

Complications Associated with Lysis of Epidural Adhesions and Epiduroscopy

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Gabor B. Racz, M.D., FIPP and James E. Heavner, DVM, Ph.D., FIPP (Hon.)

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INTRODUCTION

Lysis of epidural adhesions is an interventional pain management technique that has evolved over time [1]. The goal of lysis of epidural adhesions is to break down barriers in the epidural space that are thought to contribute to painful processes and prevent delivery of pain relieving drugs to target sites. The technique that was first described and is still most commonly used relies on introduction of a navigable catheter into the epidural space. More recently, epiduroscopy was introduced as an alternative or complementary approach to the catheter technique. The lysis procedure is conducted throughout the spinal axis but epiduroscopy assisted lysis is generally limited to the lumbar and sacral regions. This chapter focuses on complications associated with lysis to treat low back pain and lower extremity radiculopathy involving lumbar and sacral segments.

The goal during lysis of epidural adhesions is to reduce mechanical barriers preventing medications from reaching the dorsal root ganglion. The technique emerged from observations during image-guided injection. It was obvious

that in some patients scar tissue formation prevented fluid injection or catheter placement adjacent to the spinal nerves. The sensory block that develops when epidural local anesthetic is administered to produce surgical anesthesia or analgesia or anesthesia for childbirth is typically symmetric, suggesting that the spread of local anesthetic in this population is relatively uniform. However, in those with chronic back pain the spread of contrast was irregular, with large filling defects seen in many patients. Fluid placed in the epidural space will follow the path of least resistance and will not spread to locations where there is obstruction caused by scar tissue. If a catheter was placed in the vicinity of the observed scar tissue and a local anesthetic, radio-opaque contrast, and other fluids injected, pain relief often followed and the duration of the pain relief was far beyond the duration of the local anesthetic effect. Placement of large-volume injections into the epidural space often resulted in prolonged pain relief and more uniform spread of contrast throughout the epidural space. This suggested that placement of fluid within the epidural space could lead to reduction in or elimination of mechanical barriers caused by scarring.

In 1991, Kuslich et al. delineated the pain-sensitive structures in the spinal canal while doing surgical laminectomies under local anesthesia [2]. Using mechanical as well as electrical stimulation, they found that pain-sensitive structures included the annulus, nerve roots, facet joints, posterior longitudinal ligament, tendinous insertion of muscles (but not the muscles themselves), ligaments, and fascia. They also found that nerve roots are painful if they are compressed, swollen, inflamed, or restricted by scar tissue. Nerves are 3.2 times more likely to produce radicular pain if they are surrounded by scar tissue [3]. The lateral recess area is where nerve roots exit the vertebral canal. These roots are subjected to trauma from scar formation, hypertrophic facet joints, bulging discs, and numerous surgical- and injection-technique-related complications [1]. Beginning with the observations made by Kuslich et al. the ventrolateral epidural space has gradually come to be recognized as the target site for treatment during lysis of epidural adhesions. The development of a navigable radio-opaque kink-resistant soft-tipped catheter has allowed placement at or near this target site in most patients. However, there have been a number of complications associated with lysis of epidural adhesions. In some cases the use of large volumes within the epidural space has produced barotrauma to the spinal canal content, including the spinal cord, the nerve roots, and the blood supply to the cord. Here we review the complications that have been reported during lysis of epidural adhesions, discuss possible mechanisms for each complication, and suggest means of preventing these complications.

THE TECHNIQUE OF EPIDURAL LYSIS OF ADHESIONS

Our discussion is limited to the procedure that involves accessing the epidural space via the sacral hiatus. This is similar to the approach used for caudal epidural anesthesia. Radiography is used to guide needle and catheter placement and to perform epidurograms. When epiduroscopy is performed, radiography is also used to guide movement of the epiduroscope. For the catheter technique, the sacral hiatus is approached with a 15- to 16-gauge epidural needle with a curved tip (RX-Coude needle, Epimed International, Johnstown, NY; Figure 30-1) about 2 to 3 cm off midline and 4 to 5 cm inferior to the sacral hiatus. To avoid penetration of the dural sac, the needle tip is advanced no further than to the S3 neural foramen. Epidurography is performed using 10 mL of non-ionic radiographic contrast material to detect the presence of any filling voids (Figure 30-2). Next, a steerable catheter is advanced into the void and 2 to 5 ml of contrast is injected as a marker, followed by 10 mL of 0.9% saline and hyaluronidase injection to remove the defect. Contrast is injected again to confirm filling of the void. Then, corticosteroid and local anesthetic are injected in small aliquots to a total volume of 10 mL. Thirty minutes

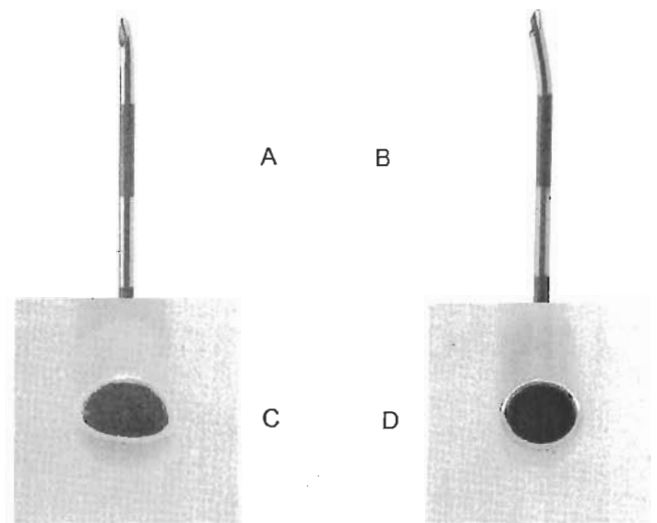


Figure 30-1 (A) Tuohy needle tip. Note curved sharp tip. (B) R-X Coude needle tip. Note open tip-curve moved more proximally. (C) Tuohy needle tip, end-on view. Note oval-shaped opening. (D) R-X Coude needle tip end-on view. Note round-shaped opening.

later, 10% (hypertonic) saline is infused through the catheter and may be repeated 2 more times at 12- to 24-hour intervals. Then the catheter is removed. Precautions to prevent infection include aseptic technique, sterile dressing of the catheter entry site, and systemic antibiotics. A bacterial filter is attached to catheters after steroid injection as long as the catheter is in place. All fluids except steroid are included with the epidural space through the filter.

When epiduroscopy is performed, the same approach used for the catheter technique is employed with two notable modifications: (1) the method used to access the epidural space and (2) the use of 0.9% saline to open the epidural space to aid visualization and to wash away material that limits visualization. Access to the space is attained using the Seldinger technique. First, an epidural needle is placed on midline, a guidewire inserted, and a stab wound made with a scalpel blade. A 10F dilator and sheath are then inserted. The guidewire and dilator are removed, and the epiduroscope is inserted through the sheath. We use a 20-mL syringe to manually inject 0.9% saline as needed to aid visualization.

DEFINITION AND SCOPE

As experience with the lysis procedure increased and the technique was refined, complications were recognized. The likelihood of complications was found to be greater if pathological processes were present, particularly arachnoiditis and extensive epidural scarring (as often found in patients with chronic pain following prior spine surgery; i.e., failed back surgery syndrome). Types of complications related to lysis of epidural adhesions are listed in Table 30-1, and the causes of complications are listed in Table 30-2. As is the case with

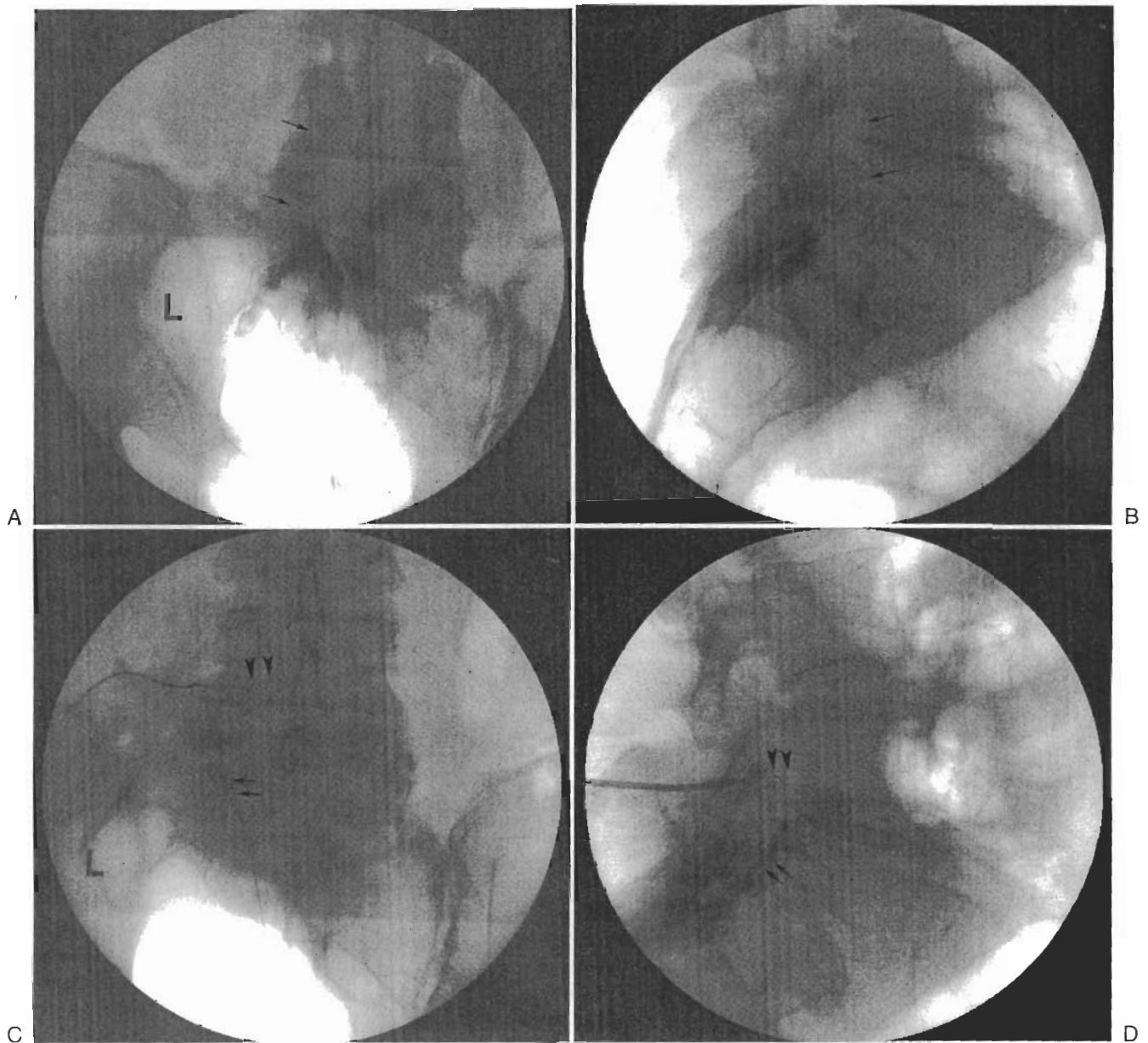


Figure 30-2 A patient with chronic back pain and radiculopathy. AP (A) and lateral (B) radiographs after contrast injection. Marked scarring is evidenced by lack of anterior spread (L, left; arrows indicate filling defects caused by scarring). AP (C) and lateral (D) radiographs after epidural lysis of adhesions demonstrating contrast spread to the anterior epidural space. Two catheters have been advanced to the left lateral epidural space at the L5/S1 level (L, Left; arrowheads indicate the transforaminal catheter; arrows indicate the tip of the caudal catheter).

Table 30-1 ■ Complications Related to Lysis of Epidural Adhesions

- Allergic reactions
- Headache
- Iatrogenic-cushingoid syndrome
- Macular hemorrhage
- Somatosensory and somatomotor dysfunction
- Bowel, bladder, sexual dysfunction
- Infection
- Pain at epidural entry site
- Local anesthetic toxicity: CNS, cardiovascular

many technically demanding techniques, the incidence of problems declines with increased operator experience. In our training program, fellows must be supervised closely for about 5 to 7 months.

COMPLICATIONS INDUCED BY MEDICATIONS

Allergic Reactions

Classes of diagnostic and therapeutic agents used during epidural lysis that have allergenic potential include iodine

Table 30-2 ■ Causes of Complications Related to Lysis of Epidural Adhesions

Reaction to Drugs (etc.)	Procedure Related
<ul style="list-style-type: none"> • Allergic • Antibiotic • Iodine-containing substances • Radio-opaque contrast • Disinfectants • Local anesthetics • Hyaluronidase • Toxicity due to absolute or relative overdose • Local anesthetics • Corticosteroids 	<ul style="list-style-type: none"> • Procedure pain at epidural access site • Due to aggravation of inflammation • Due to hypertonic saline • Excess fluid volume reinjected (relative, absolute) • Barotrauma • Ischemia of nerves or cord • Retinal hemorrhage • Nonsterile technique • Epidural hematoma • Catheter shearing • Misplaced catheters or needles • Wrong tissue planes, structures

containing radiographic contrast agents, surgical disinfectants, antibiotics, local anesthetics, and hyaluronidase. It is important to obtain an accurate history to identify patients predisposed to allergic reactions. In certain cases, prophylactic use of corticosteroid and antihistamine may allow the use of allergens in susceptible patients. Documented anaphylactic reactions to local anesthetics and hyaluronidase are rare [4].

Hyaluronidase has been documented to be effective in reducing failure from the lysis procedure from 18 to 6% [5]. Use of hyaluronidase appears to facilitate the spread of injected solutions and opening of the lateral recesses. This helps to prevent loculation of the injectate and compression of nerves, spinal canal structures, and the blood supply to the spinal cord. Based on outcomes of a large number of epidural hyaluronidase injections, Moore [4] suggested that the incidence of anaphylactic or sensitivity reactions may be 3%. Hyaluronidase is a proteinaceous substance, and therefore repeat administration could theoretically lead to sensitization. However, we have not seen a single serious sensitivity reaction following administration. Hyaluronidase is commonly injected with local anesthetic to produce retrobulbar nerve block, and allergic reactions in this setting are also rare. Nevertheless, caution must be advised because of the potential for an anaphylactic reaction. Appropriate treatment, including injectable epinephrine, must be readily available.

Hypertonic Sodium Chloride

Hypertonic saline was originally injected intrathecally into patients under general anesthesia in efforts to treat pain associated with cancer [6]. However, evidence from laboratory

studies indicated that epidural administration might be safe and more effective. Thus, we began to use epidural hypertonic saline in our practice [7].

Hypertonic sodium chloride injection is usually safe at least 20 to 30 minutes have lapsed between local anesthetic and steroid injection and the subsequent injection of hypertonic solution. In patients suffering from a demyelinating disease such as multiple sclerosis we do not use hypertonic saline. We fear that the demyelination found in those with multiple sclerosis could well result in exaggerated effects, perhaps leading to direct neuronal injury. Indr King et al. [8] demonstrated that hypertonic saline produced a persistent block of unmyelinated nerves (C-fibers) in the rootlets of cats in vitro.

During epidural lysis, intrathecal injection can occur if the needle or catheter unknowingly traverses the dura. Undesirable effects observed following intrathecal injection of hypertonic saline include severe pain and muscle cramp in affected segments, hypertension, cardiac arrhythmias, pulmonary edema, and cerebral infarction. Localized paresis lasting many hours, paresthesias sometimes persisting for weeks with sacral anesthesia have been reported as complications following intrathecal injection of hypertonic saline. Depending on the injection volume, these neurologic sequelae are often temporary and may be treated symptomatically. Subarachnoid injection is avoided only by strict adherence to technique. Injection of hypertonic saline through sharp needles where the needle tip may migrate through tissue planes should be avoided. The use of a spring-tip catheter reduces intrathecal migration and makes exact catheter localization with site-specific injection possible.

Steroids

Epidural steroid injection has been used to treat radiculopathy since the 1950s [10]. The issues are how much and what type of steroid one should use and whether the preservative may be cytotoxic and produce adhesive arachnoiditis. The fact that steroids will precipitate and form a sludge-like material is also a concern (see Chapter 18 for a discussion of epidural steroid injection). There is growing concern that intra-arterial injection of particulate steroid may produce vascular occlusion with subsequent devastating neurologic damage (see Chapter 26 for a discussion of transforaminal injection of steroids). In our current practice, we typically use 4 mg of dexamethasone because it is not particulate. 10 mL of 0.2% ropivocaine or 0.25% bupivacaine administered in 2- to 3-mL increments. During prior years we have used triamcinolone acetate as well as methylprednisolone acetate. Betamethasone is preferred by some clinicians based on the belief that its aqueous vehicle is safer than the organic vehicle and other additives to formulations of triamcinolone and methylprednisolone. Steroid-related adverse effects

are rare in the setting of epidural lysis of adhesions. Adverse effects of longer-term use of corticosteroids are discussed in Chapter 32. In a review of complications associated with epidural steroid injections, Abram and O'Connor [11] concluded that all reports of neurological sequelae following neuraxial steroid injections involved subarachnoid injections or attempted epidural injections in which subarachnoid placement could not be ruled out. These complications included arachnoiditis and aseptic meningitis. Increased susceptibility to epidural infection (epidural abscess) has also been associated with epidural steroid injection.

Radiographic Contrast

Before the advent of water-soluble agents, oil-based agents were used and produced numerous cases of arachnoiditis when administered intrathecally. Thereafter, ionic agents became widely used, but generalized seizures and a number of fatal outcomes were reported after injection of ionic contrast media with inadvertent spread from the epidural space to the subarachnoid space [12]. These observations have led to the near-universal use of non-ionic contrast agents for spinal injections of all types, the most common agent being iohexol. Common ionic agents that should be avoided in the epidural space are meglumine diatrizoate and sodium diatrizoate. Other frequently used ionic agents are diatrizoate, iothalamate, and metrizoate. Nonionic agents, such as iohexol, are the agents of choice for diagnostic myelography, and are safe and effective for both epidural and intrathecal use. The most common nonionic agents in clinical use include iohexol, iopamidol, and ioversol. The most common reactions to these are anaphylactoid, and there are some high-risk groups that should be recognized (e.g., those with previous contrast reactions). Less common are osmotoxic reactions, including acute renal failure, and rare are reactions such as arachnoiditis.

Local Anesthetics

We typically inject 10 mL of 0.25% bupivacaine or 0.2% ropivacaine during the procedure for lysis of epidural adhesions. Before doing so, fluoroscopic imaging with contrast injection is done to confirm epidural location of the catheter (not intravascular, subdural, substance, or subarachnoid). If a vein is entered, the catheter is moved to a different site. Intravenous injection of bupivacaine can lead to cardiac toxicity, but the use of contrast should detect intravascular injection before local anesthetic is administered. The small dose of local anesthetic used during this procedure is unlikely to produce cardiac toxicity even in the event it is all given intravascularly. A detailed description of the presentation of local anesthetic-related complications appears in Chapter 6.

COMPLICATIONS INDUCED BY FLUID INJECTION AND NEEDLE AND CATHETER PLACEMENT

Fluid Injection into a Confined Space: Barotrauma and Ischemia

Epidural scarring can lead to confined compartments within the epidural space. Injection of fluid into one of these compartments or into the subdural space can have the net effect of creating a space-occupying lesion that causes direct barotrauma to underlying tissue and/or blocks blood flow to the spinal cord or cauda equina—producing ischemic injury. The term *loculation* is used for this phenomenon. In 1997, Angelo Rocco et al. [13] elucidated the concept of compartmental filling in the diseased epidural space. They described the presence of epidural compartments that are sequentially filled during fluid injection. The fluid first fills one compartment, and depending on the pattern and degree of epidural scarring fluid then overflows into adjacent compartments.

Injection of hypertonic saline solution into a closed loculated compartment within the epidural space can produce direct trauma by pressing on adjacent neural structures. Hypertonic saline is hyperosmolar and will also cause fluid shifts that will further increase the volume and pressure within loculated compartments as osmosis draws fluid into the space. To reach equilibrium, the 10% sodium chloride must reach 0.9% sodium chloride, and in the process the volume expands 11 times over the injected volume. Normally, fluid placed within the lateral recesses of the epidural space flows freely through the neuroforamen to the paraspinal region outside the spinal canal. To avoid barotrauma, it is important to document free flow of contrast from the epidural space to prevent excess pressure buildup that may compress the nerves, the spinal cord, or the nerve roots through which blood supply is carried to the spinal cord. Severe neurologic sequelae ranging from temporary sensory or motor deficits to complete paraplegia can follow barotrauma. The manifestations are variable and are dependent on the exact structure or structures compromised. The only means of preventing such injury is by ensuring that any visible areas of loculation are opened during the lysis procedure in order to establish drainage during the lysis procedure, before hypertonic saline is administered.

Figure 30-3 illustrates the appearance of loculation in the cervical area of a patient and subsequent relief by additional fluid injection and movement of the patient's head. The patient had a prior C5-6, C6-7 cervical fusion for chronic neck pain following a whiplash-type injury. Subsequent to fusion, the patient was involved in another motor vehicle accident that caused hyperextension of the neck and developed left-sided severe facial pain. The patient had severe allodynia in the temporal area, the ear, and just in front of the ear spreading down toward the ramus of the mandible.

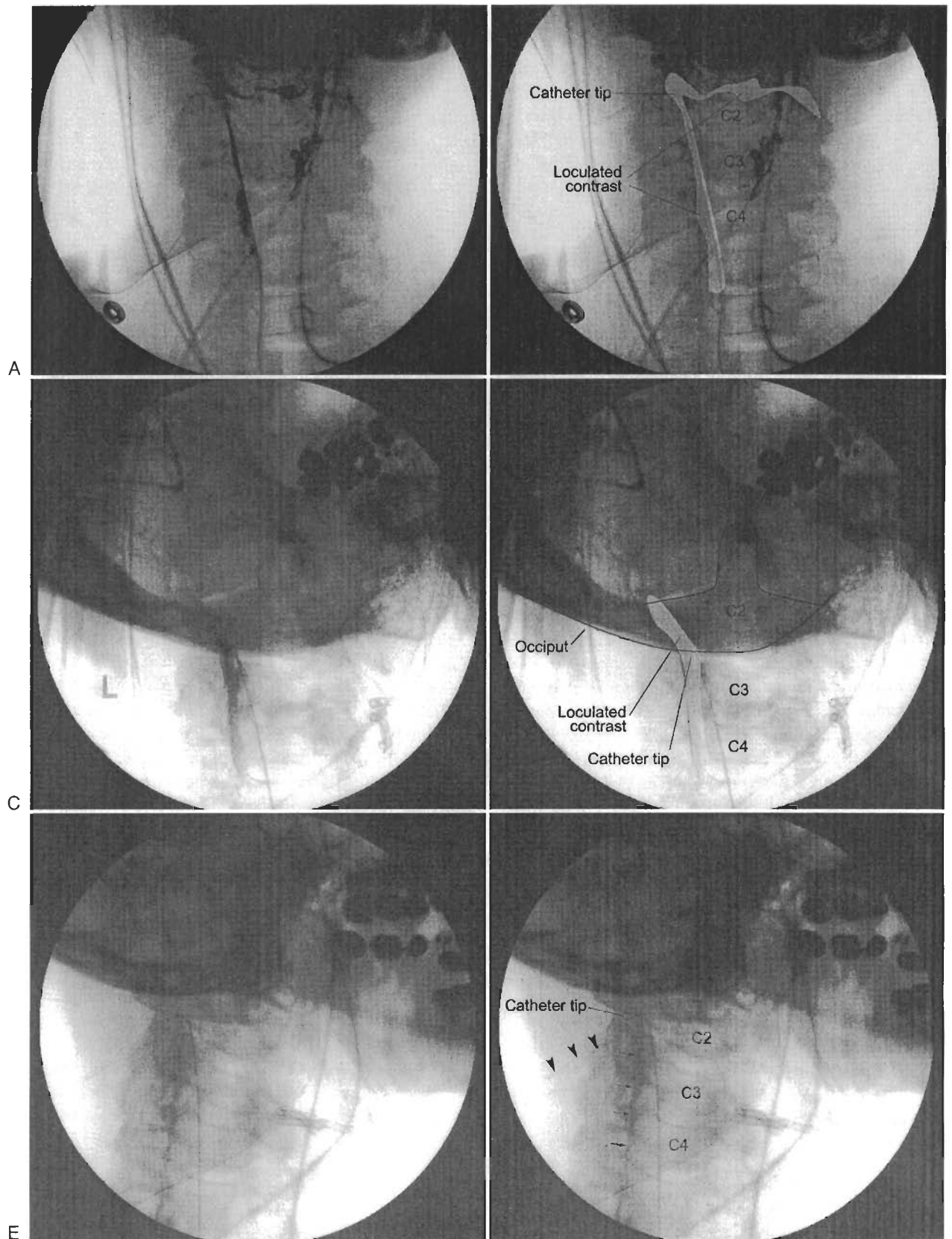


Figure 30-3 (A) Cervical AP radiograph of patient following contrast injection demonstrates restricted spread (loculation); (B) labeled image; (C) Following hyaluronidase and 0.9% saline injection and side-to-side head movement contrast can be seen entering the neural foramen; (D) labeled image; (E) Contrast runoff in the C2, 3, 4 area; (F) labeled image.

The differential diagnosis was atypical facial pain versus C3 radiculopathy, and the patient was scheduled for cervical epidural neurolysis. Contrast was injected and a Raciz Stim Cath (Epimed International, Johnstown, NY) was threaded through the left side of the C4 area laterally. Considerable difficulty was encountered in advancing the catheter. Following multiple attempts, there was a clear pop and the catheter could then be threaded cephalad to the C3 nerve root. Injected contrast remained primarily on the left side and tracked across to the right side at the C2-3 area (Figures 30-3A and B). The patient immediately reported bilateral arm and neck pain with the injection of only 2 mL of iohexol (240 mg/mL). The absence of lateral spread was recognized and hyaluronidase (1,500 U in 10 mL) was slowly injected through the catheter. The patient was asked to rotate the head left to right. During the slow injection, the contrast was suddenly seen to be displaced through the neuroforamina to the outside of the spinal canal, releasing pressure on the spinal cord (Figures 30-3C and D). The patient's pain rapidly subsided. Direct stimulation of the C3 nerve root reproduced the patient's pain, suggesting the diagnosis of posttraumatic C3 neuropathic pain. Toward the conclusion of the lysis procedure, the C2 through C4 area had clear runoff on fluoroscopy (Figure 30-3E). At this point, local anesthetic and steroids (0.2% ropivacaine containing 4 mg dexamethasone diluted in a total volume of 6 mL was injected in 1-mL increments to a total of 4 mL). The facial pain stopped and the catheter was fixed in place and connected to a bacterial filter. Thirty minutes later, 3 mL of 10% sodium chloride was infused with the patient in the left lateral dependent position. On the second day, the catheter was injected with 5 mL of 0.2% ropivacaine through the bacterial filter, followed by 4 mL of 10% sodium chloride. This was repeated the same day a second time, and the catheter was removed. At the time of discharge the facial pain was not present.

We have reviewed several cases of cord injury where the cervical injection (usually single shot) was followed by onset of pain, numbness, and motor block involving the ipsilateral lower extremity or both lower extremities with or without bladder dysfunction. It is our belief that movement of the head from side to side during the procedure causes the fluid, which is under pressure within an area of loculation, to open up to lateral runoff. This leads to reduction of the pressure on the spinal cord, the nerve roots, and their blood supply. We have developed this method over the past 20 years and it is used when loculation and pain is noted particularly during cervical lysis of adhesions. A small amount of contrast is used as a marker to be displaced by the lower-viscosity hyaluronidase solution. The pain reported by the patient is most likely related to ischemia caused by the pressure from the initial injection.

Suspected loculation of non contrast-containing fluids may be confirmed by injecting water soluble contrast into the suspected site. The injection expectedly will aggravate symptoms, but will allow documentation and drainage of the loculation.

Large-volume Epidural Injections

Uncontrolled injections of relatively large volumes of fluid into the epidural space can lead to retinal hemorrhage. There is no exact volume known to produce retinal hemorrhage, but volumes less than 65 ml are thought to be safe [14]. Our experience is that larger volumes (up to 100 ml) can be used safely if the injection rate is not rapid and flow from the epidural space (absence of loculation) is documented. The volumes used during the lysis procedure done with a catheter usually do not reach 65 ml. Lateral catheter placement where the fluid escapes from the spinal canal through the intervertebral foramen reduces the likelihood of a pressure increase and consequently minimizes the risk of retinal hemorrhage. If the catheter is in the midline or if it is within the subdural or subarachnoid space, injection of even modest volumes can result in a significant rise in CSF pressure and lead to retinal hemorrhage. We are not aware of any recorded cases of retinal hemorrhage following the catheter lysis procedure. However, 12 cases of visual impairment following epiduroscopy or epidural fluid injection have been reported [15]. The impairment was due to retinal hemorrhage characteristic of venous origin. Complete recovery of vision typically occurred over a period of days to months. There is no specific treatment for retinal hemorrhage unless there is extension of blood into the vitreous humor. In such cases, vitrectomy may help to restore vision.

Misplaced Catheters and Needles: Subdural, Intrathecal, and Intraneural Injection

The most common problem with the lysis procedure is unfamiliarity with the technique. Inexperienced practitioners often place the catheter in the midline for lysis of adhesions. In a prospective randomized study, Manchikanti et al. [16] showed that non-site-specific catheter placement is completely ineffective, as is single caudal epidural injection. In addition, the midline catheter is more likely to enter the subdural space (Figure 30-4). If the patient suffers from coexisting arachnoiditis, bowel and/or bladder dysfunction may result. Subdural contrast spread must be recognized before subsequent injection. Subdural injection of local anesthetic and steroid will result in motor block. Subdural injection of hypertonic saline can give rise to loss of bowel and bladder function [1]. The only means of preventing these devastating complications is through strict attention to detail: the catheter must be in the ventrolateral epidural space and should never be in the midline.

Subdural injections are usually recognized during the injection of radiographic contrast. Contrast spread in the subdural space produces a railroad-track-like pencil outline of the dura in anterior-posterior and lateral X-ray views. The contrast spread is extensive. If the cause is subdural catheter placement, the catheter most likely will be in the middle of the spinal canal on both anterior-posterior and lateral views.

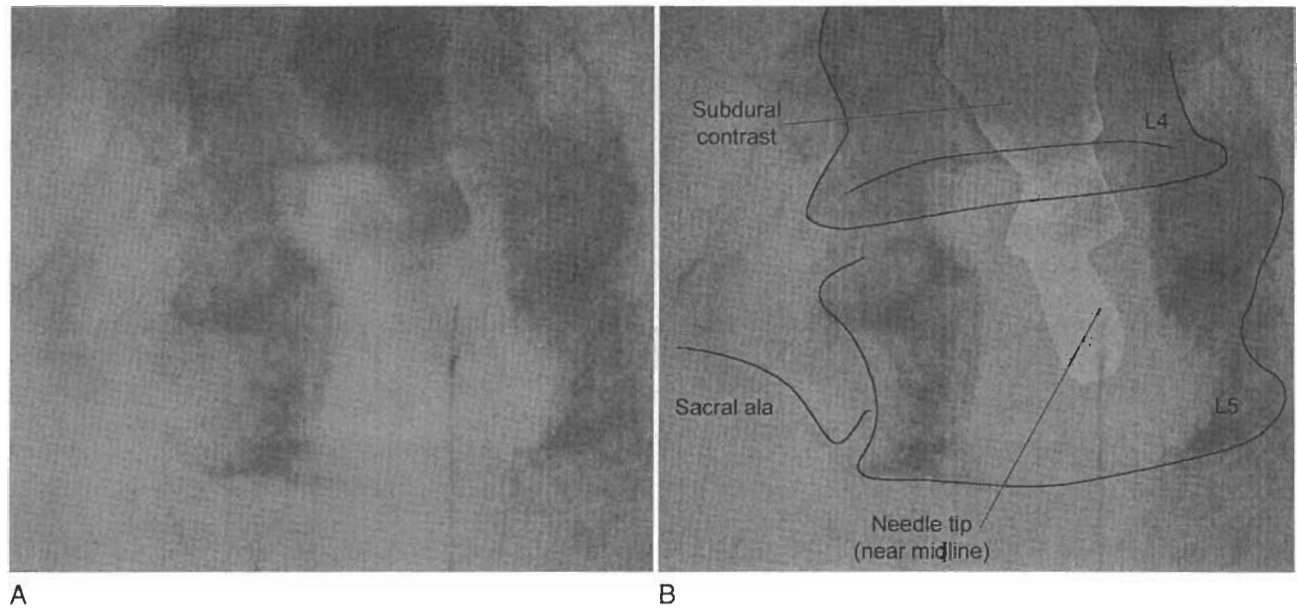


Figure 30-4 (A) Anteroposterior radiograph of the lumbar spine during epidural lysis of adhesions. This patient had previous laminectomy. The catheter is located in the midline, where penetration of the dura mater is more likely. Contrast is seen extending into the subdural compartment. (B) Labeled image

Subdural catheter placement is a particular hazard when using cutting needles such as the Husted, Tuohy, and R-K needles. The tip of the needle, although in the epidural space, can cut through the dura—producing a flap-like hole. When the catheter is inserted, it enters the subdural space through this opening. Threading of the catheter is remarkably easy, but it can be recognized to be subdural because the catheter cannot be directed to the target area, which is the lateral epidural space. On the lateral view, the catheter will be in the mid spinal canal, rather than either in a dorsal or ventral location typical of an epidural catheter position.

Subdural injection is not generally a problem if there is no resistance to dye spread within the subdural space. Restricted spread of fluid produces pressure that compresses blood supply traversing the subdural space toward the spinal cord. As a result, the cord becomes ischemic. Measures of preventing subdural injections include recognition of the characteristic contrast spread and use of small volumes of local anesthetic. Subarachnoid injections should be recognized, particularly if one always aspirates between injection and uses test doses of local anesthetics. Bupivacaine 0.25% or ropivacaine 0.2 % will give a significant sensory and motor block within a few minutes following injection.

Sheared Catheters

Avoidance of shearing catheters requires skill and the use of appropriate equipment, especially the appropriate epidural needle and catheter. In our training program with five pain fellows, we find that if fellows shear catheters they usually do so during the first four months of training. Usually the shearing is a consequence of using Husted, Touhy, or R-K needles. All are needles with a cutting edge (Figure 30-1), as

are the needles supplied with spinal cord stimulator implant kits. Using a needle that is too small also increases the risk of shearing.

Prevention of catheter shearing requires attention to the direction of the catheter and the direction of the needle tip. The direction of the catheter and the direction on the tip of the needle must be similar. If the direction of the catheter is different from the opening of the needle, the sharp edge of the needle will cut into the outer plastic coating of the spring wire or the plastic catheter if the catheter is withdrawn through the needle. The cut creates a fishhook-like defect in the catheter coating. As soon as one recognizes that the catheter is caught on the needle tip, the needle and catheter should be removed simultaneously. If difficulty in withdrawing a catheter is noted after the needle has been removed, a method proven successful for us is to wait a few minutes and then disengage the fishhook-like effect by pushing and twisting the catheter prior to pulling. The hole created by the needle is bigger than the catheter, and thus this push-and-twist motion often allows for easy removal of the catheter. If there is a hang-up, one should not forcibly pull the catheter, as this will cause separation of the catheter at the cut site. There are reports of placing an R-K needle over the catheter through the original puncture site and successfully removing the partially cut catheter.

As a part of the informed consent, we include a discussion that catheter shearing is a possibility, and in the event that we shear a catheter it will be surgically removed. The available literature focuses primarily on the fate of catheters sheared in the course of acute pain management (surgical labor and delivery) rather than chronic pain management. In the setting of acute pain treatment, most authors recommend [17] that sheared catheters be left in place, unless

the catheter's location is causing pain or radiculopathy. However, in our experience patients with chronic pain where a catheter is sheared often believe that the retained catheter piece is contributing to their ongoing pain. We are aware of several medico-legal filings arising when sheared catheters were left behind. Therefore, we arrange for surgical consultation and removal of sheared catheters. Individual practitioners need to make decisions about removal of sheared catheters on a case-by-case basis.

Both the Husted and Touhy needles have an oval-shaped opening (Figure 30-1). The tips of these needles are sharp, predisposing to cutting into the outer plastic wall of catheters. The RX-Coude needle (Epimed International, Johnstown, NY) has a wider tip, is not as sharp, and has the curvature further back on the shaft of the needle than the Husted and Touhy needles. This design allows directional assistance in guiding the catheter to the appropriate site. It is our opinion that the RX-Coude needle is far superior for directing the catheter and reducing shearing. Another option aimed at preventing catheter shearing is to use a Spinal Cord Access introducer (SCA, Custom Medical Concepts, Holden, MA), which has no potential to shear a catheter. The SCA introducer is constructed of a stiff plastic material and has a bend manufactured into the shaft to facilitate directing the catheter.

Other

Perineal numbness is probably one of the most common symptoms following the epidural lysis procedure performed via a caudal approach through the sacral hiatus. It is usually self-limited and is likely the consequence of neuropraxia produced by pressure from the needle and the catheter on the S5 nerve roots as they exit near the sacral hiatus. In rare instances, the sacral hiatus area may remain painful after the procedure. This may be due to neuroma formation and usually responds to injection of local anesthetics into the painful neuroma site. In rare instances, one of the S5 nerves may be cut by the needle tip and prolonged or permanent perineal numbness can occur. We have observed no hematomas and no loculation in the sacral canal. Fluid nearly always escapes through the S3 foramen, and usually by other routes into the pelvis.

INFECTION, HEMATOMA, AND OTHER COMPLICATIONS

Infection

The possibility of infection must be kept in mind anytime the epidural space is entered. Careful history must be taken to rule out purulent sinusitis, bladder infection, pneumonia, or periodontal infection. Any evidence of preexisting chronic infection puts the patient at risk, particularly if steroids are administered into the epidural space. Delayed overwhelming infection (sepsis) has been seen after epidural injection in

patients with preexisting chronic infection. This usually occurs on the 12th to 13th day and patients present with surprisingly few symptoms. Rarely, these patients may die from the multisystem complications that ensue. Epidural infection more typically presents with symptoms including increased pain, neck pain, headache, photophobia, numbness, or weakness. The signs are elevated temperature, meningismus, and some neural deficits. Abnormalities in the laboratory findings include elevated white blood counts, elevated erythrocyte sedimentation rate, and spinal fluid abnormalities. Epidural infections usually respond to antibiotic treatment administered for 5 to 10 days. (See Chapter 18 for a detailed discussion of epidural abscess.)

Our approach for preventing infection includes a systematic approach to placing the catheter. The patient is given intravenous prophylactic antibiotic before the procedure is begun. We insert the needle two inches distal to the sacral hiatus, one inch off midline so that a length of the catheter is tunneled through tissue. Prior to placement, the catheter is soaked in saline with 50 U/mL of bacitracin (50,000 U diluted in 1 L), and when steroid is administered through the catheter it is done in the operating room using full sterile precautions. Upon completion of the steroid injection, a bacterial filter is placed on the catheter. The bacterial filter is not removed during the remainder of the treatment, and no further steroids are administered. In the event the bacterial filter or the connector becomes disconnected, the catheter is removed. We apply antibiotic ointment at the puncture site. The site is covered by two split venous dressing gauze sponges surrounded by adhesive and covered by a transparent occlusive dressing. A pressure dressing is applied over the occlusive dressing and fixed with adhesive tape. Oral antibiotics are given for 5 days. With this approach, we have not seen a single infection necessitating surgical drainage.

Hematoma

The incidence of hematoma formation in the vertebral canal produced by the lysis procedure is rare. This may well be because high-pressure veins are converted to low-pressure veins by the lysis procedure, a concept discussed further in material following. Most of the bleeding is venous bleeding following placement of the catheter or needle. Preoperative assessment of the patient must include a careful drug history and evaluation of platelet function, as patients may take one or more of the numerous drugs that inhibit platelet function and interfere with normal coagulation. Prevention and management of epidural hematoma is discussed in detail in Chapter 18.

Harry Crock, world-renowned spine surgeon, documented that there are high-pressure veins in failed back surgery patients (personal communication). He suggested that these high-pressure veins are the consequence of occluded venous runoff through the neural foramina. He documented that by doing a single surgical foramenotomy he was able to convert the high-pressure veins to low-pressure veins and thus reduce

the likelihood of high-pressure venous bleeding. The phenomenon is analogous to deflating a tourniquet on an arm. Our experience is that the lysis procedure as we perform it is equivalent to a fluid foramenotomy. Evidence for this is secondary. We have done 5,000 to 6,000 lysis procedures in over 20 years, yet not a single epidural hematoma occurred where surgical intervention was necessary to drain the hematoma. Hematomas we are aware of are usually caused by single-needle epidural steroid injection via interlaminar epidural approaches, usually in failed back surgery patients.

Identifying High-risk Patients

Myelopathy may be produced by midline needle injection or midline or near-midline catheter placement and small-volume injections. The injected volume is insufficient to reach the lateral epidural space and open a neuroforamen. As a result, there is loculation with sustained pressure on the spinal cord.

Clinical examples of loculation come from personal experience, either in the clinical setting or in the medical-legal arena. The combined hazard of unrecognized or preexisting arachnoiditis in the presence of extensive epidural scarring in failed back patients with radiculopathy was reported in our first publication on epidural adhesiolysis. Because of extensive hardware, a pre-procedure MRI or CT scan was not done. The patient had severe pain and radiculopathy together with foot drop. The lysis of adhesions procedure was recommended. Contrast, local anesthetic (10 mL of 0.25% bupivacaine), and steroid were injected. Postprocedure motor block was noted in the recovery room. At this point, the procedure was abandoned and the motor block proceeded to recover. However, there was a permanent loss of bowel and bladder function. Unfortunately, the pain continued. A myelogram revealed severe arachnoiditis, likely a result of the previous multiple surgeries and diagnostic studies. Spinal opioid infusion was started and provided long-standing pain relief. This was reported to highlight the risk associated with doing epidural adhesiolysis in patients with arachnoiditis and epidural scarring. Unfortunately, this story has reoccurred a number of times in other physician practices with results of not only bowel and bladder function loss but also resulting in paraplegia. The best way to deal with this problem is to be highly aware of the danger of subdural spread in the presence of arachnoiditis. Both epidural scarring and arachnoiditis are particularly common in the patient who has one or more prior spinal surgeries. In such patients, even a single needle injection can produce permanent paralysis as the fluid dissects through a surgical scar into the subdural space and cuts off crucial circulation to the spinal cord.

Prolonged ischemia can be prevented by detecting loculation and moving volume away from the subdural space to the epidural space. The problem is rare and motor block typically resolves without intervention. The question remains: at

what point in time should the practitioner who recognizes that loculation of fluid within the subdural space has occurred either place multiple needle sticks to drain the loculated fluid or consider surgical intervention for decompression?

SUMMARY

Lysis of epidural adhesions for treating chronic low back pain is markedly effective on short-term follow-up and moderately effective on long-term (i.e., 12 months follow-up) demonstrated by prospective randomized studies [18]. There are numerous retrospective studies and clinical reports that demonstrate similar results. Prospective randomized studies showed that catheter placement, if it is not site specific, is ineffective. The technique is technically challenging and requires a significant learning period. Careful attention must be paid to the history and the examination of the patient. Practitioners must recognize the patient who has preexisting arachnoiditis and epidural scarring as at high risk for subdural spread that can lead to loculation and secondary ischemia of the cauda equina and the spinal cord. Loculation and the described concepts of fluid spread within the epidural space must be kept in mind at all times. The technique is effective, not only in the lumbar and sacral areas but in the thoracic and the cervical areas. The target site has to be site specific to the ventrolateral epidural space to have maximum efficacy. It is effective with radiculopathy, as well as with some of the back pain syndromes where the subarachnoid system is involved. It also is more effective in the treatment of spinal stenosis than are single-shot epidural steroid injections [8].

As a conservative estimate, the technique has been done in numerous centers worldwide over one and a half million times since the initial technique was reported. The incidence of complications is low. Infection and bleeding should be extremely rare. Shearing of catheters is uncommon among experienced practitioners and with improved needle and equipment design.

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