Complications of Selective Spinal Interventional Techniques

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Interventional pain management has evolved tremendously since the first described therapeutic nerve block performed by Tuffer in 1899.1-3 Interventional pain physicians have diverse training backgrounds and that factor, combined with significant recent increases in the utilization of interventional pain, diagnostic, and therapeutic blocks, increases the potential for complications.4 With the advent of interventional pain management as a recognized medical subspecialty, more formal and standardized interventional training will likely occur in the residency setting, serving not only to raise the standard but also reducing the likelihood of complications.

While the overall incidence of significant complications in interventional pain management is low, some catastrophic complications do occur. To help reduce these, it is important to be familiar with current pertinent literature, and to modify practice as necessary, but also to understand that many catastrophic complications are never published.

From the closed claims study5,6 it has been clear that malpractice claims have been increasing over the years, for minor and major complications, with roughly 20% of complications being disabling, 4% resulting in brain damage, and 5% ending in death.

The incidence of complications and their impact on patient outcomes can be lessened with improved technical expertise, better knowledge of the inherent risks of procedures, early recognition of these complications, better patient education with informed consent, and more attentive postoperative care.5,6

Patient Pertinent Issues

Prior to a neuraxial blockade, it is vital that a thorough history and physical examination be obtained for each patient, regardless of how the interventionalist’s practice is set up, or their patient referral pattern.

Past Medical History

This should include identification of any bleeding diathesis, immune suppressive disorder, history of allergies, anaphylaxis or asthma, and whether the patient has valvular heart disease.

Medications

It is important to note if the patient is taking oral steroids, antibiotics, anticoagulants, or Glucophage, as these will impact a patient’s outcome.

- Glucophage is generally considered safe in patients with normal renal function when a small amount of nonionic contrast is utilized during a procedure.
- Patients on Glucophage who also have impaired renal function have a risk of developing lactic acidosis when
undergoing procedures requiring larger amounts of contrast; Glucophage should be temporarily discontinued for such patients.

- Patients taking oral steroids will not only be immunosuppressed but also at increased risk of potential side effects from steroids.\(^\text{7}\)

- Anticoagulants and antiplatelet therapy may put patients at risk for hemorrhagic complications.

- Knowledge of prescription and over-the-counter medications, plus herbal remedies, are important to the process of risk stratifying patients.

- Neuraxial blocks on patients taking antibiotics for an active infection have the potential for bacteremia.

### Allergies

- Knowledge of patient allergies to medications such as steroids, local anesthetics, or antibiotics that may be used in a procedure will help reduce the chance of anaphylactic reaction.

  - If contrast is to be used, it is also important to document a patient's known allergy to shellfish.
  
  - Gadolinium may be used in iodine allergic patients, although there is a documented cross allergy to gadolinium.

  - In the case of a latex allergy, that patient's procedure needs to be scheduled as the first case of the day, in a latex-free environment.

### Review of Systems

A thorough review of systems should help rule out any occult coagulopathy, infection, cord compression, malignancy, or pregnancy.

### Physical Examination

- A general, but procedure-specific physical examination should be performed including pulmonary and cardiovascular assessment.

- A thorough neurological examination is important for the establishment of a baseline, especially in the event of an adverse neurological outcome.

- The potential for dislodging a mobile thrombus is real, so knowledge of a carotid bruit and results of a subsequent Doppler study are vital for patients undergoing procedures such as cervical discography in which the carotid artery may be penetrated.

### Imaging Study

- Interventional pain physicians should be to the spine what cardiologists are to the heart.

- Reviewing the imaging prior to procedure in all patients is important.\(^\text{5,6}\)

### The Nurse

Checklist for review:

1. **Allergies**: Nonmedication (shellfish, latex, iodine) and medication allergies.

2. **Pregnancy**: If fluoroscopy is being utilized, documentation for female patients should include the last menstrual period; if there is concern, a pregnancy test should be required.

3. **Anticoagulants**: Including herbal remedies and over-the-counter or prescription anticoagulation medications.

4. **Diabetes**: Knowledge of finger-stick blood glucose levels for diabetic patients is important as they may be hypoglycemic if fasting or at risk of hyperglycemic complications if steroid injection is planned.

5. **Fever**: Elective spinal injections should be postponed in a febrile patient, as the risk of infectious complication is increased.

6. **Fasting**: If conscious sedation is anticipated, knowledge of the last time a patient ate or drank is important.

7. **Side**: The side of the patient's symptoms should be marked with an 'X' to help reduce one of the more common preventable surgical errors.

### Surgical Preparation

- All syringes should be labeled and sterile precautions must be followed.

  - When practicing in a setting used by different specialists (i.e., a radiology suite at a hospital), it is especially important that the physician review all medications prior to each procedure.

- In patients with an iodine allergy, chlorhexidine gluconate and/or isopropyl alcohol may be used.

  - For more invasive procedures such as implant or discography, some practices utilize a triple scrub with isopropyl alcohol, chlorhexidine gluconate, and povidone-iodine.

  - While sterile towels are adequate for draping an area for most procedures, more invasive spinal procedures should use full-body draping with iodine impregnated fenestrated adhesive bio-drapes, sterile towels, and half-sheets.\(^\text{10}\)

### Patient Monitoring

- Appropriate perioperative monitoring is important for all procedures and should include IV access, pulse oximetry, cardiac monitoring with ECG tracing, blood pressure, and heart rate monitoring.

- A fully-stocked, regularly-updated crash cart should be easily accessible.

- Personnel trained in advanced cardiac life support should be available.
The postoperative patient recovery room should be staffed with trained personnel knowledgeable in recognizing post-procedural complications, including hypotension, vasovagal reactions, sensory motor blockade, excessive somnolence, respiratory suppression, and cardiovascular complications.

Patients will be in a monitored postoperative setting until discharge criteria are met—anywhere from 20 minutes to 8 hours postprocedure, depending upon the procedure and amount of sedation used.

- Discharge criteria must include that the patient is alert, oriented, and hemodynamically stable, has a stable cardiovascular and neurologic examination, is ambulating as well as expected, and has someone else to drive them home if they have had sedation.

**Physician**

- Physicians from numerous subspecialties have converged in the now recognized subspecialty of interventional pain management, all with varying levels of training and competence.
  - Until recently, standard interventional pain management training occurred in the fellowship setting but interventional pain management may soon have formal residency training programs.
  - There are still physicians performing interventional pain techniques who learned them during weekend courses.
  - While such courses are helpful, they are by no means sufficient.

- A thorough understanding of spinal anatomy and how that relates to fluoroscopic anatomy is vital.

- How an interventionalist deals with a complication is key to the outcome.
  - Physicians should anticipate potential complications for the procedure being performed.
  - Such anticipation allows for earlier recognition of a complication, a more prompt and appropriate response, and also helps minimize the effect of that complication.

- A physician should not be reluctant to reschedule a procedure if difficulties are encountered.
  - For example, if vascular uptake is noted while performing a cervical transforminal epidural steroid injection despite repositioning the needle multiple times in the foramen, the appropriate course of action may be to reschedule the patient or consider an interlaminar approach.

- Minimum experience levels required for various procedures are somewhat controversial.
  - Clearly the level of expertise required to perform an uncomplicated interlaminar lumbar epidural steroid injection on a healthy patient is far less than that required for a cervical transforminal epidural steroid injection.

- Cadaver courses may help develop some of these skills, but supervised training in the clinical setting is strongly advised.

- ABIPP and FIPP certifications provide documentation of competency.

**Equipment**

- The physician should be familiar with, and know how to operate, all equipment required for a given procedure.

**Needles**

- Three basic needle types (Fig. 1) are used in interventional pain practice:
  1. a ramped needle such as a Tuohy needle used for interlaminar epidural steroid injections;
  2. a pencil-tip needle originally developed to reduce the incidence of postdural puncture headaches in patients undergoing spinal anesthesia, but which is infrequently used in interventional pain procedures; and
  3. a Quincke or standard spinal needle, used for most common spinal injections.

- Understanding needle dynamics and bevel control is vital to precise needle placement. The direction of needle deviation is governed by the design of the needle tip (Fig. 1).

- Ramped needles (Tuohy) deviate away from the ramp.

- Pencil-tip needles (Sprotte or Whitacre) deviate a minimal amount, although not in a specific direction.

- Beveled needles (Spinal or Quincke) consistently deviate away from the bevel.

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**Fig. 1. Examples of needle types and deviation direction.** Top: Tuohy, ramped; used for interlaminar epidurals. Middle: Pencil-tip; utilized for spinal anesthesia and lumbar punctures. Bottom: Spinal/Quincke; used for most interventional procedures.
Experienced interventionalists usually accentuate this natural tendency of the beveled needle by placing a 15-degree curve proximal to the distal end of the needle.

The degree to which a needle deflects depends on the density and distance of the tissue traversed, and the needle type and gauge, with 25-gauge needles deflecting more than 22-gauge.11-14

Complications resulting from interventional pain procedures have raised safety issues concerning the use of blunt versus sharp needles.15,16

Some experts recommend blunt-tip needles rather than traditional sharp needles when performing transfemoral epidural steroid injections, with the hope of reducing catastrophic incidents of vascular penetration and anterior spinal cord infarction.

This may occur during thoracic or lumbar transfemoral injections with the inadvertent and unrecognized injection of medication into an artery, such as the radiculomedullary artery (Adamkiewicz).

It may also occur with penetration of a cervical radicular artery during cervical transfemoral epidural steroid injections.

In animal models, blunt needles were shown incapable of directly puncturing the renal artery or penetrating the spinal nerve, and are therefore felt by some to be safer.

Needle Placement

It is very important for the interventionalist to understand the concept of a 3-dimensional object, such as the spine, as it is projected in 2 dimensions on the fluoroscope. The principles of direction, depth, and direction are vital.

Medications

The interventionalist should be very familiar with all medications, including various steroid formulations that are deemed safe and appropriate for epidural use.7,17

Using a steroid with the smallest possible particle size may help reduce the potential for vascular thrombotic complications.

Compared to the particulate steroid solutions, Dexamethasone Sodium Phosphate has the smallest particles (smaller than red blood cells), the least tendency to aggregate, and the lowest density.18

These characteristics should reduce the risk of embolic or thrombotic infarcts from occurring following intravascular injection.

If compounded medications are used, be aware of the practices of your pharmacy, as United States pharmacopoeia guidelines should be followed.

In the U.S., numerous deaths resulting from meningitis, encephalitis, and septic shock have been linked to contaminated compounded betamethasone.

Contrast agents are used to accurately localize needle placement, to confirm there is no vascular uptake, and to delineate pertinent anatomy and appropriate contrast flow pattern.

Nonionic contrast agents are more hydrophilic, thus reducing subarachnoid and intravascular toxicity; they also have a lower osmolality and produce fewer adverse effects.

All epidural and intrathecal procedures should be performed with nonionic contrast agents such as Omnipaque and Isovue.

For iodine-allergic patients for whom contrast is required, the options are to use gadolinium, or to premedicate and use nonionic iodinated contrast.

Premedication should include a corticosteroid and antihistamine combination, such as prednisone, 50 mg by mouth, 13 hours, 7 hours, and 1 hour before injection, with diphenhydramine (Benadryl), 50 mg IV or by mouth, 1 hour prior to the injection.

Other experts also call for H2 blockers such as Zantac to be taken by the patient 1 hour before and following the injection.

If premedicating with steroid alone, methylprednisolone, 32 mg orally, 12 hours and 2 hours prior to the contrast agent is sufficient.19

The radiology community generally accepts that it is safe to administer gadopentetate dimeglumine in patients with a known allergy to an iodinated contrast agent.

In 1 study, however, 6.3% of iodine-allergic patients experienced an adverse reaction to gadopentetate dimeglumine, and therefore some degree of caution is still warranted.20

Knowledge is required as to the anesthetic type, whether it be an amino amide such as lidocaine or bupivacaine, or an amino ester such as 2-chloroprocaine; also required is knowledge of the usual concentration, onset, duration of action, and maximum single dosage.

Caution should be exercised not to exceed the maximum dose, something that could occur, especially with larger procedures such as spinal cord stimulation or multilevel bilateral radiofrequency medial branch neurolysis.

Toxic effects of anesthetics on the central nervous system include confusion, convulsions, respiratory arrest, seizures, and even death.

The patient should be monitored for signs of toxicity including restlessness, anxiety, incoherent speech, light-headedness, numbness and tingling of the mouth and lips, blurred vision, tremors, twitching, depression, or drowsiness.

Injections in the cervical spine require the utmost care, as even a small dose of local anesthetic injected intravascularly may result in significant systemic toxicity; deaths have been reported.21

Central nervous system toxicity by 1% Lidocaine has an onset at plasma concentrations of 5-10 mcg per mL which equates to slightly more than 400 mg (40 mL) of total bolus.
- Bupivacaine is about 4 times more toxic than lidocaine, with a toxic bolus of 100 mg (10 mL).
- All local anesthetics injected into the epidural space should be preservative free.

**Volume and Rate of Injection**

- There is some controversy as to the optimum volume for epidural injection.
  - In a young patient with no central or foraminal stenosis, large volumes of contrast can usually be injected safely without neurocompressive complications.
  - However, in the cervical spine of a patient with multi-level moderate to severe central and foraminal stenosis, where run-off is limited, compressive complications may occur with a volume as small as 3 mL, especially if it is injected quickly.
- Generally, target-specific epidural injections delivered transforaminally at the symptomatic level, or interlaminarily with a catheter advanced to the appropriate level, can be achieved with volumes of 2 or 3 mL.
  - High volume, rapid epidural steroid injection can result in large intraspinal pressure increases with accompanying risks of cerebral hemorrhage, retinal hemorrhage, visual disturbance, headache, and compromise of spinal cord blood flow.

**Fluoroscopy**

- Fluoroscopy should be used for all spinal injections, including discography, diagnostic intra-articular facet joint injections, diagnostic medial branch blocks, diagnostic sacroiliac joint injections, radiofrequency medial branch neurolysis, and all transforaminal epidural steroid injections.
  - Surprisingly, however, controversy still abounds over the need for fluoroscopy with interlaminar or caudal epidural steroid injections, despite the fact that without fluoroscopy, needle misplacement occurs 25% to 40% of the time with caudal injections, about 30% of the time with interlaminar lumbosacral epidural injections, and up to 53% of the time with cervical epidural steroid injections.
  - Federman et al. reported more than 50% of blind lumbosacral epidural steroid injections were performed at the wrong level.
- Also surprising are the results of a national survey of private and academic practices showing that for cervical interlaminar epidural steroid injections only 39% of academic practitioners utilize fluoroscopy, while 73% of private practitioners do so.
- There are multiple studies showing the unreliability of negative aspiration for vascular uptake and a high incidence of vascular penetration with transforaminal lumbar and cervi-

**Anticoagulation**

- Bleeding complications increase with poor technique, the presence of high procedure (cervical vs. lumbar), or patient-associated bleeding risk factors, and anticoagulation.
  - Many prescription or over-the-counter medications, and even herbal remedies such as garlic, ginkgo, ginseng and ginger, may impair coagulation.
  - Published guidelines define the risk of significant bleeding complications for neuraxial procedures in the presence of anticoagulation.
    - The incidence of spinal hematoma is rare; in fact, the published incidence is 1/150,000 to 1/190,000 for epidurals, and 1/220,000 for spinals.
    - While some controversy does exist, aspirin use may be viewed as a relative contraindication to spinal injections.
    - In general, ticlopidine should be held for 14 days, and clopidogrel should be held for 7 days prior to a neuraxial block.
    - Ideally, warfarin should be stopped 3 to 5 days prior to a neuraxial procedure and prior to proceeding, the international normalized ratio (INR) should be less than 1.3.
    - Prophylactic or therapeutic dose low molecular weight heparins (LMWHs) should be held at least 12 or 24 hours, respectively, before an epidural.
    - Understand, however, that there are newer, longer acting LMWHs that may need to be held longer.
  - Vitamin E and herbal medications like garlic, ginseng, ginger, and ginkgo may increase the patient’s risk of bleeding; consideration should be given to stopping them for 2 to 3 weeks, especially in the presence of other associated patient or procedure-related risk factors.

**Procedure Related Complications**

- For each procedure it is important to understand its indications, contraindications, and potential complications.
  - Prior to a procedure, this information should be verbalized to the patient in layman’s terms and informed consent obtained.
  - Ideally, consent should also be obtained prior to utilizing off-label, non-FDA approved medication.
Epidural Injections

- Absolute contraindications to epidural steroid injections include local or systemic infection, bleeding diathesis, or if the injection is being performed interlaminarily at that level, severe central spinal stenosis.
- Pregnancy is a contraindication if fluoroscopy must be used.
- The documented incidence of dural puncture ranges from 0.5% to 5% in the literature.\(^\text{44}\)
  - Potential complications of dural puncture include spinal headache, subdural hematoma, and potential for spinal anesthesia or neural injury.\(^\text{45-46}\)
    - Postdural puncture headache may follow dural puncture in up to 75% of cases.\(^\text{45}\)
    - Dural puncture brings the risk of subdural hematoma, which can be seen intracranially or spinaly.\(^\text{48,49}\)
- During an interlaminar epidural injection, if an inadvertent dural puncture occurs and is confirmed with injection of contrast and a myelogram, then without moving the needle, an intrathecal injection of 10 mL of preservative-free normal saline can significantly reduce the potential for postdural headache.\(^\text{46}\)
  - The interventionist may then move to another level, or perform the injection via a different route, such as transforaminal, but without local anesthetic because of the potential for spinal block.
- An epidural blood patch provides complete, almost instantaneous relief of spinal headache in up to 75% of patients.\(^\text{47}\)
- Many potentially serious causes of headache following epidural steroid injection include intracranial or subdural hematoma, epidural abscess, meningitis, pneumocephalus, and spinal headache from dural puncture.
- An epidural abscess, or a subdural or epidural hematoma resulting in spinal cord compression, needs to be recognized early, and surgical intervention is mandatory within 8 hours to avoid permanent neurological injury.\(^\text{50-54}\)
- Epidural abscess, bacterial meningitis, and aseptic meningitis have all been described.\(^\text{24,25}\)
- Pneumocephalus is diagnosed with CT scan, and the headache usually resolves as the air is absorbed over a period of 5 to 7 days.
- Other documented complications of interlaminar epidural injections include arachnoiditis, intrinsic spinal cord injury, spinal anesthesia, transient paralysis, arterial gas embolism, and transient blindness.\(^\text{33-38}\)
- Understanding the anatomy of the epidural space is important.
  - Triangular in shape, it is 1-2 mm in depth in the upper cervical spine, with a 3 mm depth in the lower cervical spine; this space increases to up to 5 mm in the upper thoracic spine, and has a 5-6 mm depth in the mid-lumbar spine (Fig. 2).
  - Thirty-four percent of the time, the ligamentum flavum is adherent to the dura above C5.\(^\text{8}\)
  - The ligamentum flavum has been proposed to be joined in the midline.\(^\text{59}\)
  - There appears to be a paired nature to the ligament having both a right and left portion.
  - Cryomicronee sectioning performed on the epidural space has shown that there is a variable degree of fusion of the ligamentum flavum in the midline.
  - The ligamentum flavum becomes thinner in the thoracic and cervical spine.
  - In fact, Lirk et al\(^\text{40}\) concluded that cervical and high thoracic ligamentum flavum frequently fail to fuse in the midline.
  - In a cadaveric study, the following variations were reported\(^\text{40}\):
    - The incidence of mid-line gaps at the following levels were: C3/C4 66%; C4/C5 58%; C5/C6 74%; C6/C7 64%; C7/T1 51%; T1/T2 21%; T2/T3 11%; T3/T4 4%; T4/T5 2%; and T5/T6 2%.
    - The mean with the mid-line gap in the study was 1.0 plus or minus 0.3 mm.

![Fig. 2. Ligamenta flavae (anterior aspect) in the lumbar region. Reproduced from Gray's Anatomy, 39th ed. Standring, ©2005, with permission from Elsevier.](image-url)
The needle entry point for cervical interlaminar epidural steroid injections should be at the C7/T1 level or below.
- The needle should engage the Ligamentum Flavum lateral to the midline but enter the epidural space as close to the midline as possible, where the depth is greatest.
- The needle should be anchored at the skin with the non-dominant hand and advanced with the dominant hand.
- When the epidural space is attained with the loss-of-resistance technique, a catheter should be threaded to the appropriate level. Contrast is then injected for an epidurogram to confirm the correct level and the absence of vascular uptake.8,61,62
  - One should minimize the volume injected to 2-3 mL and inject slowly.
- Prior to injection of medication, AP and lateral fluoroscopic views and lateral images should be taken to document unequivocal epidural spread of contrast.
- Contrast is injected preferably under live fluoroscopy to confirm no concomitant vascular uptake (Figs. 3, 4).

Fig. 3. AP fluoroscopic image of a cervical interlaminar epidural steroid injection with a catheter threaded to C6/7 in a patient with a left C7 radiculopathy. Note needle entry at T2/3.
Fig. 4. AP fluoroscopic image of a cervical interlaminar epidural steroid injection with a catheter threaded to C5/6 in a patient with a right C6 radiculopathy. Note needle entry at T1/2.

Sedation should be minimal because over-sedation causes loss of the monitoring tool of patient communication, it increases the potential for patient movement or a startle reflex, it increases the potential for cardiopulmonary complications, and is hard to defend if challenged later.
- This technique reduces the chance of dural puncture, spinal anesthesia, and spinal cord injury.
- Entering the midline where there are less epidural veins also reduces the potential risk of epidural hematoma.
- Transforaminal epidural steroid injections are believed safe, although the prevalence of complications remains under-reported.9
- Transforaminal approach complications are similar to those of interlaminar epidural steroid injections, with the addition of catastrophic anterior spinal cord syndrome which can follow inadvertent injection into the radiculomedullary artery (Adamkiewicz) in the lumbar
or thoracic spine, or the cervical radicular artery in the cervical spine (Fig. 5).  

- Locked-in syndrome, or brain stem infarct, may follow unrecognized vertebral artery injection during a cervical transforaminal injection (Figs. 6 and 7).

- In the thoracic and lumbar spine, 2 circumstances need to converge in order for anterior spinal cord syndrome to occur.
  - First, the radiculomedullary artery must be present at the symptomatic level and, second, there must be an undetected arterial penetration with subsequent injection.
  - The artery of Adamkiewicz usually arises on the left between T7 and L4, but may be as low lying as S1 on the left or right. It runs with the spinal nerve in the anterosuperior aspect of the foramen, and therefore may be inadvertently penetrated at this site.  

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**Fig. 5.** Vascular supply of spinal cord. Netter medical illustration used with permission of Elsevier. All rights reserved.

**Fig. 6.** AP fluoroscopic image of a right C5/6 transforaminal epidural steroid injection.

**Fig. 7.** AP fluoroscopic image of a right C5/6 transforaminal epidural steroid injection. Note that vascular uptake not seen on the previous image is apparent with contrast injection under live fluoroscopy.
Proposed theories for the occurrence of anterior spinal cord infarction include intravascular injection of particulate steroid that causes spasm or thrombosis and results in infarction because of the absence of collateral circulation.

In the cervical spine, the sole vascular supply to the anterior spinal cord comes from the anterior spinal artery, and the feeding radicular arteries are highly variable in number, location, and side. Similarly, the presence of a radicular artery at the symptomatic level, and undetected interarterial injection, can result in anterior spinal cord infarction and quadriplegia.  

Strategies to reduce the chance of this catastrophic complication include:
- understanding the fluoroscopic anatomy;
- understanding contrast flow patterns;
- optimizing interventional skills;
- using extension tubing and injection of contrast under live fluoroscopy to avoid the need to re cannulate the needle after contrast is injected;
- using digital subtraction imaging;
- using a nonparticulate steroid such as decadron;
- using blunt tip needles, although controversial, may lessen the likelihood of penetrating an artery; and
- needle placement in the posteroinferior aspect of the foramen (lumbar, thoracic) to avoid the artery of Adamkiewicz which runs with the spinal nerve in the anterosuperior aspect of the foramen.

**Trigger Point Injections**

- Trigger point injections are generally considered to be fairly straightforward; however, some catastrophic complications have been described in cases without fluoroscopy.
  - A closed claims study identified trigger point injections as the second most common cause of pneumothorax, ranking behind intercostal nerve blocks as responsible in 21% of cases.  
- Other documented complications include local infection, cellulitis, hematoma, epidural abscess, pneumothorax, spinal anesthesia, spinal cord injury, anaphylaxis, and death.
- Use of fluoroscopy for trigger point injections in the cervical or thoracic area will help reduce needle misplacement into the epidural, subdural, or subarachnoid space.
- The use of lateral fluoroscopic guidance for trigger point injections of any posterior thoracic wall musculature will document needle depth and prevent pneumothorax by remaining superficial to the ribs.  

**Zygapophysial Joint Injections / Medial Branch Blocks**

- In general, lumbar zygapophysial (facet) joint injection is a safe procedure, although complications similar to those of epidural steroid injections have been described, including infection with resulting cellulitis or epidural abcess (Fig. 8), epidural hematoma, intravascular injection, dural puncture, spinal anesthesia, spinal cord trauma, neural trauma, chemical meningitis, and pneumothorax.
  - Vertebral artery damage or injection is a potential risk with cervical facet joint injections.
  - Serious complications should not occur with the use of fluoroscopy and contrast injection in experienced hands.
  - In the cervical spine, a posterior parasagittal approach to the medial branch nerves or a posterior approach to the interarticular z-joint injection is safer than a lateral approach (Fig. 9).
    - A lateral approach brings the contents of the spinal canal potentially into the path of the needle, especially if the clinician is unable to eliminate parallax and get a true lateral fluoroscopic image.
    - The potential for going through and through a facet joint is real if needle depth is not checked frequently as the needle is advanced.
  - Ideally, under tunnel vision the periosteum of the adjacent articular process should be intentionally contacted to confirm depth prior to entering the joint and then the needle rotated into the joint.
  - This will help prevent the needle going through the joint to the adjacent tissue.

**Discography**

- Coagulopathy and active infection are general contraindications, but central spinal stenosis, myelopathy, and large disc protrusion are contraindications to cervical or thoracic discography.
- Potential and described complications pertinent to all 3 areas include superficial infection, epidural abscess, discitis, or nerve root injury.
- Potential for spinal cord injury exists in the cervical or thoracic spine.
  - Quadruplegia has been described following epidural hematoma, epidural abscess, and from subdural empyema.
  - It has also occurred secondary to cervical disc herniation from disc pressurization at discography.
  - Keeping the contrast volume in cervical or thoracic discography to a minimum is also important, with less than 0.5 mL per disc usually sufficient for cervical discography.
  - While infection is a real concern, the administration of preoperative intravenous antibiotics, intradiscal antibiotics, and a coaxial needle technique can help reduce the incidence of infection.
  - In a study of 220 patients, a coaxial needle technique has been shown to reduce the chance of discitis from 2.7% to 0.7%.  

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- Preoperative intravenous cefazolin has been shown to reduce the chance of disc infection from 1%-4% down to 0%.
- Utilizing cefazolin in a concentration of 1 mg per mL intradiscally resulted in no intradiscal infections in 127 patients.97,98
- Walters et al99 in an animal study showed that discitis was detected in all controlled animals.
- A single prophylactic 2-gram dose of cephazolin administered anytime over a 4-hour period prevented discitis in almost all animals but was not as effective in lambs.
- The lumbar discs are the largest avascular structures in the adult body, and passive diffusion is critical for the delivery of all molecules, including antibiotics to the central region.100
  - It has been reported that cephazolin penetrates the disc only when an adequate serum concentration (>20 mcg per mL) is maintained.101,102
  - However, other studies claim that cephazolin cannot penetrate the nucleus pulposus103 or any other component of the disc.104
- Prophylactic antibiotics commonly used do not prevent anaerobic discitis, which may occur with the anterior approach to cervical discography where esophageal penetration is possible. Utilizing a right anterolateral (oblique) approach reduces the chance for esophageal perforation and consequent potential anaerobic discitis.
- Because of the potential for the needle to traverse the carotid and dislodge unstable plaque, auscultation of the carotid artery should be performed and ultrasound ordered if carotid bruises are heard prior to discography when an oblique approach is utilized.
• Patients with discitis usually present with pain and fever 3 days to 2 weeks postdiscography.
• Erythrocyte sedimentation rate, white cell count, and C-reactive protein are usually positive within the first week.
• It may take anywhere from 2 to 5 weeks for a bone scan to become positive. MRI with or without Gadolinium is now considered to be the gold standard imaging study (Fig. 10).
• Many of the complications reported with lumbar discography were reported prior to 1970 with many of them in the 1950s.
• Today these complications should be minimal given the use of preoperative intravenous antibiotics and intradiscal antibiotics, plus a coaxial needle technique and an extrapedicular, extradural fluoroscopically-guided approach.168,169
• If a posterior transdural approach to a disc is planned, then it is important not to utilize intradiscal cefazolin because of the potential for intractable seizures caused by inadvertent intrathecal cefazolin injection.
• Therefore, when a posterior transdural approach is considered in a patient with previous posterosilateral intratransverse bony fusion mass, or if inadvertent dural puncture occurs with an extrapedicular, extradural approach to the disc, then contrast should be mixed with another antibiotic other than cefazolin, such as ceftriaxone, gentamicin, or clindamycin.167

![Fig. 10. T2 weighted MRI scan of lumbar spine demonstrating L4/5 discitis.](image)

• Pneumothorax has been described as a complication of thoracic discography, but could also occur with cervical discography at the C7/T1 level.

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**Key Points**

1. It is important to know the literature on current technical standards, to modify one’s practice accordingly, and understand that many complications are never published.

2. History and physical examination should be performed on all patients prior to spinal injections.

3. Physicians should review pertinent imaging studies, understand indications and contraindications of procedures, and obtain informed consent.

4. Knowledge of regional and fluoroscopic anatomy is important before attaining technical expertise in a supervised training environment.

5. Familiarity with all contrast flow patterns under live fluoroscopy is imperative.

6. Understand that complications are inevitable and it is imperative to identify and treat these problems promptly to minimize their impact when they occur, and to communicate with the patient concerning these issues.
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