can exert an anesthetic-like action by blocking nociceptive C-fiber conduction.[9] Epidural corticosteroids also exert a membrane-stabilizing effect, which may help decrease ectopic neuronal discharges and reduce radicular pain.[10]

Various studies also provide a rationale for including a local anesthetic in epidural injections. Postulated mechanisms for topical anesthetic action include the mechanical or hydrostatic effect and the interruption of both pain-spasm cycles and nociceptive stimuli from the spine that are continuously reverberating or transmitting sensory information in an unregulated manner. In addition, disruption of afferent sensory impulses leads to pain reduction, and relief attributable to a single injection confirms which nerve roots are involved and symptomatic. Patients also may experience psychological benefit when pain is relieved, if only briefly.

EVIDENCE FOR EFFICACY

The most recent study on epidural corticosteroid use was a randomized, controlled, double-blind trial involving adults who had sciatica for longer than 1 month but less than 1 year and who had CT evidence of a herniated disc.[11] Patients treated with epidural methylprednisolone acetate (80 mg in 8 mL of normal saline) showed short-term improvement in pain control and sensory deficits, compared with patients who received normal saline epidurally. Because the differences between the treatment and control groups faded over time, the study authors concluded that epi-

dural corticosteroid injections neither offer long-term functional benefit nor reduce the need for surgical intervention.

Although supportive of epidural corticosteroid injections, this study had several significant design flaws. Its major drawback was that epidural injection was the sole intervention and was not incorporated into a comprehensive rehabilitation and treatment program. The lack of fluoroscopic guidance, the availability of only 3 months of follow-up, and the fact that symptoms lasted a mean of 13 weeks before intervention (meaning that radiculopathy was no longer acute) also limited the value and wide applicability of this study. The study authors recommended that epidural corticosteroid injections not be given in isolation and that a successful outcome—as defined by ease and speed of recovery and reduction in need for subsequent operations—is more likely when injection therapy is given early in the course of illness.

In a well-designed but older retrospective study of 54 patients with lumbar radiculopathy proved by electromyography and caused by a herniated lumbar intervertebral disc, patients were treated with a back school program, various exercises (for stabilization, flexibility, and aerobic fitness), oral medications, and epidural corticosteroid injections (for pain control).[1] Outcome was good to excellent in 90% of patients, and the return-to-work rate was 92%. This study demonstrated that lumbar intervertebral disc herniations with radiculopathy can be managed nonoperatively with a regimen that includes epidural corticosteroid injections.

Ensuring safety of cervical epidural corticosteroid injections

Cervical injections present an increased risk compared with thoracic or lumbar injections, so we offer the following guidelines as an adjunct to the cautions described in this article. Spinal cord injury is the major complication seen with interlaminar cervical epidural blocks, and the possibility of immediate and delayed injury exists. Immediate cord damage is usually the result of direct trauma. Delayed injury can result from compression of the spinal cord secondary to bleeding or infection. We believe adherence to the following guidelines can help reduce the likelihood of spinal cord injury while enhancing the success rate:

1. Do not perform interlaminal cervical epidural blocks at any level when the midline sagittal diameter is less than 8 mm. When the midline sagittal diameter is between 8 and 10 mm, the procedure should be avoided if possible; if it cannot be avoided, extreme caution must be exercised.

2. Instruct patients not to take aspirin or aspirin-containing products for 7 to 10 days before the procedure and not to take NSAIDs for 3 to 5 days before.

3. Refrain from performing interlaminar epidural blocks at a level at which a disc protrusion or spondylolisthesis narrows the midline spinal canal diameter (as determined by CT myelography or MRI).

4. Do not perform a cervical epidural injection above the level of C7-T1.

5. Use fluoroscopy to select and identify the level and the midline and to help determine the depth necessary for injection.

6. Before performing a cervical epidural injection, be sure that a recent MRI scan or CT myelogram, or a comprehensive radiologic report of such scans, is available for review.

7. Use an epidural needle large enough (usually at least 20-gauge) to reliably feel the ligamentum flavum.

8. To confirm epidural placement, inject a nonionic contrast medium before administering the corticosteroid and local anesthetic.

9. Give only enough sedation to relax the patient without obscuring vital pain responses or rendering the patient unaware or nonresponsive.

10. Avoid corticosteroid formulations that contain polyethylene glycol (such as depot-type formulations).

11. If the dura is punctured inadvertently, abandon the procedure immediately.

Additional support for use of lumbar epidural corticosteroid injections comes mainly from uncontrolled case studies or trials in which 33% to 77% of injected patients reported pain reduction. The success of the injections, as with all therapeutic interventions, depends on patient selection and technique. Unfortunately, even the controlled studies available on safety and efficacy of epidural corticosteroids have flawed methodology because diagnoses are mixed or nonspecific, functional outcome data are lacking, numbers of patients in control or treatment groups are inadequate, or drug delivery into the epidural space was not confirmed by fluoroscopy.[5,11]

CANDIDATES FOR INJECTION

Epidural corticosteroid injections are an acceptable and preferred treatment in the comprehensive management of patients with discogenic radicular pain emanating from the cervical, thoracic, and

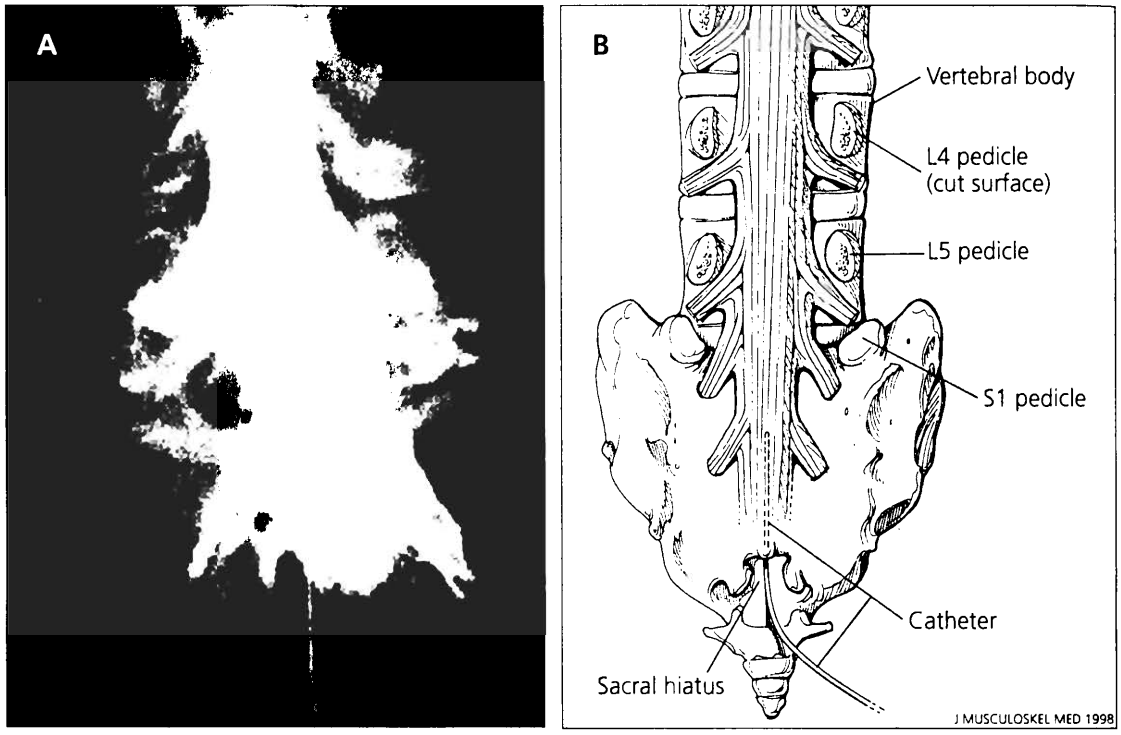

Figure 2 – *This epidurogram of a caudal epidural block shows the injection of 10 mL of local anesthetic containing contrast. The contrast can be seen to reach the L3-4 level. The L4, L5, and S1 roots are outlined (A). The drawing shows the anatomic landmarks (B).*

lumbar spine.[2,3,12,18] They are also used in the treatment of spondylosis, nonspecific radiculitis, and spinal stenosis.

When a subacute, inflammatory spine pain syndrome is unresponsive to more conservative treatment, we have found epidural corticosteroid injections to be very appropriate and effective.[3,4] This would typically include spine pain following whiplash injury, pain from low back strain caused by a twisting-lifting injury, or simply radiating leg symptoms from a nerve root irritation (rather than from a peripheral muscular cause). Most patients who respond to injections will have some irregularity apparent on MRI, whether it be spinal or foraminal stenosis or simply a small, unilaterally prominent paracentral disc irregularity that correlates clinically with the patient's extremity complaints. Epidural corticosteroid injections have also been used to control pain from cancer, viral brachial plexitis, and reflex sympathetic dystrophy.

RISKS AND WARNINGS

Complications and adverse effects

The risks associated with needle placement or injection of the local anesthetic and corticosteroid suspension (which are either mixed together or injected separately during the procedure, depending on the clinician's preference and purpose) are those associated with spinal injection of any diagnostic or therapeutic substance. These include infection, bleeding, nerve injury, transient numbness or weakness, paralysis, reaction to the contrast medium, adrenal suppression, and fluid retention with systemic manifestations that may include peripheral swelling.

Pneumothorax may occur in patients who have undergone a thoracic spinal injection. Total spinal blockade is possible with cervical procedures but is exceedingly rare. There is also a potential for minor subcutaneous infection and for vasovagal episodes. Infection has been reported only rarely following epidural corticosteroid injection, and only in cases in which there was an epidural abscess and an extradural abscess. Dural puncture, with a subsequent spinal headache (diagnosed by the fact that its severity changes with position) has been reported to occur as often as 5% of the time in translaminar injections. Epidural injections can also cause adrenal suppression for as long as 3 weeks.

Given that failure to obtain a de-

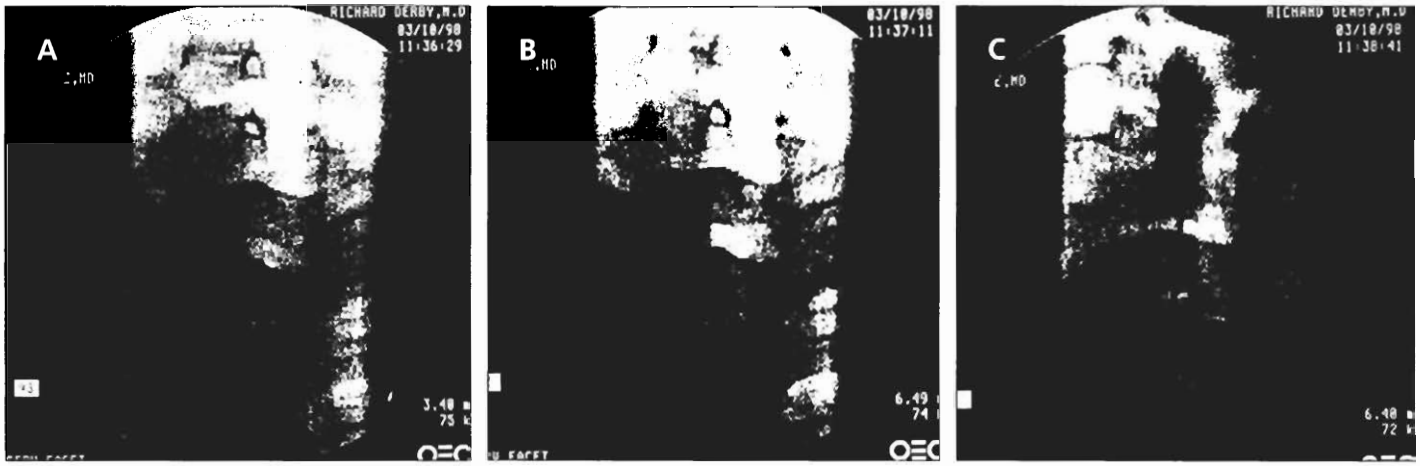

Figure 3 – *To perform an epidural injection using a catheter technique, we first infiltrate the skin and subcutaneous fascia to the lamina with local anesthetic under direct fluoroscopic vision. Then we advance a 17-gauge Tuohy needle to the upper lamina of T2 (A). Once the ligamentum flavum is contacted, we pass the needle through it and into the epidural space (B). Then we advance the catheter to the midbody of T4 and inject 0.05 mL of nonionic contrast (C). When contrast stays within the epidural space, we know that intravascular or subarachnoid injection has not occurred.*

finitive diagnosis or a positive therapeutic benefit is possible, the ratio of risk to benefit in the individual patient must be carefully assessed. It is generally accepted (at least tacitly) that by their very nature, medical procedures possess an inherent risk-to-benefit ratio and expose the patient to some degree of risk. Procedures that are used primarily as a means of temporary chronic-pain control are no exception. Currently, there are no official or widely accepted safety or procedural guidelines for physicians who routinely perform epidural injections, but we have developed practical recommendations (see "Ensuring safety of cervical epidural corticosteroid injections").

Contraindications to injection

Absolute contraindications to performing epidural injections include

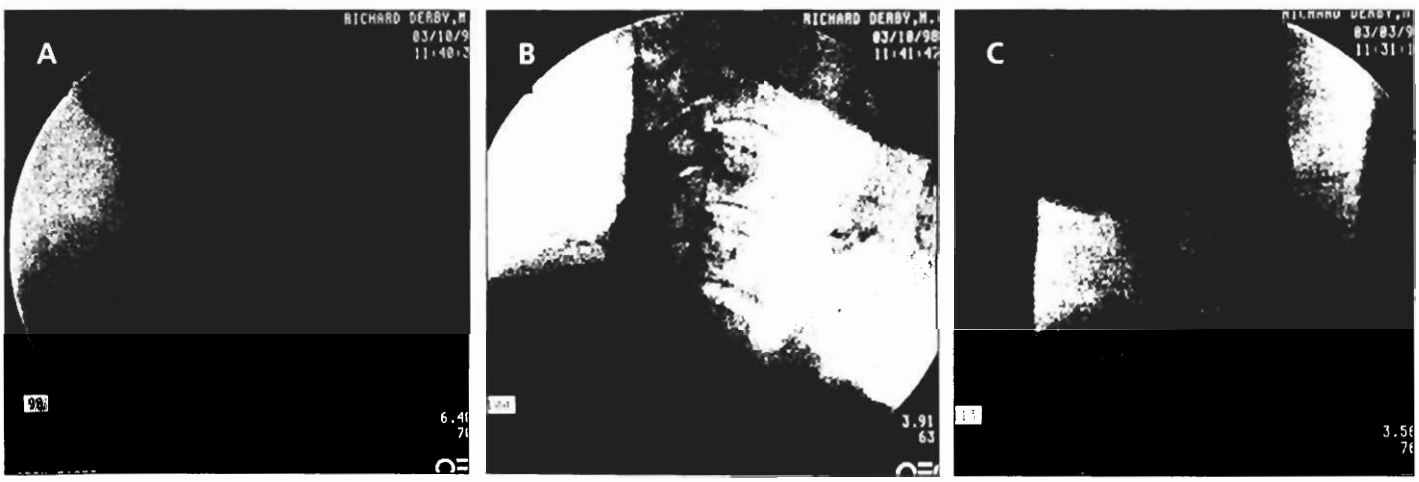

Figure 4 – *After a successful translaminar epidural injection, the anteroposterior view confirms the multisegmental and bilateral spread of contrast (A). The lateral view, taken 1 minute after injection, shows the primary difficulty with interlaminar epidural injection procedures: Most of the injected material remains in the dorsal compartment, which is not where the patient's main lesion usually lies (B). Selective epidural blocks get around this problem by applying the local anesthetic and the corticosteroid much more precisely to where it is most needed (C).*

known hypersensitivity to the medications and agents used, local or systemic infection, local malignancy, bleeding diathesis, congestive heart failure, and uncontrolled diabetes mellitus. Substantial elevations in blood sugar levels can develop in patients with type 1 (insulin-dependent) diabetes following epidural injections.

OPTIMIZING THE OUTCOME

Training and experience

Clinicians who commonly perform epidural corticosteroid injections include physicians with specialty training in anesthesiology, physiatry (physical medicine and rehabilitation), and radiology. In some parts of the country, there are also small numbers of orthopedic spine surgeons, neurologists, and even neurosurgeons who perform spinal injections. The majority have completed advanced training in interventional spine and pain management techniques, whether it be in a fellowship setting, cadaver workshops, or continuing medical education course work carried out under close supervision.

One way of finding a qualified physician in a specific region is to contact the International Spinal Injection Society by telephone (415-757-3657) or through the Internet (www.spinalinjection.com). Physician certification in pain management or completion of a fellowship that includes interventional spinal injection training is also an indicator of competence.

These procedures are typically performed in a hospital or ambulatory surgery outpatient center because of the availability of imaging equipment and staff for monitoring and assessment. Some physicians, however, perform a limited number of "blind" techniques in office settings without imaging equipment.

Most physicians who perform injections require that their patients maintain a pain diary. The diary, which should include self-reports for up to 1 week after an injection, serves as a way of validating the difference between preprocedural and postprocedural status and documents response to the procedure. Frequently, the subjective assessment of pain is by means of a visual analogue scale.

Frequency of injection

It is the practice of some physicians to give a second epidural corticosteroid injection when two conditions are met: response to the first injection is partial, and the patient has enough residual pain to warrant further treatment. Injections should be separated by 2 weeks because the duration of hypothalamic-pituitary axis suppres-

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Figure 5 – *A two-needle technique can be used to perform selective transforaminal epidural injections in the lumbar region. Here, an 18-gauge introducer needle is first advanced into contact with the L5 transverse process and directed slightly caudad without advancement. Then a 22-gauge needle with a slight distal curve is slowly passed through the introducer and penetrates the intertransverse membrane, ending up at the lower aspect of the pedicle, just under the exiting L5 dorsal root ganglion (A, B). Injection of 1 mL of contrast gives a negative outline of the dorsal root ganglion just below the L5 pedicle; the contrast flows cephalad, outlining the dorsal root (C). The L5 dorsal root exits from the dural sac at the lower border of the L4-5 disc.*

sion and corticosteroid-related adverse effects is 2 to 3 weeks.

Unpublished practice audits have found that a second injection will not be beneficial if there was no response to the first and fluoroscopic guidance was used to ensure correct placement. There are no data to support the routine use of a series of three epidural corticosteroid injections in spinal pain syndromes.

Route of injection

Various routes may be used for the administration of epidural corticosteroids. The caudal route involves introduction of a needle through the sacral hiatus (Figure 2). A larger volume of fluid needs to be injected with the caudal approach than with other lumbar injections, to act as a carrier so that the active agent can reach the lumbar nerve roots, which are at least 10 cm cephalad to the site of injection.[3]

Caudal and translaminar epidural injections may be hampered by scarring or by the arrangement of epidural ligaments, which could prevent migration of medication to the target epidural space.

Translaminar injections, sometimes referred to as paramedian translaminar epidural injections, are placed dorsally (or posteriorly in relation to a seated or standing patient) by passing a needle through an interlaminar space, preferably just lateral to the interspinous ligament.[3,19] The needle must then penetrate the ligamentum flavum before entering the epidural space but must pass just superficial to the underlying dural sac (Figure 3). Significant dexterity and manual feel for a "loss of resistance" with a special syringe are required in this technique. With this technique, delivery of the medication to the desired site requires diffusion to the ventral target tissue (Figure 4).

Transforaminal injections, preferred in many centers as the most specific and effective route for epidural administration of corticosteroids, are administered laterally through the selected neuroforamen under fluoroscopic guidance (Figure 5). They are sometimes known as selective transforaminal epidural injections.[4,19] This technique allows for the administration of smaller volumes of medication, because the bolus is delivered closer to the site of pathology (the interface of the nerve root, the disc, and the ventral dura) than with other approaches. Medication delivered by this route also tends to flow ventrally, or preferentially to the symptomatic side and along the involved nerve root.

A smaller-gauge needle is generally used for transforaminal injections so the risk of needle-related trauma is reduced. Such trauma includes bleeding and the creation of a hole that could leak in the event of intrathecal puncture. Injection can provide additional physiologic information not disclosed by spinal imaging, electrodiagnostic methods, or physical examination of a patient. Pain reduction obtained from selective thoracic transforaminal corticosteroid injections can be helpful in identifying a pathologic segment or nerve root lesion causing pain that extends into the extremities or the thoracic spine, flank, or abdomen.[4]

Determining specific approach

When there is evidence to suggest that the source of pain is the anterior column of the spinal cord, then the standard choices for intervention include selective interlaminar or transforaminal epidural corticosteroid injections, or both. This would be the case with intrinsic disc pain, radiculopathy from disc disease or other causes, and extrinsic disc-mediated pain without radiculopathy.

With multilevel pathology, an interlaminar epidural corticosteroid injection is usually performed. When there is a unilateral, single-level lesion or foraminal disease, a selective transforaminal epidural injection is usually appropriate. If documentation of the pain source is required for medicolegal reasons, or if the results of confirmatory diagnostic testing may change subsequent interventions, then nerve root blocks, diskography, or

both may be performed after conservative care, including epidural corticosteroid injections, has failed.

Need for fluoroscopic guidance

We strongly recommend the use of fluoroscopic guidance for placement of the spinal needle. Although epidural corticosteroid injections can be attempted without fluoroscopy and contrast medium, numerous convincing arguments exist that strongly support their use. By imaging the spinal anatomy, adequate localization of the injection and distribution of the corticosteroid can be documented, allowing for ideal delivery of medication to the optimal (symptomatic) level, side, or nerve root.[5,20]

With fluoroscopic guidance using contrast, accuracy and safety are greatly enhanced and therapeutic benefit is improved. Studies show that up to 40% of blind injections may not enter the epidural space.[5,20] When the epidural space is missed, the physician may erroneously perceive that epidural placement of the needle occurred and may continue the procedure. Reasons for missing the epidural space include inadequate or excessive depth of tissue penetration and intravascular placement, which would not be apparent if there is no aspiration of blood. The radiation exposure in most epidural corticosteroid injection procedures is comparable to that with any other procedure requiring fluoroscopy.

Niche in management program

Therapeutically, the selective administration of epidural corticosteroid at what appears to be the patient's most symptomatic level can provide pain relief from neural irritation and inflammation. This can allow the patient to progress methodically in a conservative and comprehensive rehabilitation plan. Progress in such a plan may include advancement along a progressive physical activity protocol as well as in spinal stabilization and strengthening exercises.

Frequently, an irritative nerve injury cannot be visualized on imaging studies and may not be detectable with electrodiagnostic methods. It may, however, be identified by a positive response to a combined nerve block and transforaminal epidural injection. The information obtained can be used both diagnostically and therapeutically for nonoperative or surgical intervention. ■

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